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KEYNOTE ADDRESS

Plant Introduction in Development and Diversification of Indian Agriculture

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Major agricultural crops were domesticated over a period of thousands of years in different phyto-geographical regions of the world, known as centres of origin and diversity. The development of trade between different civilizations, led to the dispersal of plants of economic importance to other parts of the world contributing to evolution and diversification of agriculture. The process of free movement and exchange of plant genetic resources (PGR) and its utilization in breeding continued through various regimes leading to the development of modern agriculture that feeds more than 6 billion people in the world today. For these reasons, no country is self-sufficient in genetic resources and needs genetic resources from other countries to meet the challenges of crop improvement, responding to changing global agricultural scenario with regard to food and nutritional security and/ or agro-industrial development. The dependence of different countries on non-indigenous crops varies from 63 (e.g. India, West-central Asia) to 100 percent (eg. Australia).

India is one of the major centres of diversity for a large number of indigenous and introduced crops and has immensely benefited from the introduction of crops, high yielding varieties and sources of trait specific genes. In 1960s introduction of dwarfing genes, the Norin-10 and the Dee-gee-woo-gen in wheat and rice, respectively, for developing new plant architecture brought Green Revolution and provided self-sufficiency in food. Naturally occurring male sterility led to the exploitation of opportunities for harnessing hybrid vigour to increase production in many field and horticultural crops. As a result of recent plant introductions, soybean and sunflower became major field crops in India, while several new species, such as hops, simarouba, jojoba, guayule, kiwi, tree tomato, seabuckthorn, oil palm, rambutan, mangosteen and some others have been adopted by Indian farmers and consumers. Trait-specific introduction in a large number of crops such as oilseeds (groundnut, soybean, sunflower, brassica, oil palm), vegetables (potato, tomato, chilli, onion, cabbage, cauliflower, capsicum) and fruits (apple, pear, peach,

apricot, almond, walnut, plum) has been used for enhancing yield and other traits. Some examples of utilisation of exotic germplasm in resistance breeding are nematode resistant varieties, such as NRT 3, NRT 8 and NRT 12, using Nemalex, and H 86 and H 88 with resistance to early blight using *L. pimpinellifolium* and *L. hirsutum* respectively in tomato; bacterial wilt resistant varieties IIHR 110, IIHR 121-2 and IIHR 85 using Black Beauty in brinjal; downy mildew resistant variety, Phule Shubhangi using Poinsette in cucumber and black rot resistance variety Pusa Mukta using EC 24855 and EC 10109 in cabbage. The opportunities opened by the molecular biology for moving genes across sexual barriers during 1980s has further enhanced the interest in exchange and use of diverse genetic resources globally, including India.

National Bureau of Plant Genetic Resources, New Delhi, since its inception in 1976 has procured over 2 million accessions/ samples of diverse varieties, genetic stocks, breeding lines, wild relatives of crop plants from 113 countries and 8 International Agriculture Research Centres. A large number of these have been utilized in breeding programmes. A few varieties have been directly introduced to commercial cultivation in crops like wheat (Ridley, Lerma Rojo 64, Sonara 63 & 64); rice (IR 8, 20, 36 and 50); barley (BG105, 108 and DL70); oat (Kent and Rapida); sunflower (Peredovik, Armavirskii); soybean (Clark 63, Bragg and Lee); pea (Arkel, Bonneville, Early Badger and EC 33866); cowpea (EC 50000); French bean (Kentucky wonder, Contender, Jamapa); tomato (Sioux, La Bonita, Fire ball, Dwarf Money Maker and Molakai); onion (Pusa Ratnar and Early Grano); radish (China Red) and water melon (Asahi Yamoto, Sugar Baby).

However, the enforcement of Convention on Biological Diversity in 1993 and the new regimes of intellectual property rights (IPR) as per the provisions of Trade-Related Aspects of Intellectual Property Rights Agreement of 1995 and the International Treaty on Plant Genetic Resources for Food and Agriculture of 2004 have caused a major paradigm shift for exchange and

access to PGR. Whilst free-flow of germplasm has benefited agriculture for all countries, apprehensions about such unrestricted access have risen due to major advances in molecular biology, biotechnology and information technology along with the use of intellectual property regimes in these fields. Nevertheless, the search for new genes is an endless effort. In view of ever-changing world scenario, a country like India needs to have a balanced approach to harness the benefit of rich global agro-biodiversity through its technological

competence in the larger interest of the nation. Recognising this, concerted efforts are needed on introduction of trait and crop specific germplasm, such as better malting quality germplasm in barley, better wine quality germplasm in grapes, resistant root stocks in fruits, diverse and wild germplasm in oil palm and temperate fruits, and sources of resistance to biotic and abiotic stresses and genetic stocks with specific desirable traits in various agricultural and horticultural crops.

INVITED PAPERS

Plant Introduction and Rice Improvement for South Asia

Gurdev S Khush¹ and DS Brar²

¹ Former Principal Plant Breeder, International Rice Research Institute, Philippines

² Plant Breeder, International Rice Research Institute, Philippines

Rice is the single most important food crop and 90 percent of it is grown and consumed in Asia. During 1960s there were widespread concerns about the impending food crisis in Asia as rice yields were stagnant and population growth rates were accelerating. International Rice Research Institute (IRRI) was established in 1960 to apply science to problems of rice production. Germplasm conservation, evaluation and utilization received top priority from the beginning of the institute's research programmes.

Rice germplasm bank was established in 1961 through contacting national and international agencies in major rice producing countries. The international conferences held at IRRI and at Hyderabad, India in 1970 led the start of International Rice Collection and Evaluation Project (IRCEP). The outcome of these conferences was the agreement to coordinate and strengthen national efforts on field collection, evaluation and conservation on a systematic and international basis. By early 1980s the number of accessions in IRRI genebank rose to 49,027. The Assam Rice Collection from the Indian programme was a valuable addition to the IRRI genebank. Germplasm in IRRI genebank was continuously augmented and it has now 85,997 accessions of which 27,861 accessions are from South Asia. During 1980s IRRI undertook several exploration missions in Asia, Africa and Papua New Guinea to collect wild relatives of rice. IRRI genebank now contains 3,696 accessions of 21 wild species of

Oryza besides 1,333 accessions of African cultivated rice *O. glabberima*.

Systematic characterisation of rice germplasm for a range of morphological and agronomic traits including resistance/ tolerance to biotic/ abiotic stresses was undertaken at IRRI. Similarly, the wild species have also been characterised and evaluated. IRRI germplasm is freely accessible and no IPR protection applies to germplasm held in the genebank in trust. A Material Transfer Agreement is used for exchange of germplasm from the collection under which recipients must also certify that they will not apply IPR to the germplasm accessions. Major resources have been devoted to develop improved germplasm with high yield potential, superior grain quality, disease and insect resistance and abiotic stress tolerance. Many donors from South Asia have been utilized in the genetic enhancement programme. Major improvement in the genetic yield potential of rice occurred through reduction in plant height by incorporation of a gene of short nature. The improved varieties are lodging resistant and responsive to fertilizers and have maximum yield potential of 9-9.5 tons per ha. Photoperiod insensitivity was the other important trait inherited mainly from Indian variety TKM6 that contributed in increasing the adaptability and yield stability in new varieties developed at IRRI. These short duration varieties have led to increased cropping intensity.

In the wet and humid tropics, the rice plant is subject to attack by diseases such as blast, bacterial blight,

access to PGR. Whilst free-flow of germplasm has benefited agriculture for all countries, apprehensions about such unrestricted access have risen due to major advances in molecular biology, biotechnology and information technology along with the use of intellectual property regimes in these fields. Nevertheless, the search for new genes is an endless effort. In view of ever-changing world scenario, a country like India needs to have a balanced approach to harness the benefit of rich global agro-biodiversity through its technological

competence in the larger interest of the nation. Recognising this, concerted efforts are needed on introduction of trait and crop specific germplasm, such as better malting quality germplasm in barley, better wine quality germplasm in grapes, resistant root stocks in fruits, diverse and wild germplasm in oil palm and temperate fruits, and sources of resistance to biotic and abiotic stresses and genetic stocks with specific desirable traits in various agricultural and horticultural crops.

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In the wet and humid tropics, the rice plant is subject to attack by diseases such as blast, bacterial blight,

tungro and grassy stunt viruses. Several donor sources used in breeding programme resulted in development of breeding materials with multiple resistance. Many sources for disease resistance such as Ram Tulsi (India) for blast; TKM 6 (India), DZ 192 (Bangladesh) for bacterial blight; *O. nivara* (India) for grassy stunt, and Adday selection (India) and Habigang DW 8 (Bangladesh) for resistance to tungro came from Indian subcontinent. Similarly excellent sources of resistance to insect-pests like stem borers, plant hoppers, leafhoppers and gall midge have been identified and varieties with multiple resistance have been developed. Most of the sources of insect-pest resistance were from India, TKM 6 for striped borer resistance; Mudgo, MTU 15, ASD 7, Ptb 18 and Co 22 for brown planthopper resistance; Pankhari 203, ASD 7, ASD 8 and Ptb 8 for green hopper resistance, and Ptb 10, Ptb 18, Eswarakora and ARC 1368 for gall midge resistance. Several donors for brown plant hopper resistance such as Rathu Heenati and Babawee came from Sri Lanka. Improved germplasm with moderate level of tolerance to salinity has also been developed at IRRI using donors from India such as Pokkali, Getu and Nona Bokra, and some of the lines with salinity tolerance has been released in the Philippines. As most of the donors for disease and insect-pest resistance from India used in breeding programme had high amylose, the improved varieties developed at IRRI have high amylose and long slender and translucent grains. These varieties are highly acceptable in Indian subcontinent. There is considerable emphasis for developing improved germplasm with aroma. Basmati rices and Pankhari 203

from India are the main donors for this trait in the breeding programme at IRRI.

IRRI germplasm has been extensively shared with the national rice improvement programmes. Seeds of donor varieties, early generation breeding materials, fixed elite lines and named varieties are sent to national programme scientists at their request and through international nurseries. The breeding materials have been sent to 87 countries irrespective of geographical location or ideology. These were evaluated for local adaptation and subsequently released as varieties and also used as parents in national rice breeding programmes. More than 300 IRRI bred lines have been released as national varieties in Asia, Africa and Latin America. About 80 varieties have been released in Indian subcontinent alone. The gradual replacement of traditional varieties by improved ones has had a dramatic effect on the growth of rice output in Asia. Since 1966 when the first high yielding variety of rice was released, the rice area harvested has increased marginally, from 126 to 152 million hectares (20%), while the average rice yield has increased from 2.1 to 3.9 tons per ha. (86%). The total rice production increased from 257 million tons to 600 million tons (133%). The increase in per capita availability of rice and a decline in the cost of production per ton of output contributed to a decline in the real price of rice both in international and domestic markets. The decline in food prices has, therefore, benefited the urban poor and the rural landless, who are not directly involved in food production but who spend more than half their income on food grains.

Achievements and Opportunities of Plant Introduction in India— The Case of Wheat

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The wheat and wheat types originated in Middle Eastern region. Modern wheat types such as bread wheat and durum wheat are now grown worldwide on about 200 million hectare area with an annual production of 590 million metric tons. There has been continuous movement

and introduction of original landraces across the globe during the last 500 years. India's modern wheat breeding programme is based on large germplasm introductions from CIMMYT since early 1960s to date. A number of lines and sets of international trials have been

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continuously introduced and evaluated in India each year and the CIMMYT-derived wheat germplasm is now the core of Indian Wheat Research Programme. About 50,000 genotypes from CIMMYT have been evaluated in India so far and a set of elite germplasm has been created. The CIMMYT-based wheat germplasm introductions during 1960s led to the establishment of the modern Indian Wheat Programme coordinated by ICAR. The two green revolution wheat varieties with dwarf stature and input responsiveness, Kalyansona and Sonalika, bred in Mexico by Dr Norman E Borlaug and his colleagues, played the catalytic role to spark the changes in technology adoption with small farmers in the North-Western region of the Indo-Gangetic Plains. Within ten years India experienced a dramatic impact and the country reached self-sufficiency in wheat. Consequently, ICAR created a coordinating centre of wheat research in India, the Directorate of Wheat Research located at Karnal in the state of Haryana. CIMMYT has ever since remained a partner of ICAR and continues to serve as a reliable provider of tailor-made germplasm suitable for Indian farmers' needs. Through this partnership a large number of CIMMYT germplasm has been adopted and over 100 varieties released for variable Indian conditions. Some of these varieties namely, Kalyansona, Sonalika, C 306, WH 147, HD 2009, Lok 1, HD 2189, WL 711, UP 262, UP 2003, HUW 234, HD 2329, WH 542 and PBW 343 occupied a large acreage in India with varying longevities. PBW 343, a line with a complex blend of pedigree called "Atilla" in Mexico and released by Punjab Agricultural University in 1995, is till continuing as a most predominant wheat variety in India. This variety is grown in about 7 million hectares in India with a yield gain of 5 q/ha over the popular variety HD 2329. It is estimated that additional benefits to Indian farming community have been in the range of at least 500 million dollars per year due to this variety alone. Further, PBW 343 is a descendent of Veery # 5 and would also be a germplasm of paramount importance in the future wheat breeding to capture

stability and yield potential. The Indian Wheat Research Programme has also contributed in increasing wheat production in other parts of the world and many Indian wheat varieties have been released in other countries. India's wheat production statistics are very impressive. The overall yield has increased from 9.1 q/ha in 1965 to 27.5 q/ha in 2003. The area under wheat cultivation has been doubled from 1965 to 2003 with 6 times increase in production during the period. India now enjoys self-sufficiency in wheat but the projected statistics of 33.83 q/ha for 2020 is not that encouraging. According to International Food Policy Research Institute projection, India would still have to import 6,731,000 tons of wheat in 2020 which may cost about 1 billion dollars at current international price. To avert this situation the average national yield has to be increased to 36.24 q/ha in 2020 rather than 33.83 q/ha. To achieve this target, a cohesive science policy environment, suitable production incentives to farmers and appropriate financial support to regions where wheat productivity is still lagging is required. Future wheat yield gains would be made particularly in Eastern Gangetic Plains and Central Zone. The future wheat research priority in these zones include, maximizing yield potential and yield stability; removing disease susceptibility constraints; stabilizing high temperatures, drought and salinity tolerance through better adapted genotypes, and improving water use efficiency. To achieve maximum efficiency for these traits, a combination of both conventional breeding and biotechnological interventions, would be required. Germplasm from indigenous and exotic sources would be required. The indigenous germplasm has been tried with limited success. The alien species *Ae. squarrosa*- derivatives may be exploited for high temperature and drought tolerance. Yield stabilization in North Western Plain Zone is also important. We need to watch out evolution of rust pathotypes through monitoring within the country and other countries situated in Middle East, Central Asia, Nile Valley and East Africa which influence the epidemiological impact in India.

Introduction of Maize Germplasm in India: Utilization and Opportunities

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Maize (*Zea mays* L.) is an important cereal crop having significance as food, feed and industrial raw material. India harbours quite rich diversity in maize particularly in the North-eastern Himalayan region. Impressed by this diversity some workers have proposed Asiatic origin of maize. But indigenous diversity is very limited in comparison to that available in Mexico and South America, and it widely agreed that maize originated in Mexico about 9,000 years ago.

In mid-1940s, many varieties were introduced in to India and evaluated along with indigenous material. Among them Malan and Amarillo-de-Cuba deserve mention. In early 1950s, a number of commercial hybrids were introduced from the USA, Australia and other countries. Some hybrids from the US Cornbelt like US 13, Dixie 18, Texas 26, NC 27 and Illinois 1656 showed marked superiority over local varieties. These hybrids, however, could not create an impact due to their unattractive grain type, late maturity and problems associated with their seed production.

The Indian Council of Agricultural Research established All-India Coordinated Maize Improvement Project in 1957 to organize and integrate maize research at the national level. This project introduced a large number of germplasm from many countries particularly the USA, Mexico, Colombia, Peru, Venezuela and Caribbean islands. Inbreeding was undertaken in the promising introduced and indigenous germplasm which led to the development of many hybrids, the first set of which was released in 1961. The emphasis then shifted to open-pollinated varieties, and six composites were released in 1967. In late 1980s maize breeding programme was again reoriented with a focus on single cross and other simple hybrids and first single cross, Paras, was released in 1995.

Germplasm introduction got great importance with the establishment of CIMMYT, Mexico, in 1966. In addition to germplasm bank accessions, CIMMYT has been providing improved germplasm (pools, populations, inbred lines and experimental varieties and hybrids). Earlier CIMMYT worked on the development of open-pollinated varieties and the programme was reoriented towards hybrid breeding in 1980s; and this affected

the type of material supplied by CIMMYT. The CIMMYT maize germplasm has significantly enhanced genetic diversity of maize in India and has contributed to the development and release of several new maize cultivars.

Since 1961, 50 open-pedigree hybrids and 97 composites have been released for general cultivation. The cultivars that played a role in increasing the maize productivity in the country include hybrids Ganga Safed 2, Hi-starch, Ganga 5, Sartaj, Ganga 11, Deccan 103, Deccan 105, Paras and Parkash; and composites Vijay, Kisan, Ageti 76, Tarun, Parbhat, Navjot, Arun, Shweta, Navin, Pusa Composite 1, Parvati, Mahi Kanchan, Megha, Mahi Dhawal and Devaki. Almost all these have been developed by using exotic germplasm, the contribution of indigenous germplasm being only a little. There have been some outstanding introductions. Suwan 1, Pop 44 and [VC 80 x (ETO x Tuxpeno *br2*)] were directly released for commercial cultivation. In addition, Tuxpeno PB, Pop 35, Antigua Gr 1 and CM202 are other examples of extensive use in the breeding programme. During the initial years (1961-64), nine hybrids were released, the parents of which included CM202, which later on was used as a parent of other commercial hybrids; and CM104 and CM105, which showed durable resistance against leaf blights. These elite lines and germplasm like Suwan 1 and Antigua Gr1 could not be utilized much in inbred line development.

With an emphasis the reorientation towards the breeding of single-cross hybrids, constitution and improvement of heterotic pools got emphasis. Indian maize programme has developed eight pairs of heterotic pools. Three of them have been developed by Punjab Agricultural University (PAU), Ludhiana. Of these, Makki Safed & Tuxpeno and Indigenous & Semi-exotic, adapted to rainy season, have full-season and early maturity, respectively. Exotic germplasm have largely contributed in the constitution of Makki Safed and Semi-exotic pools, and Tuxpeno is entirely based on introduced germplasm. The third pair, which is adapted to winter season, has almost all germplasm of exotic origin mainly US Cornbelt. The important germplasm which have been used to develop and improve various pools are: Arun, Ageti 76, Navjot, Partap, Tarun, Vijay, CM111, CM123,

CM202, CM205, CM206, A670, B57, B73, B79, B84, BS13, FR13A, FR619, FR632, FR670, FRVa26, H96, H98, H99, H100, H101, Mo17, MSP1, Tuxpeno, Suwan 1 and Populations 24, 26, 31 and 36. Commercial hybrids like Paras, Parkash, JH3459, Sheetal and Buland have been developed using the inbred lines derived from these heterotic pools.

The efforts on introduction of maize germplasm have been focused on CIMMYT. Other sources need to be tapped, such as heterotic pools developed in other parts of the world; physiologically efficient, input responsive, high plant density and inbreeding stress tolerant germplasm in the US Cornbelt and Europe; high oil and protein germplasm in the USA; high protein and cold tolerant germplasm in Germany; cold tolerant germplasm in Canada, northern Europe and New Zealand; downy mildew resistant germplasm in South-east Asia besides known genetic stocks having genes for nutritional, stress resistance/tolerance and other traits. Trait specific germplasm developed by CIMMYT, such as resistance/tolerance to downy mildews, maize streak virus, drought, acid-soils and other abiotic stresses needs more rigorous efforts on introduction and utilization. Further, germplasm adapted to Indian agro-climatic conditions have been obtained in abundance from CIMMYT, which should not be expected in case of germplasm introduced from other sources. Many times exotic germplasm would be required to be subjected to adaptive mass selection,

and early generation recycling would need to be incorporated in inbreeding. The utilization of exotic germplasm has to be a stepwise approach.

The germplasm from different geographical areas have different useful traits. For example, the tropical germplasm are tall, late and large biomass producers. Therefore, these are good for fodder maize. The US Corn Belt germplasm have high harvest index, standability, responsiveness to inputs and tolerance to high plant density (relatively light canopy and erect leaves). Highland germplasm have cold tolerance, rapid seedling emergence, long roots, purple pigmentation on stem and leaf, and pubescent leaf. In India major germplasm introduction has been of tropical and sub-tropical germplasm whereas temperate germplasm did not get required focus. The genetic base of specialty maize (quality protein, high oil, special starch types, sweet corn, pop corn etc.) and fodder maize germplasm available with Indian maize breeders is very narrow which needs to be urgently widened. Introduction of germplasm of teosinte and *Tripsacum*, particularly that of the former, is also required. The importance of maize as feed and industrial crop is bound to increase. Maize cultivation during winter may expand with expected climate change. To meet these challenges, an increased need for expanding genetic base of maize in India is foreseen, for which highly diverse germplasm would have to be introduced, evaluated, adapted and utilized.

Sorghum and Millets Introduction: Achievements and Opportunities in India

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The origin and domestication of *Sorghum bicolor* (L.) Moench has taken place in Africa about 5000–8000 years ago. Indian subcontinent is the secondary centre of origin of Sorghum. The evidence for its cultivation was discovered at Saurashtra dating back to about 4500 years. Sorghum was probably brought to India from eastern Africa during the first millennium BC. It is reported to have existed there around 1000 BC. The sorghums of India are related to those of northeastern

Africa and the coast between Cape Guardafui and Mozambique. *Pennisetum glaucum* (L.) R.Br. is important millet in India, second to sorghum. It is considered to have been introduced to India from Africa. A large number of related species are found wild in Africa. The small millets indigenous to India are little millet (*Panicum sumentranse* Roth), kodo millet (*Paspalum scrobiculatum* L.) and Indian barnyard millet (*Echinochloa frumentacea* Link). On the contrary, three other small

CM202, CM205, CM206, A670, B57, B73, B79, B84, BS13, FR13A, FR619, FR632, FR670, FRVa26, H96, H98, H99, H100, H101, Mo17, MSP1, Tuxpeno, Suwan 1 and Populations 24, 26, 31 and 36. Commercial hybrids like Paras, Parkash, JH3459, Sheetal and Buland have been developed using the inbred lines derived from these heterotic pools.

The efforts on introduction of maize germplasm have been focused on CIMMYT. Other sources need to be tapped, such as heterotic pools developed in other parts of the world; physiologically efficient, input responsive, high plant density and inbreeding stress tolerant germplasm in the US Cornbelt and Europe; high oil and protein germplasm in the USA; high protein and cold tolerant germplasm in Germany; cold tolerant germplasm in Canada, northern Europe and New Zealand; downy mildew resistant germplasm in South-east Asia besides known genetic stocks having genes for nutritional, stress resistance/tolerance and other traits. Trait specific germplasm developed by CIMMYT, such as resistance/tolerance to downy mildews, maize streak virus, drought, acid-soils and other abiotic stresses needs more rigorous efforts on introduction and utilization. Further, germplasm adapted to Indian agro-climatic conditions have been obtained in abundance from CIMMYT, which should not be expected in case of germplasm introduced from other sources. Many times exotic germplasm would be required to be subjected to adaptive mass selection,

and early generation recycling would need to be incorporated in inbreeding. The utilization of exotic germplasm has to be a stepwise approach.

The germplasm from different geographical areas have different useful traits. For example, the tropical germplasm are tall, late and large biomass producers. Therefore, these are good for fodder maize. The US Corn Belt germplasm have high harvest index, standability, responsiveness to inputs and tolerance to high plant density (relatively light canopy and erect leaves). Highland germplasm have cold tolerance, rapid seedling emergence, long roots, purple pigmentation on stem and leaf, and pubescent leaf. In India major germplasm introduction has been of tropical and sub-tropical germplasm whereas temperate germplasm did not get required focus. The genetic base of specialty maize (quality protein, high oil, special starch types, sweet corn, pop corn etc.) and fodder maize germplasm available with Indian maize breeders is very narrow which needs to be urgently widened. Introduction of germplasm of teosinte and *Tripsacum*, particularly that of the former, is also required. The importance of maize as feed and industrial crop is bound to increase. Maize cultivation during winter may expand with expected climate change. To meet these challenges, an increased need for expanding genetic base of maize in India is foreseen, for which highly diverse germplasm would have to be introduced, evaluated, adapted and utilized.

Sorghum and Millets Introduction: Achievements and Opportunities in India

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The origin and domestication of *Sorghum bicolor* (L.) Moench has taken place in Africa about 5000–8000 years ago. Indian subcontinent is the secondary centre of origin of Sorghum. The evidence for its cultivation was discovered at Saurashtra dating back to about 4500 years. Sorghum was probably brought to India from eastern Africa during the first millennium BC. It is reported to have existed there around 1000 BC. The sorghums of India are related to those of northeastern

Africa and the coast between Cape Guardafui and Mozambique. *Pennisetum glaucum* (L.) R.Br. is important millet in India, second to sorghum. It is considered to have been introduced to India from Africa. A large number of related species are found wild in Africa. The small millets indigenous to India are little millet (*Panicum sumentranse* Roth), kodo millet (*Paspalum scrobiculatum* L.) and Indian barnyard millet (*Echinochloa frumentacea* Link). On the contrary, three other small

millets viz., finger millet (*Eleusine coracana* (L.) Gaertn), foxtail millet (*Setaria italica* (L.) P. Beauv) and common/proso millet (*Panicum miliaceum* L.) have originated elsewhere but reached India long ago. Finger millet originated in highlands of Africa and foxtail and common millet in Eurasia. The long history of cultivation of these three introduced crop species accompanied with human selection has resulted in generation of large variability especially in finger millet, giving India, a status of secondary centre of diversity.

The first major effort in the assembly of a World Collection of sorghum germplasm was in the 1960s by the Rockefeller Foundation's Agricultural Research Programme in India. A total of 22,701 exotic germplasm have been introduced into India from different countries of the world for various sources of important traits. The major contribution is from the Ethiopia, Sudan, Nigeria, Uganda, Zimbabwe, Cameroon, and USA. Ethiopia, Uganda, and Sudan in East Africa, Nigeria, Mali, and Burkina Faso (Upper Volta) in West Africa are the best sources of alleles for several agronomic attributes. Resistance to several diseases is found in the *conspicuum* of Nigeria. Alleles for high productivity with prospects for increased yield due to nodal tillering appear to be in combinations of *caudatum*, *durra*, and *caffrorums* from both West and East African regions. The Ethiopian *durras* are an excellent source for the staygreen (non-senescence) trait related to post-flowering drought tolerance trait. There are several examples of pearl millet introductions that have proved to be of direct commercial significance. The introduction of cytoplasmic-nuclear male-sterile line (Tift 23A) from the Coastal Plain Experiment Station, Tifton, Georgia, USA, which led to the development and release in India of the first commercial hybrid HB 1 is a landmark in direct commercial utilization of an introduction. Finger millet is presumed to have been introduced first to peninsular India at least 5000 years ago. The antiquity of foxtail millet cultivation although not very clear might have come from China and cultivation gradually extended to different parts of Indian sub-continent. The proso millet, which originated in Manchuria was possibly introduced from China, first to Himalayas and gradually spread to other parts of the country.

In sorghum, the introduction and collection of germplasm from other countries was being done through ICRISAT and Rockefeller Foundations in the past. NRCS has introduced 426 accessions from six countries since

2002. The materials are of forage lines (cold tolerant), varieties, popular landraces, and sweet sorghum. It has already evaluated 380 accessions, 18 accessions in the field, 2 accessions to be evaluated and 26 accessions are in the quarantine. Sorghum varietal improvement was achieved by introducing temperate and tropical material. First variety, CSV 1 is a direct introduction of American line IS 3924. By crossing temperate and tropical germplasm, subsequent varieties CSV 2 and CSV 3 were developed. CSV 4, which was used as restorer of three most popular hybrids, CSH 5, CSH 6 and CSH 9, became a very popular variety. The variety is a converted line of an African germplasm line IS 3541, and developed by crossing it with a USA germplasm line, IS 3675. CSV 5, another variety developed from Indian local and US line IS 3687. It has striga resistance. CSV 10, next variety, which became popular for high fodder value was developed from a cross between American elite variety SC 108 and Indian elite variety CS 3541. Another variety which became very popular, SPV 462, (from Coimbatore) developed from multiple cross involving IS 2947 and IS 3687 from USA and IS 1151 and BP 53, locals of Maharashtra and Gujarat in India, respectively. The variety is high yielding for grain and fodder with good grain quality. CSV 13, yet another variety developed from multiple cross having exotic and local genetic base is high grain yielding with medium height. The source for multiple resistance to shoot fly and stem borer are IS 18577, IS 18554 (Nigeria), IS 2312 (the Sudan), IS 18551 (Ethiopia), IS 2122, IS 2134 and IS 2146 (USA).

In pearl millet, an early maturing male-sterile line AKM 2068, developed at Fort Hays Branch Station, Kansas, USA was introduced by ICRISAT in India and distributed as 843A (ICMA 2). Haryana Agricultural University (HAU) succeeded in developing and releasing an extra early maturing hybrid (HHB 67) based on this male sterile line that matures in 60-62 days and is now quite popular with farmers in parts of Haryana and Rajasthan. Similarly, AKM 2021, developed at Fort Hays, was introduced by ICRISAT in India and distributed as 842A (ICMA 3). HAU used this male sterile line to breed an early maturing hybrid (HHB 68) that was released in 1993.

The World Composite, constituted and initially improved for productivity and downy mildew resistance at the Ahmadu Bello University, Samaru, Nigeria was introduced by ICRISAT in India. Evaluation of full-

sib progenies from this composite led to the identification of seven promising progenies in a trial at Coimbatore in Tamil Nadu, which were recombined to develop a promising open-pollinated variety WCC 75. This variety was released in 1982 for cultivation in India. A Smut Resistant Composite, based on smut resistant lines selected from the germplasm from western Africa, was constructed at the ICRISAT. An early maturing and large seeded open-pollinated variety, ICTP 8203 was developed by recombining five S2 progenies derived from a landrace from northern Togo. It was released in 1988 for cultivation in Maharashtra and Andhra Pradesh.

The utilization of introduced materials in hybridization programmes has greatly contributed in pearl millet improvement. An outcross of a local strain of Punjab with an African introduction possessing long bristles resulted in the development of an open-pollinated variety S 530 and was released in Punjab. The parents of a promising open-pollinated variety (ICMS 7703), developed at the ICRISAT and released in India in 1985, were derived from crosses involving germplasm from western Africa. Another promising open-pollinated variety ICMV 84400, developed at ICRISAT found to be superior to WCC 75 for both grain and forage yields was developed from the New Elite Composite. This composite derives a great deal of its genetic base from the germplasm from western Africa. A vast array of germplasm from western Africa, the primary centre of genetic diversity for pearl millet has been introduced to India for genetic and cytoplasmic diversification of pearl millet breeding materials. These introductions have provided useful sources of genes for disease resistance, large seed size, dwarfing genes, high panicle volume and cytoplasmic nuclear male sterility and numerous other characters.

In small millets, there are no examples of successful introduction of varieties for direct cultivation in India in any of the small millets. However, introduction of

germplasm and selection has contributed a great deal towards development of varieties with superior performance. African finger millet cultivars have been used extensively as donors for improving the Indian varieties. Indo – African crosses were first attempted in early seventies with the identification of donor parents viz., IE 927, IE 929, IE 980-R, IE 910, IE 902, IE 882 and IE 1012 which resulted in the development and release of many popular varieties. The African germplasm has been good source of useful genes for disease resistance, large ear size, higher test weight and grain density besides plant robustness which are lacking in indigenous cultivars.

Finger millet germplasm conserved in the country includes collections from Sri Lanka, Japan, Kenya, Uganda, Malawi, Tanzania and Zambia. The foxtail millet and proso millet collections include materials from Afghanistan, USSR and Turkey. Two varieties in proso millet-GPUP 8 and GPUP 21 were developed from Indo-Eurasian crosses. Three exotic collections of barnyard millet-PRB 9402, PRB 9403 and PRB 9404 have shown very high degree acclimatization and superior performance in Himalayan region.

In sorghum, germplasm with high yielding, sweet-stalk, specific qualities groups and resistant to biotic and abiotic are important traits that need to be introduced from other countries in future. Search for the resistant gene for shootfly and stemborer and new sweet sorghum lines for industrial uses are very important. The photosensitive lines, core collections, wild and weedy relatives are to be evaluated and maintained.

In small millets, the opportunities are to use the introductions as donors in the hybridization programmes. The exotic collections from Africa, Middle East, and South East Asia are poorly represents in the national collections and efforts are needed to introduce germplasm from the centres of origin.

Role of Plant Introductions in Varietal Development of Pulses in India

Masood Ali, Sanjeev Gupta, BB Singh and Shiv Kumar

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Plant Introduction is the oldest and simplest method of breeding as well as an effective mean to overcome the narrow genetic diversity observed in certain parts of the world. Over a period of time several promising introductions in pulses were made in India from different countries. A total of 11 exotics of chickpea, 2 of pigeonpea, 10 of mungbean, two of lentil, three of Rajmash and three of fieldpea have contributed in the development of 51 cultivars of different pulse crops released in India. Chickpea variety, Pragati, was the outcome of the direct introduction of Cyprus local. Besides, 16 cultivars of chickpea released in India have been developed through utilization of exotic germplasm as an immediate parent in their pedigrees. Some of these varieties are Pusa 261, Pusa 244, Pusa 267, C 104, L 550, L 144, BG 1003, BG 1053, Phule G 12, BG 391, Gaurav and BGD 72. Pigeonpea cultivar, Hy 3C was a secondary selection from exotic line PI 2817-2. Another exotic line Brazil 1-1 has been used as a source of earliness in pigeonpea, which, in combination with NPWR 15, NP 41 and NP 69, has led to the development of early maturing varieties Mukta, Sharad and Pusa Ageti. Promising introductions were extensively utilized in the development of at least seventeen popular cultivars in mungbean. Pusa Vishal, a selection from

AVRDC accession NM 2, released for NWPZ has been becoming popular because of its large seed size (6 g/100 seed weight). Selections made from exotic material introduced from China and Iran have led to the development of Shining Moong 1 and PS 16, respectively. These selections were widely used in crossing programme and subsequently few superior cultivars such as KM 1, Sunaina and RMG 62 were released. Introduction of an early, rust resistant macrosperma line, Precoz, from Argentina has accelerated microsperma x macrosperma crosses in lentil resulting in the development of NDL 1 and DPL 58. Rajmash cultivar Uday was selected from exotic germplasm, EC 94453 introduced from Bulgaria, while Amber and Utkarsh were selected from Columbian accessions, ET 8447 and EC 400431, respectively. The pea variety, Hans was a mutant of L 116, an exotic accession from Sweden, and Harbhajan was a selection from exotic line, EC 33866. Exotic pea accessions for useful traits viz., resistant to pea mosaic virus (EC 271572), resistant to powdery mildew (EC 322745 and EC 381853), tolerant to drought (EC 389374) are yet to be exploited in pea improvement programme. Access to unique and potential valuable germplasm is key to sustained pulse improvement programme.

Plant Introductions in Soybean-Achievements and Opportunities

SP Tiwari

Assistant Director General (Seed), Indian Council of Agricultural Research, Krishi Bhawan, New Delhi-110 001

Soybean presently covers about 7 million hectares in the country and significantly contributes towards agrarian economy and farm-prosperity. Although soybean has originated in China, the north-eastern region of the Indian sub-continent has a degree of endemic variability. The earlier soybean introductions have been owing to propinquity of these areas with China. Early varieties like Punjab White/ Punjab-1 and a host of strains grouped under Bhat/ Bhatmash/ Kali Tur are also part of this

endemic variability. These have saved the Indian soybean variability from the founder-effect as, later, most of the yellow-seeded varieties and strains of soybean in India have been introduced via USA. Several important genes such as those for resistance to yellow mosaic virus and other diseases, nutritional characteristics, photosensitivity, long-juvenility etc. have been introduced in India, mainly from USA followed by Taiwan, Brazil and other countries. Of late, a sizable number of black-

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endemic variability. These have saved the Indian soybean variability from the founder-effect as, later, most of the yellow-seeded varieties and strains of soybean in India have been introduced via USA. Several important genes such as those for resistance to yellow mosaic virus and other diseases, nutritional characteristics, photosensitivity, long-juvenility etc. have been introduced in India, mainly from USA followed by Taiwan, Brazil and other countries. Of late, a sizable number of black-

seeded soybean varieties of Indian provenance have been repatriated from USDA, USA. The introductions particularly for specific genes of interest have helped in bringing about a renaissance of this ancient crop of northern India into a commercial crop of the country.

Opportunities exist to further have directed-introduction for several traits and genes of interest which were hitherto unimportant but are presently assuming significant such as those for food and nutritional quality, lack of anti-nutritional factors etc.

Introduction and Management of Groundnut Germplasm in India

K Rajgopal and MS Basu

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Groundnut (*Arachis hypogaea* L.), which is a premier oilseed crop is cultivated in more than 100 countries, spread across 40°N and 40°S latitudes. The crop is grown in about 24 m ha with a total production of 31 m tones and productivity of 1304 kg ha⁻¹. Groundnut occupies about 35 % of the area and 40 % of the production among the oilseed crops, and is being cultivated in 7.6 m ha producing about 7.8 m tonnes (nuts in shell) with productivity of about 1000 kg/ha.

The genus *Arachis* L. includes both diploid and tetraploid taxa confined to South American countries viz., Argentina, Bolivia, Brazil, Paraguay and Uruguay. The cultivated groundnut is believed to be originated in northern Argentina and southern Bolivia. Prior to early 1500, groundnut was not known outside the Americas and worldwide distribution of two seeded and three seeded forms took place soon after the discovery of New World. The groundnut moved up the west coast from Peru to Mexico and then across the pacific to Philippines. The introduction of groundnut to African agriculture is accredited to Portuguese. The earliest form successfully introduced into southeastern United States was probably from Africa. Groundnut was introduced to India in the east coast of the erstwhile Madras Province in the middle of 19th century and assumed agricultural importance in the late 19th and early 20th centuries. It was surmised that groundnut was introduced to India from Manila (Philippines). Presently about 90 per cent of the total production of India is shared by Andhra Pradesh (27 percent), Tamil Nadu (23.4 percent), Gujarat (17.2 percent), Karnataka (13.8 percent) and Maharashtra (8.3 percent).

Arachis hypogaea is placed under the family Fabaceae, tribe Aeschynomeneae and subtribe Stylosanthinae. The

genus is divided into nine sections (Krapovickas and Gregory 1994) viz., *Arachis*, *Caulorhizae*, *Erectoides*, *Extranervosae*, *Heteranthae*, *Procumbentes*, *Rhizomatosae*, *Trierectoides* and *Triseminatae*. The section *Arachis* comprises the cultivated groundnut, tetraploid species *A. monticola* and a number of diploid wild species. Among the cultivated forms, subspecies *fastigiata* has been divided into four botanical varieties, *fastigiata*, *peruviana* Krapov and WC Gregory, *aequatoriana* Krapov. and WC Gregory and *vulgaris* C. Harz. The sub species *hypogaea* comprises two botanical varieties, *hypogaea* and *hirsuta* Kohler (Table 1).

As per the revised classification (Singh & Simpson 1994), the primary gene pool comprises *A. hypogaea* and a tetraploid *A. monticola* which is freely cross-compatible. The cross-compatible diploid species of section *Arachis* forms the secondary gene pool. The tertiary gene pool comprises the members of the section *Procumbentes* that probably co-evolved the species of series *Perennes* of the section *Arachis* and are weakly cross compatible with section *Arachis*.

The National Research Centre for Groundnut (NRCG) was established in 1979 by the ICAR with a mandate to conduct, coordinate and steer research programme on groundnut based production systems. One of the major objectives of NRCG is to collect, characterize, evaluate, conserve and document groundnut genetic resources. The centre is identified as National Active Germplasm Sites under the Indian Plant Genetic Resources System (IPGRS) the activities of which are monitored by NBPGR, New Delhi. The All India Co-ordinated Research Project on Oilseeds was shouldering the responsibility of collection of groundnut germplasm at national level prior to the establishment of the Centre.

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The centres located in the states of Tamil Nadu, Andhra Pradesh, Maharashtra, Karnataka and Gujarat collected land races from their respective regions. A total of 5066 accessions thus assembled were donated to International Crops Research Institute for Semi-arid Tropics (ICRISAT), Patancheru at the time of establishment of Genetic Resources Unit. Later ICRISAT conducted further collection expeditions in collaboration with Indian programme and National Bureau of Plant Genetic Resources (NBPGR), and collected 1042 accessions from 11 states of the country. Explorations were also undertaken in six states by the NRCG during 1981-1993 to enrich the working collection and thus 108 accessions were assembled. Under the All India Co-ordinated Research Project on Oilseeds-Groundnut system a total of 3399 accessions of cultivated groundnut and 38 wild *Arachis* accessions are being maintained at 7 centres. It is also felt that being a recently introduced crop to India, exploration undertaken earlier have captured most of the variability within the country.

Introduction of useful germplasm from exotic sources has been one of the major activities of NBPGR, New Delhi. The NBPGR is contributing by facilitating the assembly of germplasm at ICRISAT from various parts of the world. Until 1988, 5297 accessions from the Peoples Republic of China, Indonesia, Japan, Malawi, Nigeria, Senegal, South Africa, Tanzania, UK, USA, USSR, Zambia and Zimbabwe were assembled. The NBPGR has also introduced another 4985 accessions from 37 countries.

The NRCG has been approaching NBPGR, New Delhi from time to time for the procurement of elite exotic germplasm. A total of 111 germplasm lines were procured including both cultivated and wild *Arachis* species. Land races (170) collected by NBPGR, New Delhi within the country were also annexed to the working collection of the centre. Recently a few accessions of other three varieties *hirsuta*, *peruviana* and *aequatoriana* have been introduced to NRCG from USDA through NBPGR.

The characterization of new introductions has been done to identify accessions having specific traits, for identifying duplicates and gaps in the working collection. The working collection maintained at the Centre was characterized for various agronomic traits and about 15 evaluation catalogues have been brought out. A wide spectrum of variability has been identified over years of characterization and evaluation. Recently, elaborate

characterization for 20 qualitative traits and 32 quantitative traits was undertaken and promising accessions in the working collection were identified. The information generated has been brought out in the form of catalogues. Large number of accessions of cultivated groundnut identified for various abiotic and biotic stress factors have been compiled and brought out as a reference manual.

The working collection at NRCG is conserved in medium term module at a temperature of 4°C and 35-40 per cent RH. The repository holds 8934 accessions at present in the form of seeds. It also includes 3937 accessions procured over last three years from the ICRISAT under the repatriation programme. The collection represents 96 countries with major chunk is of Indian origin followed by USA. A duplicate set belonging to both wild and cultivated forms numbering 7397 is being maintained at the National Gene Bank at NBPGR for long-term conservation. A field gene bank comprising 96 accessions belonging to 5 sections of *Arachis* has been established for characterization and further utilization in crop improvement programmes. Accessions belonging to rest of four sections were assembled from the ICRISAT recently for enriching the collection of wild species. Emphasis has been given to conserve the genotypes which reached the final stage of testing under the multi-location trial system of the AICRP (Groundnut) to avoid the loss of these genotypes (finished product) even if they are rejected for promotion as a variety.

Under the Memorandum of Understanding signed between ICAR and ICRISAT, groundnut germplasm accessions donated by institutes or collected through exploration within the country by the ICRISAT will be deposited in National gene Bank NBPGR for long-term conservation. A total number of 6060 groundnut accessions have been identified for repatriation. The regeneration of accessions to enhance the seed quantity was undertaken since 2001 and with the present rate of multiplication the repatriation of accessions will be over by 2005.

For sustainable crop improvement, there is an urgent need for introduction of accessions with resistance to various biotic and abiotic stresses, particularly to diseases, such as bud necrosis, late leaf spot, and pests, such as leaf miner and armyworm (*Spodoptera*). In addition, to broaden the genetic base of groundnut cultivars and incorporation of stable resistance against diseases and pests, introduction of wild *Arachis* species is desired.

Utilization of Germplasm Introductions in Sunflower Improvement in India

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Plant introduction in broader perspective is a crop species or a variety or a genetic stock introduced from one country to another. In olden days the moving farmers and communities carried with them the crops and the varieties used by them to newer areas of their migration. After the advent of new world, the movement of crops between the new and old world increased enriching the crop diversity enormously in both the regions. Sunflower is one of the recent examples of successful introduction of a new world crop to India from erstwhile USSR, helping in crop diversification and improving edible oil supply in the country.

Large-scale commercial production of sunflower began in India with the introduction of four varieties from USSR – Armavarts (EC 69874), VNIIMK 8931 (EC 68413), Peredovic (EC 68414) and Armaviriskij 3497 (EC 68415). However, the new open pollinated varieties introduced were poorly adapted to climate in India. The genetic heterogeneity of the populations along with intensive selection work led to elimination of non-adopted types, resulting in new populations showing better fitness and yield. Thus the introduced sunflower varieties gradually became adopted and the two varieties viz., Peredovic and Armaviriskij 3497 covered large areas in the country. Cernianka 66 or Morden (EC 101145) is another variety introduced in 1978 after the initial process of 3-4 years of acclimatization. Owing to its superior plant stature, earliness and good seed filling found ready acceptance of the farmers. Another variety Rumsun Record (EC 132351), a cultivar introduced from Rumania was released for cultivation in Punjab.

Soon after the introduction of sunflower in early 1970's, crop improvement work was initiated using the introduced materials. The hybridization among introduced varieties resulted in generating the required genetic variation for selection (adaptation) and contributed a great deal towards the development of newer varieties with superior performance. About a dozen open pollinated varieties have been released from the above efforts.

Heterosis breeding which began in 1975 in the country was initially based on introduced CMS, Restorer

and Inbreed lines from USA. Majority of the hybrids released in the country till now have one or both parental lines that are introductions. The New Seed Policy which came into being during 1988 became an important instrument for introducing superior planting materials especially hybrids from the other countries to India. As many as 116 hybrids have been tested under this scheme for their performance and adaptation and several of them have found their way to commercial cultivation.

As the sunflower breeding in the recent years is getting advanced, the introductions are largely being used as donors of gene or gene combinations required for improving the varieties/parental lines lacking in one or more characteristics such as susceptibility to important diseases like downy mildew, rust, *Alternaria* leaf spot and viral necrosis; pests such as capitulum borer and several foliage feeding caterpillars; and for improving oil content and quality.

More than 7000 accessions of sunflower germplasm have been introduced from over 33 countries during the past five decades through NBPGR. This includes wild species, open pollinated varieties, improved populations, land races, CMS/GMS lines, maintainer lines, restorer lines, large number of inbreds, hybrids and other genetic stocks. As many as 43 wild and weedy species representing secondary and tertiary gene pool have been introduced.

The introduced germplasm have been evaluated for their usefulness in national crop improvement activities. Germplasm accessions promising for yield components, agronomic attributes, oil content, oil quality, high autogamy, various biotic and abiotic stresses have been identified. The utility of wild species as sources of useful genes especially for major diseases prevailing in the country has been assessed.

Genetic enhancement work has been going on at several locations in the country using the introduced germplasm. One area of concern related to introduced germplasm is inadequate attention shown towards its conservation. Only one-fourth of the introduced genetic stocks may have been conserved in the country and even these stocks might have undergone significant

genetic changes due to inadequate population size during maintenance and regeneration.

Sunflower being a recent introduction to India, the availability of local germplasm is negligible therefore, the dependence on introduced germplasm is inevitable.

Off late access to new materials present outside the country is getting difficult and restricted. It is important to find ways and means of augmenting superior germplasm and channalizing them to the national breeding programmes. This includes primary, secondary and tertiary gene pools especially from the centres of crop diversity.

The Central and North America possess the largest diversity especially in wild and weedy relatives which

could be used as donors of useful genes for managing several important biotic and abiotic stress factors.

Sunflower was domesticated first in Europe in later part of 18 century and contributed a great deal for the creation of large diversity in cultivated sunflower (primary gene pool). Carefully planned introductions from these countries could help considerably the genetic enhancement of the already acclimatized local elite material. Introductions from Australia, Argentina and Brazil having similar ecology as that of India might be equally useful. Introduction of germplasm having special attributes like non oil types and with unique oil quality (high oleic, high linoleic) is important for enlarging the industrial base of the crop in India.

Using Genetic Resources to Augment Sunflower Production

Dragan Škoric

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Key Words: Sunflower, Genetic resources, Breeding, Diseases, Insects, Drought, Oil Quality

The limiting factor in sunflower production is the narrow genetic variability within cultivated sunflower genotypes, insufficient resistance to diseases and insects, insufficient tolerance to stress conditions (soil and atmospheric drought), poor adaptability to changed growing conditions, low self-fertility, insufficient attractiveness to pollinators (bees), and inefficient use of soil nutrients. All this highlights the importance of utilizing wild species of the genus *Helianthus* in increasing the genetic variability of the cultivated sunflower.

In countries of southeast Asia, sunflower is a new oil crop. Its production in the region is hampered by a number of limiting factors. This paper reviews the possibility of increasing the genetic variability of the cultivated sunflower through an increased use of wild species of the genus *Helianthus* by means of interspecific hybridization.

Sunflower breeding for direct and indirect components is key to obtaining productive hybrids of this crop. The breeders' primary task is to find genes for resistance to downy mildew, rust, *Alternaria*, *Sclerotinia*, *Macrophomina* and other pathogens in wild sunflower species and then incorporate them into cultivated sunflower genotypes. Sunflower breeding

for resistance to drought is also very important. Another high-priority task is the development of increased salt tolerance. No less important is selection for increased tolerance to certain insects causing economic damage to sunflower crops. Wild sunflower species can be successfully used in breeding for resistance to certain herbicide groups.

In breeding programs, it is very important that the breeder realizes limitation of working on a large number of traits simultaneously. Therefore, priorities need to be in advance set and hybrid development to be carried out gradually. Also, it is essential for the breeder to involve experts from various fields. Recently, use of the new biotechnology methods assumed great importance to achieve the goals faster and with greater success rate. The quality of sunflower oil can also be changed using induced mutations.

Conclusions of our analysis of sunflower production in southeast Asia with special focus on India as the region's main sunflower grower, reveals that sunflower production is limited by a number of factors. The main factor is deficiency of genes found in sunflower genotypes used commercially. Inadequate implementation of cultural practices also leads to low and unstable yields. Problems

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facing sunflower production can be overcome by increasing the genetic variability of the cultivated sunflower by using wild sunflower species for interspecific hybridization.

Breeding for yield components, disease, insect and drought resistance, salt tolerance, oil quality and herbicide resistance require increased utilization of wild species of the genus *Helianthus*.

Indo-UK Collaboration on Oilseeds—Towards Improving the Genetic Base of Rapeseed-Mustard in India

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The key factors to increased production are the evaluation of a wide range of genotypes under appropriate testing environments. Genetic enhancement will continue to be an exciting and important dimension for the improvement of cropping systems and will certainly contribute to the sustainability of crop production in the future.

Indo-UK Collaboration (Phase II) on Oilseed Crops (Rapeseed-Mustard) is an 8-year project started in 1998, which follows on from a successful phase-I project (1991-1998). Phase I was collaboration between Rothamsted Research (UK) and GB Pant University of Agriculture and Technology—Pantnagar (GBPUAT). Rothamsted Research is implementing phase-II under the umbrella of the Indian Council of Agricultural Research in collaboration with the National Research Centre on Rapeseed-Mustard (Bharatpur), The Energy and Resources Institute (New Delhi) and GBPUAT-Pantnagar. Phase-I focused on resistance to downy mildew, whereas phase-II is focusing on; a) developing resistance to white rust and *Alternaria* blight diseases, b) develop rapeseed-mustard crops in 15 districts across seven states in India through farmers participatory research as well as rural livelihoods development.

A range of accessions, which included breeding lines developed at Rothamsted Research with wide

differential resistant profile to *Phytophthora parasitica*, were given to GBPUAT-Pantnagar through the National Bureau of Plant Genetic Resources (New Delhi) for adaptation, evaluation and further selection. These included 54 accessions of *Brassica napus*, 52 of *B. juncea* and 23 of *B. rapa*. Two accessions of *B. napus* code named EC 338986-2 and EC 338996-1, maintained high resistance to downy mildew and white rust as well as tolerance to *Alternaria* blight and *Seclerotinia* stem rot, whereas EC 339000 stood out as relatively early maturing with high yield, particularly in the hilly regions like Kangra (Himachal Pradesh) and RS Pura (Jammu & Kashmir) and had more yield than the national check (GSL-1). Four accessions of *B. juncea*, EC 399296, EC 399299, EC 399301 and EC 399313 appeared to be almost free from downy mildew, white rust and *Seclerotinia* as well as tolerant to *Alternaria* blight diseases. Moreover, two more accessions of *B. juncea*, EC 414308 (code named NRCR-837) and EC 414319 (code named NRCR-836) were evaluated in initial variety trial (IVT) and found to be tolerant to downy mildew, white rust and *Sclerotinia* stem rot. EC 414308 was promoted to advanced variety trial -1 (AVT-1). EC 399301 has been extensively utilized in the breeding programme.

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Sugarcane Introduction in South Asia—Achievements and Opportunities

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With the increased usage of sugarcane for the production of power, paper, ethanol, ethanol based chemicals and a host of other value added products besides sugar and gur, the profitability of sugarcane agriculture and industry has improved and this crop has increasingly contributed to the economic prosperity of South Asian countries where sugarcane is a major crop.

Before the advent of improved sugarcane varieties from research stations, three species of *Saccharum* viz. *S. officinarum*, *S. barberi* and *S. sinense* were under cultivation. *S. officinarum* has originated in the Papua-New Guinea-Indonesia region. Its natural distribution is confined to Pacific Islands, Thailand and Philippines besides the Indonesia-New Guinea region. *S. barberi* originated in India and was under cultivation from Punjab to Bengal. *S. sinense* had its origin in China and was cultivated extensively in China. The wild species *S. spontaneum* has originated in India and has extensive distribution from Solomon Islands to Africa. *S. robustum* has its origin and distribution in Indonesian Archipelago.

The introduction of *S. officinarum* to India took place in several stages. The initial spread has taken place along with race migrations from South Pacific to South East Asia and India through the chain of islands between Asia and Australia. The targeted introduction of *S. officinarum* to India dated back to the colonial days when several clones of the species was introduced to the different provinces of the country for commercial cultivation. These canes were categorized as Pounda canes. Major areas under Pounda cultivation were in Assam, Bengal, United Province and the whole of tropical India. Pounda canes were introduced in Peshawar region around 1853. By 1915 more than 120 *S. officinarum* varieties were under cultivation in India. Major importation of *S. officinarum* took place during 1951-52 when the world collection of sugarcane germplasm was duplicated in India.

There is no recorded history of the initial Introduction of *S. sinense* (Chinese Sugarcane) to India. It could have taken place through traders from either countries.

The first recorded introduction was in 1796 when a few varieties of Chinese canes from Canton, China were sent to Roxburgh, who was with the East India Company, Calcutta.

The introduction of *S. spontaneum* to India from various countries, besides our own explorations and collections, over the years has helped to establish the world's best collection of this species in India. The introduction of *S. robustum* to India was mainly through the International Society of Sugarcane Technologists germplasm collection.

The first man made hybrids were produced in Java during 1900. These hybrids were brought to India as and when they were produced in Java. Varieties from Barbados, Australia, Natal and Mauritius were also introduced for cultivation in the country during 1900. During 1930 to 1950 several hybrid varieties from different cane breeding stations were introduced to India but none became commercial cultivars. Many of these cane varieties were used as parents in sugarcane breeding in India.

Introduction of Indian canes to other countries dates back to 327 BC during the invasion of Alexander. Subsequently many original Indian cane varieties were introduced to many countries for commercial cultivation. Early hybrid varieties evolved at Coimbatore were under cultivation in many countries. There was free exchange of new varieties from research stations around the world, which enriched the sugarcane breeding pool. The cane varieties produced by Java and India formed the basic material as parents for the subsequent cane improvement programmes world over.

The world collection of sugarcane is being maintained in India and USA which includes the whole range of variability available in *Saccharum* species and man made hybrids. We have total access to this world collection with unlimited opportunities. What is required further is a well organised utilisation programme to meet the growing requirements.

Evaluation and Utilization of Introduced/ Exotic Cotton Germplasm

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The National Cotton Gene Bank of India was established in Central Institute for Cotton Research (CICR), Nagpur. The total gene pool available in this bank today approximately represent 70 percent of the global genetic variation for over 60 attributes sought by the breeder for one or the other breeding objective. The present holding in National Genebank after eliminating the duplicates are given in Table 1. The collections are maintained both in medium-term cold storage module at CICR and long-term storage module at NBPGR, New Delhi, besides a short-term cold storage facility for all the working collections that are replenished once in 2 or 3 years, as needed. The wild species and cytogenetic materials are maintained in the species garden at CICR, Nagpur.

The evaluation studies were conducted on the exotic germplasm accessions of *G. hirsutum* (780), *G. barbadense* (383), *G. herbaceum* (19) and *G. arboreum* (43) for several agronomic and physiological attributes, 5 to 7 fiber quality parameters, 2-4 aspects of seed oil and protein, 4-6 biomass and harvest index attributes, 6-8 leaf attributes, 5-7 boll attributes, 5-6 seedling characters, 3-4 on boll setting efficiency, 5-6 on boll and seed setting efficiency, plant type, resistance attributes and potential for insect and disease resistance for nearly 4-6 insect pest and 5-6 disease, 9-10 marker character expression, earliness, drought resistance, male sterility, restorer system, reproductive potential influencing fertility, anthocyanin pigmentation, gossypol distribution pattern, amino acid profile, protein profile

Table 1. Current holdings in National Gene bank of Cotton at CICR, Nagpur

Represented by	Total number of accessions
<i>Gossypium hirsutum</i>	5980
<i>G. arboreum</i>	1989
<i>G. herbaceum</i>	548
<i>G. barbadense</i> +	383+
Wild species	25
Races	
<i>G. hirsutum</i>	7
<i>G. arboreum</i>	6
<i>G. herbaceum</i>	1
<i>G. barbadense</i>	1
Perennials	20
Wild species derivatives	25
Total	8985

+ maintained at CICR Regional Station, Coimbatore

and nectar gland pattern. Evaluation was also done on regular basis for multilocal testing and performance based in North, Central and South Cotton Zone.

A large number of exotic elite types were distributed to agricultural universities, government research and development organizations, breeders and researchers for genetic studies and breeding work and quite a large number of hybrid combinations and segregating material have been generated. At CICR, immunity to bacterial blight, immunity to grey mildew, higher oil content, compact plant type with short stature, high fibre strength, jassid tolerance, aphid resistance, high ginning outturn etc. have been incorporated in upland cotton.

Plant Introduction—Achievements and Opportunities in Jute and Allied Fibre Crops in India

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Collection and introduction of jute and allied fibre crop germplasm through different modes like institute efforts, correspondence, joining in National and International Programmes from early twentieth century to recent time are narrated chronologically. Variability in different traits within the collected germplasm is studied and short listed accessions are utilized as base material of useful donor parent in breeding programme for crop improvement. Role of these valuable germplasm in developing different suitable varieties is enumerated. Their impact on national

productivity and in various industrial sectors has been dealt with.

Future need and scope in collecting germplasm for their utilization in developing varieties needed for diversified products are indicated for sustainability of these crops from competition with the synthetic fibres. Important traits and relevant country of rich diversity and germplasm availability in different crop species are stated for future collection and utilization as per changing industrial need of the country and for the farmers for managing their crop more remuneratively.

Plant Introduction in Forage Crops—Achievements and Opportunities

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Introduction of new germplasm of forage crops is highly important because of complex breeding behaviour of forage grasses and legumes. The fodder crops suffer from a lot of problems unique to these groups and are generally not encountered in the cultivated crops. Some of the general constraints faced with forage production and improvement include non synchronous flowering/ anthesis and spikelets maturity, abscission of spikelets after maturity in grasses, overlapping of vegetative and reproductive growth phases, uneven pod setting, maturity and shattering in legume species. In addition, apomictic nature of most of tropical forage grasses limits their genetic improvement. Hence, introduction of superior cultivars only offer logical approach for their genetic improvement.

Since ancient times Indian farmers practice mixed farming. Thus livestock and fodder are important component of agriculture and rural economy. India being a country with diverse agro-geographical zones needs a large variety of fodder crops for different zones to sustain its huge livestock population. Indian gene centers

also holds rich diversity in native grasses and legumes, which have potential to become important components of pastures and rangelands. However, the wide range of genetic diversity is the pre requisite for any breeding programme in the improvement of fodder crops. The threat of genetic erosion of fodder crops is much more higher for both landraces as well as for wild relatives, due to ever increasing expansion and development of agriculture through out the tropics.

During the last few decades introduction of new species, ecotypes, biotypes, wild relatives and improved cultivars have considerably enriched the genetic diversity available in the country. It has changed significantly the scenario of fodder cultivation in the country and has contributed a lot in the animal productivity. Particular mention may be made of introduction of new crops such as Berseem (*Trifolium alexandrinum*), Oats (*Avena sativa*), Lucerne (*Medicago sativa*), Stylos (*Stylosanthes* sp.), Subabul (*Leucaena leucocephala*) etc. that has contributed significantly in the fodder productivity and has completely revolutionized the fodder cultivation concept.

Introduction of wild relatives and new genotypes have considerably helped the genetic improvement programmes in many important crops. At IGRI Jhansi concerted efforts have led to introduction of several species of *Trifolium*, *Avena*, *Stylosanthes*, *Medicago*, *Leucaena* etc. These lines are being utilized by various breeding tools for development of improved cultivars. The introductions have either been used directly as a variety or selections were made from the introduced materials. The introductions were also used as source of desirable allele for

resistance to diseases, drought and lodging, grain or fodder quality and other valuable agronomic characters.

Further improved varieties/ strains in *Cenchrus*, *Chloris*, *Dichanthium*, *Panicum*, *Setaria*, *Stylosanthes*, *Desmodium*, *Medicago*, *Trifolium*, *Avena* and *Leucaena* could provide useful genetic resources for forage improvement programmes in India for livestock feed and fodder. Sustained efforts are required for achieving such objectives.

Plant Introduction—Achievements and Opportunities in Fruit and Plantation Crops in South Asia

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South Asia comprising of Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka grows more than 40 fruit and 7 plantation crops commercially and is a centre of rich variability/gene pool for various fruit and plantation crops. Among these, India is known to be the primary centre of origin for many tropical and subtropical fruits like *aonla*, *bael*, *ber*, *bilimbi*, citrus, *garcinia*, jack fruit, *jamun*, *karonda*, *khejri*, *lasora*, mango, *phalsa*, *pilu*, tamarind, wood apple, etc and secondary centre of origin for apple, banana, cashew, coconut, mulberry, pomegranate, *Prunus*, *Pyrus*, *Rubus*, etc. Many of these fruits are also known to have major centre of diversity in other countries of South Asia. Many of the fruit crops although not originated in this region, have a wide range of variability owing to long period of domestication and diverse climatic and growing conditions resultantly a rich gene pool for genetic enhancement.

Plant introduction has been practiced since the start of crop husbandry. The early introduction of fruit and plantation crops was brought through traders, invaders, travelers etc. and was done without any specific plans. Many of today's commercial fruit and plantation crops grown are the result of these unorganized introductions. Some of the early introductions were grapes, pomegranate, sapota, loquat and custard apple. Pineapple reached India as early as 1548, guava, papaya in the sixteenth century and litchi in seventeenth century. After 1870, European

and American settlers and Missionaries carried out introduction of pome, stone and nut fruits. During this period Captain Lee in Kullu valley, Coutts in Shimla and EC Stokes in Kotgarh made valuable introductions. Pychard (A French person) introduced many apple varieties in Kashmir between 1910 to 1920. As a result several temperate fruits namely apple, pear, peach, plum, apricot, walnut and almond fully adapted and established in the temperate region. Several of today's commercial cultivars were introduced during the period. Portuguese in Malabar Coast introduced cashew nut while Oil palm was introduced in India towards the end of 19th century.

In India, planned introduction of important tropical, subtropical, temperate fruits and different plantation crops was taken up in 1946 under a scheme at the Division of Botany, IARI, which was upgraded as Plant Introduction and Exploration unit in 1956 and as the Division of Plant Introduction in 1961. It was separated in 1976 as an independent institute, named as NBPGR. Over the last 28 years, NBPGR has introduced 5301 accessions of different fruit and plantation crops from more than 25 countries under strict quarantine. These collections are being maintained at various national active germplasm sites e.g. arecanut at Vittal, arid fruits at Bikaner, banana at Tiruchirapalli, cashew at Ullal and Puttur, citrus at Nagpur, coconut at Kasargod, grapes at Pune, oilpalm at Eluru, tropical fruits at Bangalore, subtropical fruits at Lucknow, temperate fruits at Srinagar

and Shimla. Several new fruit crops have also been introduced in the South Asian region. Some of these fruit crops have been commercialized/adapted namely, kinnow, jojoba, macademia nut, mangosteen, passion fruit, tomatillo, prickly pear, kiwi fruit, olive, pecan nut, persimmon, seabuckthorn, etc. In south Asia, India has the largest collection of almost all the fruit and plantation crops particularly in apple, *ber*, banana, citrus, coconut, grape, guava and mango at various germplasm collection sites.

In spite of large introductions much remains to be introduced particularly in fruit crops. Many wild species in mango, superior types in pineapple, papaya, litchi, *ber* and temperate fruits are still to be introduced in different countries of South Asia. There is also much to be introduced in rootstock materials particularly in citrus, grape, *ber*, sapota, *Annona* and in all temperate

fruit crops with particular reference to biotic and abiotic stress tolerance and dwarfing behaviour. A wide range of varieties/ hybrids are also to be introduced in some tropical and subtropical fruits like *Annona*, avocado, banana, *ber*, citrus, grape, litchi, mango, papaya, mangosteen, etc. Emphasis would be to introduce new fruit crops. Attempts need be made to introduce diverse germplasm, wild species, genetic stocks and cultivars with diseases and stress tolerance from South American, Central Asian and South East Asian countries. Besides, emphasis on high export potential varieties of different fruits such as coloured varieties in mango and guava, large fruited types in sapota, wine types in grapes and high juice yielding varieties in *Citrus* species and some temperate fruits from European and Mediterranean countries need to be introduced.

Genetic Resources of Spices

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Spices have played a major role in human life and history. India is the land of spices and many important spices like black pepper, cardamom, ginger, turmeric, cinnamon, tamarind and garcinia are native to India. India has a good amount of diversity in these crops. Collection, conservation and evaluation of native diversity is being pursued vigorously. India is also a major producer and exporter of these spices.

The other important spices relevant in Indian context are coriander, chilli, fennel, fenugreek, cumin, nutmeg, clove and vanilla in addition to other minor spices. Being crops of exotic origin, the indigenous genetic diversity in these crops is limited and does not represent the actual diversity available in these crops. Their variability is limited to the earlier introductions and their recombinants. Careful and unbiased collections from the centres of diversity can enhance the utility of the collection for crop improvement especially in developing high quality and disease resistant types. For example introduction of cumin genotypes with high oil and sweet fennel types, containing mostly anethole, and smaller quantities of

d-phellandrene and *d*-limonene and no fenchone from European region will enrich our germplasm.

Introduction of genetic diversity from the centres of diversity is much needed in crops like paprika, nutmeg, clove, allspice and vanilla.

In addition introduction of specific genotypes with special characters especially like high quality lines and lines resistant to biotic and abiotic stresses will augment our future breeding programmes. Some important aspects worth considering are introduction of resistance source to *Phytophthora capsici* from the primary centre of diversity for genus *Piper* i.e. Central and South America and some of the pepper selections with resistance to *Phytophthora capsici* and *Radopholus similis*; introduction of Sri Lankan wild cardamom *Elettaria ensal* (Abheyv) (syn. *E. major* Thw.) which is reported to be tolerant to stem borer and recently reported 7 species of *Elettaria* from the Malaysian-Indonesian region; introduction of low fibre and vegetable varieties of ginger from China, Jamaica, Nigeria and Australia. This will help in improving our genetic stocks for future utilisation.

Plant Introduction—Achievements and Opportunities in Jute and Allied Fibre Crops in India

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Collection and introduction of jute and allied fibre crop germplasm through different modes like institute efforts, correspondence, joining in National and International Programmes from early twentieth century to recent time are narrated chronologically. Variability in different traits within the collected germplasm is studied and short listed accessions are utilized as base material of useful donor parent in breeding programme for crop improvement. Role of these valuable germplasm in developing different suitable varieties is enumerated. Their impact on national

productivity and in various industrial sectors has been dealt with.

Future need and scope in collecting germplasm for their utilization in developing varieties needed for diversified products are indicated for sustainability of these crops from competition with the synthetic fibres. Important traits and relevant country of rich diversity and germplasm availability in different crop species are stated for future collection and utilization as per changing industrial need of the country and for the farmers for managing their crop more remuneratively.

Plant Introduction in Forage Crops—Achievements and Opportunities

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Introduction of new germplasm of forage crops is highly important because of complex breeding behaviour of forage grasses and legumes. The fodder crops suffer from a lot of problems unique to these groups and are generally not encountered in the cultivated crops. Some of the general constraints faced with forage production and improvement include non synchronous flowering/ anthesis and spikelets maturity, abscission of spikelets after maturity in grasses, overlapping of vegetative and reproductive growth phases, uneven pod setting, maturity and shattering in legume species. In addition, apomictic nature of most of tropical forage grasses limits their genetic improvement. Hence, introduction of superior cultivars only offer logical approach for their genetic improvement.

Since ancient times Indian farmers practice mixed farming. Thus livestock and fodder are important component of agriculture and rural economy. India being a country with diverse agro-geographical zones needs a large variety of fodder crops for different zones to sustain its huge livestock population. Indian gene centers

also holds rich diversity in native grasses and legumes, which have potential to become important components of pastures and rangelands. However, the wide range of genetic diversity is the pre requisite for any breeding programme in the improvement of fodder crops. The threat of genetic erosion of fodder crops is much more higher for both landraces as well as for wild relatives, due to ever increasing expansion and development of agriculture through out the tropics.

During the last few decades introduction of new species, ecotypes, biotypes, wild relatives and improved cultivars have considerably enriched the genetic diversity available in the country. It has changed significantly the scenario of fodder cultivation in the country and has contributed a lot in the animal productivity. Particular mention may be made of introduction of new crops such as Berseem (*Trifolium alexandrinum*), Oats (*Avena sativa*), Lucerne (*Medicago sativa*), Stylos (*Stylosanthes* sp.), Subabul (*Leucaena leucocephala*) etc. that has contributed significantly in the fodder productivity and has completely revolutionized the fodder cultivation concept.

Introduction of wild relatives and new genotypes have considerably helped the genetic improvement programmes in many important crops. At IGRI Jhansi concerted efforts have led to introduction of several species of *Trifolium*, *Avena*, *Stylosanthes*, *Medicago*, *Leucaena* etc. These lines are being utilized by various breeding tools for development of improved cultivars. The introductions have either been used directly as a variety or selections were made from the introduced materials. The introductions were also used as source of desirable allele for

resistance to diseases, drought and lodging, grain or fodder quality and other valuable agronomic characters.

Further improved varieties/ strains in *Cenchrus*, *Chloris*, *Dichanthium*, *Panicum*, *Setaria*, *Stylosanthes*, *Desmodium*, *Medicago*, *Trifolium*, *Avena* and *Leucaena* could provide useful genetic resources for forage improvement programmes in India for livestock feed and fodder. Sustained efforts are required for achieving such objectives.

Plant Introduction—Achievements and Opportunities in Fruit and Plantation Crops in South Asia

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South Asia comprising of Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka grows more than 40 fruit and 7 plantation crops commercially and is a centre of rich variability/gene pool for various fruit and plantation crops. Among these, India is known to be the primary centre of origin for many tropical and subtropical fruits like *aonla*, *bael*, *ber*, *bilimbi*, citrus, *garcinia*, jack fruit, *jamun*, *karonda*, *khejri*, *lasora*, mango, *phalsa*, *pilu*, tamarind, wood apple, etc and secondary centre of origin for apple, banana, cashew, coconut, mulberry, pomegranate, *Prunus*, *Pyrus*, *Rubus*, etc. Many of these fruits are also known to have major centre of diversity in other countries of South Asia. Many of the fruit crops although not originated in this region, have a wide range of variability owing to long period of domestication and diverse climatic and growing conditions resultantly a rich gene pool for genetic enhancement.

Plant introduction has been practiced since the start of crop husbandry. The early introduction of fruit and plantation crops was brought through traders, invaders, travelers etc. and was done without any specific plans. Many of today's commercial fruit and plantation crops grown are the result of these unorganized introductions. Some of the early introductions were grapes, pomegranate, sapota, loquat and custard apple. Pineapple reached India as early as 1548, guava, papaya in the sixteenth century and litchi in seventeenth century. After 1870, European

and American settlers and Missionaries carried out introduction of pome, stone and nut fruits. During this period Captain Lee in Kullu valley, Coutts in Shimla and EC Stokes in Kotgarh made valuable introductions. Pychard (A French person) introduced many apple varieties in Kashmir between 1910 to 1920. As a result several temperate fruits namely apple, pear, peach, plum, apricot, walnut and almond fully adapted and established in the temperate region. Several of today's commercial cultivars were introduced during the period. Portuguese in Malabar Coast introduced cashew nut while Oil palm was introduced in India towards the end of 19th century.

In India, planned introduction of important tropical, subtropical, temperate fruits and different plantation crops was taken up in 1946 under a scheme at the Division of Botany, IARI, which was upgraded as Plant Introduction and Exploration unit in 1956 and as the Division of Plant Introduction in 1961. It was separated in 1976 as an independent institute, named as NBPGR. Over the last 28 years, NBPGR has introduced 5301 accessions of different fruit and plantation crops from more than 25 countries under strict quarantine. These collections are being maintained at various national active germplasm sites e.g. arecanut at Vittal, arid fruits at Bikaner, banana at Tiruchirapalli, cashew at Ullal and Puttur, citrus at Nagpur, coconut at Kasargod, grapes at Pune, oilpalm at Eluru, tropical fruits at Bangalore, subtropical fruits at Lucknow, temperate fruits at Srinagar

and Shimla. Several new fruit crops have also been introduced in the South Asian region. Some of these fruit crops have been commercialized/adapted namely, kinnow, jojoba, macademia nut, mangosteen, passion fruit, tomatillo, prickly pear, kiwi fruit, olive, pecan nut, persimmon, seabuckthorn, etc. In south Asia, India has the largest collection of almost all the fruit and plantation crops particularly in apple, *ber*, banana, citrus, coconut, grape, guava and mango at various germplasm collection sites.

In spite of large introductions much remains to be introduced particularly in fruit crops. Many wild species in mango, superior types in pineapple, papaya, litchi, *ber* and temperate fruits are still to be introduced in different countries of South Asia. There is also much to be introduced in rootstock materials particularly in citrus, grape, *ber*, sapota, *Annona* and in all temperate

fruit crops with particular reference to biotic and abiotic stress tolerance and dwarfing behaviour. A wide range of varieties/ hybrids are also to be introduced in some tropical and subtropical fruits like *Annona*, avocado, banana, *ber*, citrus, grape, litchi, mango, papaya, mangosteen, etc. Emphasis would be to introduce new fruit crops. Attempts need be made to introduce diverse germplasm, wild species, genetic stocks and cultivars with diseases and stress tolerance from South American, Central Asian and South East Asian countries. Besides, emphasis on high export potential varieties of different fruits such as coloured varieties in mango and guava, large fruited types in sapota, wine types in grapes and high juice yielding varieties in *Citrus* species and some temperate fruits from European and Mediterranean countries need to be introduced.

Genetic Resources of Spices

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Also worth considering is introduction of other useful but at present not so popular spices and herbs like chives, lavender, anise, dill, rosemary, oregano, sage,

marjoram, thyme etc as they help in diversifying our spices production and introducing them to non traditional areas too.

Germplasm Introduction in Tropical and Sub-tropical Vegetables in South Asia—Achievements and Opportunities

BS Dhankhar¹ and JP Mishra²

¹ Department of Vegetable Science, CCS HAU, Hisar, Haryana

² Division of Vegetable Science, IARI, New Delhi-110 0 112

It is well understood that while adaptability is a set of characters specific to a particular region or agro-climate, the attributes related with yield and sustainability (stress resistance) have to be pooled from diverse sources which highlights the need of introductions. Among South Asian countries, India is the most privileged nation having almost all sorts of agro-climates, a large area under undisturbed / partially disturbed forests as reservoir of variability, and a large group of tropical and sub-tropical vegetables having maximum diversity and distribution. The existing variability is getting depleted irrespective of the national boundaries with the adoption of only few high yielding genotypes most suited to present day conditions of a particular region. The ill effects of this are now well known, due to fast narrowing of genetic base of varieties getting prone to biotic and abiotic stresses fast. This situation warrants for continued interchange and recombination of plant improvement material, particularly in South Asian countries where a good number of vegetables are grown and farmers are the most important partners of the population.

In India, introductions date back to times even before Christian era as 'Alabu' (bottle gourd, native of Africa), 'Kalinga' (watermelon native to Africa), 'Palandu' (onion native to Central Asia) and similar other types have been described in ancient literature. Adaptation has also effected change in habit of introduced crops viz., cauliflower from temperate Western Europe has given birth to types suitable for warm and humid conditions of North India, the temperate 'long day' perennial onion has been adapted to subtropical / near tropical 'short day' conditions of Maharashtra and Karnataka, respectively as an annual. Chilli introduced in 15th century has now many variable adapted forms. Temperate

garden peas have now variants that are successfully grown in warm and humid western Maharashtra and eastern Madhya Pradesh. The resistance to various biotic factors in plant material introduced from countries / regions devoid of such stresses have helped in developing resistant commercial varieties in many crops. Similarly introductions have also helped in developing cold-set and hot-set varieties in crops like tomato which has facilitated tomato cultivation even beyond the specific growing seasons. Some of the important examples of direct introductions are Sioux, Labonita, Marglobe and Roma in tomato; Asahi Yamato, New Hampshire Midgut and Sugar Baby in watermelon; Pusa Chetaki in radish and many varieties in sweet potato. Similarly, introductions have also led to the development of many outstanding vegetable varieties. Some examples may be cited as Pusa Ruby, Pusa Early Dwarf, Punjab Chhuhara and HS 101 in tomato; Punjab Padmini, Parbhani Kranti and Pusa A-4 in okra; Arka Manik and Pusa Bedana in watermelon; Pusa Sharbati and Punjab Sunehri in muskmelon; Pusa Sunehri in sweet potato; Pusa Kesar and Pusa Meghali in carrot; Pusa Himani in radish and several others.

With the globalization now world has become one big market. Competitiveness has increased and we have to produce to the needs of other nations as per their requirement also. As such, more attention is needed towards collection and utilization of genetic variability for sustainable production of quality vegetables. Exchange of plant material between South Asian countries will also enrich one another and help in development. India has rich diversity- both wild and cultivated types- in crops like ridge gourd, egg plant and also in cowpea, okra, tomato, chilli, watermelon etc. which can be utilized

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by other South Asian countries. Similarly, resistant sources for leaf curl virus in chillies; bacterial wilt in brinjal; powdery mildew in melons, etc. are available in primitive types, land races and wild forms in India and can be utilized for breeding resistant varieties.

Introductions in vegetable crops in present days are needed for developing tomato varieties with stress resistance, nutritional and processing qualities; chilli varieties for hot conditions and suitability for export; brinjal varieties for heat tolerance (for fruit-set) and resistance to bacterial, viral and phytoplasmal diseases; watermelon and muskmelon varieties suitable for transport, storage and disease and insect (fruit-fly) resistance; bitter melon and long melon with fruit-fly resistance; sweet potatoes with long neck and resistance to weevil, etc.

Cultivated types with wider adaptability and higher productivity, processing quality and stress resistance will still form the major thrust in introductions. Besides wild related forms having resistance against one or more biotic/abiotic stresses need to be introduced for developing pre-breeding material where crossability is difficult or else for direct utilization in developing commercial varieties. An integrated gene management strategy has to be developed in each mandate vegetable crops. In addition to varieties, new vegetable crops also need to be introduced, particularly for improved nutrition,

value addition and export. Even exchange of elite germplasm among South Asian countries can help a lot in boosting production of tropical and sub-tropical vegetables as experienced in one of the SAVERNET programmes on varietal evaluation.

In agricultural terms, the richest country is one that has maximum bio-diversity. During earlier days bio-diversity was considered a common heritage of mankind and introductions used to be a free and frequent activity. Global conventions during recent years have altered the concept. Now bio-diversity is the sovereign property of the nation in whose political frontiers it occurs, and as such, the introduction of germplasm now involves certain procedures, commitments and cautions. Further, as suggested by Dr. MS Swaminathan, concerned public institutions should create novel genetic combinations under well-designed pre-breeding program and through participatory breeding involving grass-root farmer breeders, get the novel genetic traits for resistance to biotic and abiotic stresses incorporated in to locally adapted varieties. This will ensure ecological, economic and social sustainability as well. Vegetable cultivation in this part of the world is mainly practiced by women and the adoption of the suggested strategy may not be difficult.

Temperate Vegetables: Germplasm Resources, their Utilization and Achievements in India

TS Verma¹ and Chander Prakash²

¹ Division of Vegetable Crops, IARI, New Delhi-110 012

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The diverse climatic conditions in large number of vegetable crops. Vegetable crops are classified into two major groups according to its temperature requirement namely tropical and temperate. Temperate vegetable crops need chilling temperature (4-7°C) for about 2 months for changing their vegetative phase into reproductive phase. The different pockets in the Hindukush Himalayas namely Humid Western and Eastern Himalayan Region comprising J&K, H.P., Uttaranchal, NE states have congenial climate for seed production of temperate vegetable crops. The history of germplasm introduction

in respect of temperate vegetables and their breeding dates back prior to second world war when seeds of all the temperate vegetable crops were imported from abroad mainly from England by seed company e.g. M/s Suttons & Sons. Later Imperial Govt. in India established a research station at Quetta (Baluchistan) in 1942-43 which went to Pakistan after independence and subsequently Govt. of India set up a Central Vegetable Breeding Substation at Katrain in Kullu valley in H.P. in 1949 that was transferred to IARI in 1955 in order to strengthening the improvement work on temperate

by other South Asian countries. Similarly, resistant sources for leaf curl virus in chillies; bacterial wilt in brinjal; powdery mildew in melons, etc. are available in primitive types, land races and wild forms in India and can be utilized for breeding resistant varieties.

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vegetable crops. From historical facts, it is evident that most of the temperate/European vegetable crops were introduced in India by the Portuguese during 18th century followed by English in 19th century. Jenson from Kew introduced cauliflower varieties as early as in 1822 and grew it in botanical garden at Saharanpur. After independence several organizations like NHRDF, DARL, VPKAS, GBPUA&T etc were established and different programmes namely AICRP were implemented at different times to give further fillip to breeding of temperate vegetable crops. In recent times, under open general license (OGL), the private seed companies have introduced lot of seed material and started their own R&D programmes. India has also collaborated with AVRDC, Taiwan, China, USSR and SAVERNET (South Asian Vegetable Research Network) countries for testing of vegetable entries. Some of the research projects on temperate vegetable crops were funded by NATP (National Agriculture Technology Project). A detailed account on utilization of vegetable crops has been highlighted with special reference to cole crops and root crops. Cauliflower being the most important cole crops received maximum attention and lot of varieties of late cauliflower (Group

IV) namely, Pusa Snowball 1, 2, Pusa Snowball K1 were developed using exotic lines. Private seed companies have released F₁ hybrids namely, Himani, Guardian (Indo American), Candid Charm, White Flesh (Sakata), Serrano (Sandoz) using CMS and SI lines developed from exotic lines. In cabbage majority of ruling varieties are through introductions e.g. Golden Acre, Pride of India etc. Pusa Mukta, a black rot resistant variety, was developed by crossing two exotic lines (EC 24855 X EC 10109). Many tropical cabbage hybrids e.g. KK cross, Golden cross etc. were introduced and tropical cabbage lines DTC 50-7-4, 513, 528 etc. were developed. CMS system has also been transferred successfully to all cabbage lines from EC 173419 at Katrain. In other cole crops, majority of the varieties are developed mainly through introductions. In root crops also the improved cultivars are developed either through introduction followed by selection or by hybridization with exotic lines as one of the parent. The sources of pests and diseases resistance in cole crops are mainly exotic lines through introductions. The vast genetic resources of temperate vegetable crops have opened up the prospects of breeding using the introductions made from different countries.

Plant Introduction in Medicinal and Aromatic Plants in India: Achievements and Opportunities

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Human civilization witnessed the origin of a number of Health Tradition Systems through out the world. Each system has developed a number of effective herbal disease cure practices, which spread through out the world. An enormous number of medicinal plants are available in each health care system and are distributed in different parts of the world. Cultivation of medicinal plants is comparatively new phenomenon and domestication is widely prevalent in medicinal plant cultivation directly from the wild material.

The history of plant introduction is associated closely with human civilization. Even though, India is rich in its natural medicinal plant flora, there is a number of medicinal plant introductions occurred within the country from the time immemorial. A number of success stories of achieving the benefit of direct plant introduction are

available within the country such as commercial cultivation of isabgol, opium poppy, cinchona, senna etc.

In the earlier years, plant introduction was made at random by invaders, traders, missionaries and others. There are no records about the exact period of some plant introduction that has happened as in the case of Aloe whose center of origin is Africa, however naturalized in India and at present widely utilized in Indian health care systems and also in industry. It is interesting to record that foxglove introduced as ornamental plant in the hill resorts of Kashmir has become an important medicinal plant and now being cultivated.

Cinchona is the pioneer example of systematic medicinal plant introduction for commercial cultivation in India. Among aromatic crops, geranium, Japanese mint, chamomile and salvia are important examples of

vegetable crops. From historical facts, it is evident that most of the temperate/European vegetable crops were introduced in India by the Portuguese during 18th century followed by English in 19th century. Jenson from Kew introduced cauliflower varieties as early as in 1822 and grew it in botanical garden at Saharanpur. After independence several organizations like NHRDF, DARL, VPKAS, GBPUA&T etc were established and different programmes namely AICRP were implemented at different times to give further fillip to breeding of temperate vegetable crops. In recent times, under open general license (OGL), the private seed companies have introduced lot of seed material and started their own R&D programmes. India has also collaborated with AVRDC, Taiwan, China, USSR and SAVERNET (South Asian Vegetable Research Network) countries for testing of vegetable entries. Some of the research projects on temperate vegetable crops were funded by NATP (National Agriculture Technology Project). A detailed account on utilization of vegetable crops has been highlighted with special reference to cole crops and root crops. Cauliflower being the most important cole crops received maximum attention and lot of varieties of late cauliflower (Group

IV) namely, Pusa Snowball 1, 2, Pusa Snowball K1 were developed using exotic lines. Private seed companies have released F₁ hybrids namely, Himani, Guardian (Indo American), Candid Charm, White Flesh (Sakata), Serrano (Sandoz) using CMS and SI lines developed from exotic lines. In cabbage majority of ruling varieties are through introductions e.g. Golden Acre, Pride of India etc. Pusa Mukta, a black rot resistant variety, was developed by crossing two exotic lines (EC 24855 X EC 10109). Many tropical cabbage hybrids e.g. KK cross, Golden cross etc. were introduced and tropical cabbage lines DTC 50-7-4, 513, 528 etc. were developed. CMS system has also been transferred successfully to all cabbage lines from EC 173419 at Katrain. In other cole crops, majority of the varieties are developed mainly through introductions. In root crops also the improved cultivars are developed either through introduction followed by selection or by hybridization with exotic lines as one of the parent. The sources of pests and diseases resistance in cole crops are mainly exotic lines through introductions. The vast genetic resources of temperate vegetable crops have opened up the prospects of breeding using the introductions made from different countries.

Plant Introduction in Medicinal and Aromatic Plants in India: Achievements and Opportunities

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National Research Centre for Medicinal and Aromatic Plants, Anand, Boriavi-387 310, Gujarat

Human civilization witnessed the origin of a number of Health Tradition Systems through out the world. Each system has developed a number of effective herbal disease cure practices, which spread through out the world. An enormous number of medicinal plants are available in each health care system and are distributed in different parts of the world. Cultivation of medicinal plants is comparatively new phenomenon and domestication is widely prevalent in medicinal plant cultivation directly from the wild material.

The history of plant introduction is associated closely with human civilization. Even though, India is rich in its natural medicinal plant flora, there is a number of medicinal plant introductions occurred within the country from the time immemorial. A number of success stories of achieving the benefit of direct plant introduction are

available within the country such as commercial cultivation of isabgol, opium poppy, cinchona, senna etc.

In the earlier years, plant introduction was made at random by invaders, traders, missionaries and others. There are no records about the exact period of some plant introduction that has happened as in the case of Aloe whose center of origin is Africa, however naturalized in India and at present widely utilized in Indian health care systems and also in industry. It is interesting to record that foxglove introduced as ornamental plant in the hill resorts of Kashmir has become an important medicinal plant and now being cultivated.

Cinchona is the pioneer example of systematic medicinal plant introduction for commercial cultivation in India. Among aromatic crops, geranium, Japanese mint, chamomile and salvia are important examples of

successful introduction. The introduction of safed musli to South Indian states like Andhra Pradesh and Tamil Nadu from Maharashtra is an example of plant introduction within the country.

Narrow genetic base in introduced medicinal plants is the primary constraint for further crop improvement as in isabgol, senna, opium poppy, stevia, mints, citronella, etc. In some of the introduced crops quality and quantity of secondary metabolites are inferior than from where these were introduced due to environmental interaction which plays an important role in secondary metabolite production. Quarantine measures also have to be taken care in medicinal plant introduction as in the case of any other crops.

In the post-CBD era due to introduction of several restrictions and regulations, free exchange of genetic material has become limited. Almost all the introductions made in the past were species based. However, at present the introductions are mainly made to broaden the genetic base with well-defined targets. In medicinal plants, the scope of new species introduction is limited due to the interaction of genotype and environment on quality of secondary metabolite production. However, broadening of the genetic base of the existing endemic or introduced medicinal plants under cultivation needs to be targeted seriously to enhance the productivity of these crops in future.

Integrative Strategies for Genetic Conservation of Asian Medicinal Plants through Participatory Approach for Livelihood and Sustainability

SPS Khanuja, S Dwivedi, AK Mathur and AK Gupta

Central Institute of Medicinal and Aromatic Plants, PO: CIMAP Lucknow-226015, Uttar Pradesh

South-East Asian countries accounts for more than 60% of the global supply of herbs in the trade today. The time has now come when several models of integrative approaches must be devised and be put to test in utilizing our collective traditional knowledge and bio-resources towards the visible emergence of a joint Sector of Asian System of Medicines. The ASEAN model can act as a template to begin with in this direction. Obviously, this would involve equal partnership of various components of the entire value chain, comprising of traditional healers, plant collectors, conservation scientists, farmers, industry, traders and retailers. Exchange of plants and their introduction and quality evaluation/ validation in neighbouring countries will be an intense activity of this proposed model. All strategies aim to be applied in this mission must have three focal deliverables in

sight: IPR interests of the entire region, conservation of the exclusives and, people participation for sustainability and societal benefits. The age old concept and slogan of "Gene rich regions" has to be converted into business by reversing the status of supplier of raw materials to producers of the end products. Sufficient infrastructure and expertise are now in place to move ahead on this collective mission through complementation and synergism. We have to make our herbs quality validated in the backdrop of wider agro-climatic adaptability, cheaper cultivation costs and efficient nutrient utilization. The philosophy of establishing the Bio-villages for plant introduction, pioneered by CIMAP in last three years, will be presented in the symposium to exemplify the proposed model.

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Underutilized and New Crops–Germplasm Introduction

BS Phogat, RP Dua and RK Arora¹

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The region of South Asia is very diverse in its physiography, agro-ecology and climate, and possesses rich biodiversity in cultivated crops. Several under exploited and underutilized species occur which include native diversity and also, well acclimatized species introduced particularly in the past few decades.

In India, a total of 15,258 accessions of 60 underutilized and new crops have been introduced since independence. Out of these, 3361 accessions of 21 underutilized plants have been evaluated under the aegis of All India Coordinated Research Project on Underutilized Crops, which led to identification of 395 promising lines. Some of these materials, have been very useful as food and industrial crops and through germplasm evaluation several promising varieties have been released for cultivation at national level. To mention among are Suvarna in amaranth, Himpriya in buckwheat, BRS 1

in rice bean, VH 82-1 in faba bean, Arizona-2 in Guayule and EC 33198 in jojoba. These are now well adapted to diverse agro-ecosystems/agricultural systems. Further, about 70 species of underutilized crops have been identified to have promise in Asia pacific region and can play a pivotal role in diversification of the agriculture, management of wastelands and meeting the nutritional requirements of the people.

Similar diversity of known potential has been documented for other centres of diversity of crop plants, so as to introduce germplasm from the respective mega diversity regions and evaluate these for their adaptation and usefulness in South Asia region. In this paper, which is based on work carried out by NBPGR and other centres in India, an attempt has been made to assess the impact of such diversity and the opportunities envisaged through further exotic introductions.

Policy Issues in Germplasm Management

Sanjeev Saxena and N Murthi Anishetty

National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110 001

Plant genetic resources have played significant role in the development of agriculture, providing food, feed and fodder and also numerous medicines and industrial products. In general, the genetic diversity in plant is mostly located in tropical and sub-tropical regions of the world and countries are inter-dependent on their germplasm needs. The first international and intergovernmental discussions on access to genetic resources related to food and agriculture were initiated in 1979 and a formal agreement, the International Undertaking on Plant Genetic Resources (IUPGR) was adopted in 1983. It established the principle of plant genetic resources as the “heritage of mankind” and consequently these resources were available to *bonafide* users without restriction. The scientific and technical

achievements in the field of plant genetic resources thus have earlier focused mainly on their conservation, use and management since access to genetic resources was not an issue. However, the international development related to the intellectual property rights and trade in the last two decade have witnessed access to genetic resources emerge as a central topic of debate at national -global forum. The Convention on Biological Diversity in 1992 recognized the sovereign right of nations to exploit their own resources pursuant to their own environmental policies. It also established a new participatory relationship between provider and user of genetic resources incorporating the instruments of ‘Mutually Agreed Terms’ and ‘Prior Informed Consent’ for access to genetic resources for fair and equitable

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sharing of benefits derived from the use of genetic resources. In November 1993 the Commission on Genetic Resources for Food and Agriculture initiated the negotiations for the a legally binding instrument for Plant Genetic Resources and adaptation of the IUPGR in harmony with the CBD. After sustained intergovernmental discussions and negotiations the International Treaty on Plant Genetic Resources for Food and Agriculture was adopted in November 2001. The Treaty provides a framework of Multilateral System of exchange to ensure access to plant genetic resources, especially for plant species that are of importance for food security and of crops on which countries are interdependent. These global developments and the intricate relationship among them with regards to genetic resources have created a highly complex situation for the management of these resources. The world opinion today is clearly divided into two groups one

advocating a strictly regulated policy and other suggesting flexibility for controlling access to genetic resources. The developing countries are legitimately concerned about current developments that provide trans-national corporational opportunities for monopolizing the control and use of biologically derived materials, specifically through product or process patents or plant breeders' rights. Genetic resource managers thus are confronted today with new dimensions of obligations of some that are legal while others that are political and ethical. The respective nations are obliged to enact legislation and develop suitable regulatory mechanisms to ensure the enactment of the commitments made in the various negotiations. Not undermining the interdependence of nations in sharing and exploitation of genetic wealth on a sustainable basis, reaching a balanced and equitable agreement, seems a long drawn and difficult task.

International Crop Germplasm Exchange at ICRISAT

CL Laxmipathi Gowda and HD Upadhyaya

ICRISAT, Patancheru-502 324, Andhra Pradesh

Success of crop improvement programmes depends on the availability of diverse germplasm resources. Collection of the crop germplasm got impetus in the 1920s and as a result, presently, over six million germplasm accessions are held in over 1300 genebanks across the world. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is one of the important crop germplasm centers and holds 114 870 accessions of sorghum, pearl millet, chickpea, pigeonpea, groundnut, and six small millets. The germplasm collection has been built up by the generous donations of several national and international institutes and collections from the farming communities around the world. A large portion of this germplasm consists of landraces (78.6%) followed by breeding lines (15.4%), wild relatives of crops (2%), released cultivars (1.3%), and precise information is not available for the remaining 2.6% of germplasm accessions. About 99% of the collection has been characterized for a number of morphological, agronomical, and the nutritional quality traits, and the information has been computerized under an easy retrieval system. The germplasm accessions are maintained

following high scientific standards and conserved in a sophisticated facility. Besides managing the genetic resources, ICRISAT also has mandate for the genetic improvement of above cited first five crops. ICRISAT scientists generate breeding research materials of these crops and provide it to the scientists in national research programmes. As of now, over 1.2 million germplasm samples from ICRISAT genebank have been distributed to scientists worldwide. About 30% of these samples have been shared with the Indian national program scientists. This germplasm sharing has resulted in release of 544 varieties (478 from bred- and 66 from basic germplasm) supplied from ICRISAT.

ICRISAT has adhered to the policies of NBPGR/ Government of India while importing and exporting the germplasm using the Plant Quarantine Facility at ICRISAT-Patancheru where NBPGR and ICRISAT scientists have been working closely. So far there is no instance of the occurrence of any disease or insect-pest from the ICRISAT supplied germplasm material to other countries.

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Plant Introductions in the Maldives

KL Mehra

Former Director, National Bureau of Plant Genetic Resources, New Delhi-110 012

Agriculture in the Maldives is based mainly on plant species introduced periodically from time immemorial. Information is provided on the manner in which agriculture is practiced in the Maldives, including people's attitude towards plant products.. Several UN agencies made efforts towards the development of agriculture, horticulture and forestry by deputing consultants from time to time to advise the government on the suitability of different species for specific islands. While Mr Butany conducted field trials in several islands/atolls, using several species of field crops and vegetables, several other experts enlisted elite cultivars of tobacco, spices, tree species, fruits species and vegetables, for growing in specific islands based on their visits to different islands/atolls.

Dr Arora visited several islands/ atolls to study the diversity of different cultivated species and Mehra collected and evaluated several species of cultivated plants grown in different islands/Atolls.

Based on the reports of the consultants, the presentation discusses the achievements and opportunities for agricultural development in the Maldives especially related to the suitability of several introduced species, for household farming, community farming, crop-island development, development of un-inhabited islands, integrated agri-horticulture- forestry development, ornamental horticulture, fodder production, export crops and hydroponics.

Indian Plant Genetic Resource Management System

BS Dhillon, Anuradha Agrawal, RV Singh and JL Karihaloo

National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110 012

Plants provide raw materials for food, feed, fibre, shelter and medicines and several other uses. Termed as plant genetic resources (PGR) these are recognized as tangible resources of as much importance as soil, water, oil and minerals. The PGR are characterized by unequal distribution on earth; with some geographical regions endowed with greater diversity and called as centres of diversity. Growth in agriculture throughout the world has been achieved through two important processes – selection for better traits and introduction of plants from different geographical regions. Introduction of plants like rubber, coffee, tea, oil palm has played an important role in the economies of many countries. In India, rubber, coffee, cashew, sunflower, soybean, and maize are some of the examples of introduced plants which have become major crops.

Since the industrial revolution when scientific plant breeding has markedly improved agricultural production, the role of systematic collection, evaluation, conservation and exchange of PGR has gained rapid strides.

Management of PGR is an important issue, especially for a country like India, which is predominantly an agrarian society and also richly endowed with PGR. Realizing the importance of PGR, the Indian Council for Agriculture Research established the National Bureau of Plant Genetic Resources (NBPGR) in 1976. The Bureau is the nodal institute working on survey, collection, exchange, quarantine, characterization, evaluation, conservation and documentation of PGR. It has played a pivotal role in crop improvement and development and diversification of agriculture in India through germplasm introduction from various foreign sources and germplasm collection from within the country and abroad, and germplasm supply to plant breeders and other users. International collaboration and infrastructural facilities were strengthened manifold during the 1980s. While a cold-storage module (with a seed storage capacity of 30,000) was established in 1983, the state-of-the-art technology National Genebank (NGB) was established in 1996 with a storage capacity of one million

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seed accessions. Well-equipped cryopreservation and *in vitro* conservation facilities were developed to cater to the conservation of recalcitrant seed species and vegetatively propagated materials in 1986. The NGB maintain a germplasm holding of 0.29 million accessions of field and horticultural crops. Germplasm accessions numbering about 0.1 million have been evaluated and 79 catalogues published. Realizing the need for molecular characterization of the indigenous genetic diversity, a National Research Centre on DNA Fingerprinting was established at NBPGR in 1996. Also, to document the performance of promising germplasm and promote their exchange and use, the ICAR started the registration of potentially valuable plant germplasm at NBPGR in 1996. The NGB, ranks fourth in terms of base collection of germplasm in the world.

For better evaluation and enhanced utilization of PGR, the activities of NBPGR have been recently

expanded in a network mode. This involves coordination with the Project Director/Project Coordinators, All-India Coordinated Crop Improvement Projects, who serve as the National Active Germplasm Sites. In addition, collaboration is carried out with the Consultative Group and National Genebanks of other countries.

The modalities for access to PGR have changed rapidly in the last decade with the advent of the Convention on Biological Diversity (1993), the World Trade Organization (1995) and the International Treaty on Plant Genetic Resources for Food and Agriculture (2004). These treaties have also led to strengthening of intellectual property regimes in areas of agriculture and biotechnology which have directly and indirectly impacted PGR management in India. Important aspects related to these issues would be discussed in the presentation.

Plant Introduction in India during Pre- and Post-CBD Periods—An Analysis

Vandana Tyagi, AK Singh, Deep Chand, RV Singh and BS Dhillon

National Bureau of Plant Genetic Resources, New Delhi-110 012

The Introduction of exotic germplasm has enriched the Indian agriculture since times immemorial, resulting in establishment of a large number of crops and in development of high yielding varieties. In fact most countries are dependent on crops that have originated elsewhere and are considered to be interdependent with respect to genetic resources required for their crop improvement programmes.

In last two decades with the enforcement of CBD and provisions of the TRIPs under WTO, there is a general apprehension that free exchange of germplasm would be adversely affected because of issues related to sovereign rights of countries and IPR. Therefore, an analysis has been carried out on introduction of germplasm from other national genebanks and Consultative Group (CG) centres. The CG centres have assembled a large amount of germplasm in their mandate crops through international cooperation and freely distribute the genetic resources of these crops to the world community. The analysis includes the number of accessions received during the last 5 years of pre-

CBD era (1988-1992) and another 5 year (1997-2001) of post-CBD era. The period during 1993 to 1996 was not included to avoid the effect of transit phase.

A total of 46,650 accessions were received from national genebanks in different crop groups during pre-CBD (52.1 percent) and 42,911 (47.9 percent) from CG centres. Whereas, post-CBD 39,625 (47.3 percent) accessions were received from national genebanks and 44,057 (52.7 percent) accessions from CG centres. The data also indicates that national gene banks are major providers of cereals, oilseeds, forages, vegetables and fruits, while for grain legumes supply was almost equally distributed between national genebanks and CG centres. In cereals, the germplasm received in the form of international nurseries/trials which are received from CG centres was not included in this data. In cereals, national genebanks contributed 33.46 percent during pre-CBD, which got slightly increased (34.75 percent) during post-CBD.

Further, analysis regarding the type of genetic material received in cereals indicated that of the total

seed accessions. Well-equipped cryopreservation and *in vitro* conservation facilities were developed to cater to the conservation of recalcitrant seed species and vegetatively propagated materials in 1986. The NGB maintain a germplasm holding of 0.29 million accessions of field and horticultural crops. Germplasm accessions numbering about 0.1 million have been evaluated and 79 catalogues published. Realizing the need for molecular characterization of the indigenous genetic diversity, a National Research Centre on DNA Fingerprinting was established at NBPGR in 1996. Also, to document the performance of promising germplasm and promote their exchange and use, the ICAR started the registration of potentially valuable plant germplasm at NBPGR in 1996. The NGB, ranks fourth in terms of base collection of germplasm in the world.

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The modalities for access to PGR have changed rapidly in the last decade with the advent of the Convention on Biological Diversity (1993), the World Trade Organization (1995) and the International Treaty on Plant Genetic Resources for Food and Agriculture (2004). These treaties have also led to strengthening of intellectual property regimes in areas of agriculture and biotechnology which have directly and indirectly impacted PGR management in India. Important aspects related to these issues would be discussed in the presentation.

Plant Introduction in India during Pre- and Post-CBD Periods—An Analysis

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National Bureau of Plant Genetic Resources, New Delhi-110 012

The Introduction of exotic germplasm has enriched the Indian agriculture since times immemorial, resulting in establishment of a large number of crops and in development of high yielding varieties. In fact most countries are dependent on crops that have originated elsewhere and are considered to be interdependent with respect to genetic resources required for their crop improvement programmes.

In last two decades with the enforcement of CBD and provisions of the TRIPs under WTO, there is a general apprehension that free exchange of germplasm would be adversely affected because of issues related to sovereign rights of countries and IPR. Therefore, an analysis has been carried out on introduction of germplasm from other national genebanks and Consultative Group (CG) centres. The CG centres have assembled a large amount of germplasm in their mandate crops through international cooperation and freely distribute the genetic resources of these crops to the world community. The analysis includes the number of accessions received during the last 5 years of pre-

CBD era (1988-1992) and another 5 year (1997-2001) of post-CBD era. The period during 1993 to 1996 was not included to avoid the effect of transit phase.

A total of 46,650 accessions were received from national genebanks in different crop groups during pre-CBD (52.1 percent) and 42,911 (47.9 percent) from CG centres. Whereas, post-CBD 39,625 (47.3 percent) accessions were received from national genebanks and 44,057 (52.7 percent) accessions from CG centres. The data also indicates that national gene banks are major providers of cereals, oilseeds, forages, vegetables and fruits, while for grain legumes supply was almost equally distributed between national genebanks and CG centres. In cereals, the germplasm received in the form of international nurseries/trials which are received from CG centres was not included in this data. In cereals, national genebanks contributed 33.46 percent during pre-CBD, which got slightly increased (34.75 percent) during post-CBD.

Further, analysis regarding the type of genetic material received in cereals indicated that of the total

introductions received from national genebanks, 95.3 percent and 96.5 percent were germplasm; 3.5 percent and 2.2 percent varieties and 1.2 and 0.5 percent wild and weedy relatives in pre- and post-CBD era, respectively. Similarly from CG centres 94.3 percent and 93.4 percent were germplasm; 2.9 percent and 4.4 percent varieties and 2.7 and 2.3 percent wild and weedy relatives in pre- and post-CBD era, respectively. Amongst the national genebanks, USDA, USA was the main supplier. Significant number of accessions were also introduced from Australia, UK, Italy, Germany and Canada.

These results indicate an overall decline of 6.6 percent in the introduction of germplasm during post-CBD period. However, this decline was confined to

the supplies from national genebanks, which suggest of the cautious approach adopted by different countries in sharing of germplasm. Another interesting observation was that despite overall decrease, there was an increase in import of accessions from CG centres, probably because of the attempts on restoration of germplasm from CG centres. Also, the results indicated that 81 percent of germplasm was introduced from technology rich countries, which are not the centre of diversity of respective crops. This might be because of early realization of the importance of plant genetic resources in these countries in crop improvement, leading to collection and conservation from world over.

Prehistoric Plant Introductions in South Asia

KL Mehra¹ and L Costantini²

¹ Former Director, NBPGR, New Delhi-110 012

² Director, Italian Institute for Africa and the East, Rome, Italy

Archaeo-botanical records have revealed an independent beginning and diffusion of Agriculture in Uttar Pradesh, India, in the ninth millennium BC, and the subsequent diffusion /introduction of rice based agriculture into Kashmir, Gujarat, Pirak, Baluchistan and Sind in the third millennium BC. Several crops of Indian origin were domesticated and grown in summer and kharif seasons at several archaeological sites located in the Saraswati river valley. Agriculture also began to be practiced in Mehrgarh, Baluchistan and adjoining southeastern Iran during the seventh–sixth millennium BC and in Afghanistan during the third millennium BC, using local domesticates and introduced crops from Southwest Asia. At the archaeological sites in Gujarat and in the Indus valley in Sind and Punjab, crops of Indian, Southwest Asian and African origins

began to be grown in the third millennium BC. With the decline of the Harappan civilization and the joining of the Satluj river with the Indus river and the Yamuna river with the Ganges river, agriculture spread to Bihar, Bengal and Madhya Pradesh. This presentation discusses the impact of pre-historic plant introductions from Southwest Asia into South Asia, especially the agricultural revolution, using crop rotation for the first time in the world, viz., the growing of introduced crops of Southwest Asian origins in winter and crops of African and Indian origins in summer and kharif seasons. Mention is also made of prehistoric plant introductions from East and Southeast Asian regions into South Asia, although archaeological records are not available to elucidate the time frame of such introductions.

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Ancient Introductions of Crops and Related Taxa into India and Export out of Indian Subcontinent: Some Factual Data and Gaps in Our Knowledge

Mukund Kajale

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Indian Sub-continent with its tremendous eco-geographical, climatic, pedological and floristic variations has been a wonderful field cum natural laboratory for testing various hypotheses regarding introduction of crop plants, their putative ancestors and related taxa of plants as well as animals since prehistoric times, at the hands of Man. This has been a land of innovation, absorption, amalgamation, improvements and donations (exportations) since antiquity. In cultural terms, Mahatma Gandhi, Pandit Jawaharlal Nehru and scholars from various fields have aptly described it as "Unity in Diversity".

The author tries to visualize the botanical evidences in the form of carbonized and phosphatised grains, husks, fruits, impressions, etc. From scores of archaeological sites to know the time and place of exploitation of botanical wild germ plasm resources along with brief reference to animal wealth. The paper reviews broad phases of initiation of plant domestication in the Indian

sub-continent, introduction of foreign crops around c. 6000 B.P., c. 4000 B.P., c. 2000 B.P. and c. 400 B.P.; their adoption, assimilation, improvement and exportation of indigenous crops to other regions of the world in antiquity. The rich modern farming system of Indian sub-continent has evolved through historical and archaeological processes and the author tries to present factual palae-bio-geographical indicators for appreciating chronology, region of acceptance, improvements, reflections of cultivated species and wild food produces in historical texts and hints at harnessing of rich biodiversity of potentially useful agricultural plants. The author proposes that such integrated and fundamental studies will also be useful to science-policy makers for duly establishing intellectual property rights of the Indian people with reference to various indigenous arable, tree crops, tuber crops, etc. being exploited since times immemorial.

Plant Quarantine Issues for Germplasm Exchange and Scope for Networking in South Asia

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Plant quarantine plays an important role in preventing introduction of pests and their subsequent establishment along with the exchange of germplasm material in a new geographical area. It is motivated by the philosophy that it is better to endure some inconvenience and expense in an effort to exclude the exotic pests, rather than submit to losses involved following their entry and establishment.

The South Asian countries have a lot of commonalities with respect to agro-ecological conditions, cropping

systems and crop spectra. Most of them have contiguous land borders without any natural barriers. The land races and wild relatives of many crops are distributed across national boundaries. Exchange of plant genetic resources (PGR) has contributed significantly towards crop improvement and increased crop production in the region. However, a number of pests have also moved across the countries along with planting material. For example, *Hemileia vastatrix* causing coffee rust, bunchy

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top of banana and coffee berry borer *Hypothenemus hampei* have moved from Sri Lanka to India in 1876, 1940 and 1993, respectively. Now, with the liberalization of trade under World Trade Organization (WTO), the quarantine set-up of all the countries in the region needs to be reviewed. In India, National Bureau of Plant Genetic Resources (NBPGR) is the nodal agency for exchange of germplasm including transgenics. There are a number of issues related to quarantine in germplasm exchange. The legislative issues are country specific where as those of quarantine processing and methodology are applicable to all.

The national quarantine legislation needs to be in harmony with the international norms laid down by International Plant Protection Convention, and India has attempted to do so by bringing out the new Plant Quarantine (Regulation of Import into India) Order, 2003. However, the legislation has been drafted more for facilitating bulk imports than for exchange of germplasm. Under this order a pest risk analysis (PRA) has been made mandatory. The various schedules V, VI and VII of the Order give lists of crops for which a generic PRA is given and detailed PRA is not required. In case of germplasm, a large number of species of cultivated crops (and their wild relatives/ land races) with useful traits are imported but do not find mention in any of the schedules. Hence, a detailed PRA becomes obligatory for them which, in fact, is elaborate and modalities of its preparation are still not clear. Also, the presence of wild relatives, land races of germplasm whose pest profile is not recorded is likely to hamper PRA preparation. There is a need to decentralize the power to waive off the requirement of having a detailed PRA in specific case of germplasm of species not mentioned in any of the aforesaid schedules.

The amount/ size of the germplasm sample is very crucial from quarantine processing point of view, as sampling procedures meant for bulk material cannot be adopted. Also, the technique applied should enable detection of miniscule amounts of pest in the samples drawn and also be non-destructive. The sample size may not be enough for direct testing of seed and post-entry quarantine testing and release from indexed virus-free plants may take one crop season. Diagnostic reagents such as antisera for viruses/ bacteria and the reference collection for insect pests are often not available for exotic pests. Also, the quarantine processing of transgenic plant material needs a containment facility for taking care of the biosafety requirements. Research needs to

be intensified on the development of sensitive and non-destructive detection and salvaging techniques, alternatives to methyl bromide, molecular techniques for detection of races/ biotypes/ strains and also low levels of infections. A database on potential quarantine pests and list of endemic pests of different crop species is essential for quarantine personnel as a ready reckoner. A repository of antisera etc. needs to be established, as one has to deal with exotic pests in quarantine.

There is a need to establish a regional plant quarantine network through harmonization of plant quarantine regulations in South Asia on the lines of the Association of South East Asian Nations (ASEAN) and the European and Mediterranean Plant Protection Organization. The plant health related standards of the Region also need to be harmonized to facilitate smooth flow of planting material/ plant products within and outside the region. Common pests present in all the countries could be listed to enable the waiver of additional declarations in the issue of import permit. This would imply a compilation of information on pests present or absent all over the region, or a part of the region. Such a data would also facilitate development of PRA for crops/ pests and trade related plant safety standards of common interest to prevent their use as non-tariff barriers in international trade. Countries with expertise for undertaking quarantine of special crops/ pests could take up that task on behalf of other member countries. Also, movement of plant pests recently introduced in any of the South Asian countries such as *Bemisia tabaci* (B biotype) introduced in India, a polyphagous pest with a wide host range of > 600 plants introduced in India requires immediate attention. Pests like sunflower downy mildew introduced into India and which have yet not spread to other sunflower growing countries like Bangladesh in the region, needs to be carefully monitored especially since we have contiguous land borders. Multidisciplinary collaborative research needs to be taken up, particularly in view of scarcity of resources in many parts of the region.

International Plant Genetic Resources Institute (IPGRI), South Asian Network on PGR (SANPGR), Committee on Sanitary and Phytosanitary Measures of SAARC and Asia and Pacific Plant Protection Commission (APPPC) enhance their efforts in developing a strategy at regional level to identify areas of collaboration, streamline the technical and policy issues and network for safe exchange and quarantine.

Cost of Plant Introduction—The Expanding Horizons of Crop Diseases

Satvinder K Mann

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The number of diseases which moved inadvertently to new ecological regions from their original habitats have increased over the years due to the increased mobility of men and materials. In spite of the stringent regulations and considerable investments to prevent entry of Karnal bunt pathogen of wheat, caused by *Tilletia indica*, in to USA, the organism was detected in about 25 years of its detection in Mexico, indicating inadequacy of the quarantine efforts. This calls for an introspection. Subsequently relaxation of the minimum quarantine specifications were considered, but nevertheless “expanding horizons of plant pathogens remain a reality”. There is need to look at the plant introduction and its consequences objectively on a long term basis and beyond disease free materials. Because when virgin disease free planting material is considered for planting, at times it may become more susceptible due to absence of resistance against indigenous pathogens. When introductions are made through germplasm exchange, the materials, which are susceptible, are likely to get eliminated with respect to the major disease problems. However minor diseases which are not considered for screening and testing were later found to have assumed significance. The consequences of large scale introduction of disease free exotic material and their introgression in to new cultivars in the breeding programme since last 40 years in India and rest of the world, has resulted in converting many minor endemic organisms in to major disease problems. This situation was well illustrated with rice and wheat crops in India, where number of “minor diseases like Karnal bunt and leaf blights in wheat and BLB, sheath rot, sheath blight, false smut and brown spot in rice and grain discolourations in both have assumed significance”, after the new dwarf varieties were released for cultivation in the farmers field since 1960’s,

further adding to the cost of their management. The domains of these organisms have increased, further aggravating the situation, because here is no control on seed trade and retailing of the seeds of new cultivars and their movement in to unscheduled regions with in the country. The pathogens like *T. indica*, which were endemic to the foot hills of north India, colonized all the niches in the north western plain zone. Therefore, along with preventing the introduction of exotic pathogens, the possibility of the indigenous pathogens becoming severe also needs to be taken care of. As the subsequent flare ups and spread of indigenous pathogens adds to the cost of plant introduction many folds. This needs to be considered in future, to prevent recurring cost to sustainability. Risk for this will aggravate with trade in agricultural commodities assuming global proportions. Therefore along with implementation of quarantine at the international level, there was need to (a) revoke domestic quarantine, (b) devise legislative measures to check indiscriminate sale and spread of seed varieties in the unscheduled regions in the domestic market to arrest ever expanding domains of endemic pathogens and (c) Screening efforts to test the new materials against minor pathogens also need to be taken care of, considering the extent of economic damage the Karnal bunt caused to the surplus wheat from north western plain zone of India. A delayed domestic quarantine against flag smut of wheat had cost USA the wheat trade with China from early nineteenth century till fifties. Since increased movement of agricultural produce in future will entail increased spread of pathogens, therefore “preventive” (i) international as well as (ii) domestic measures are equally important to reduce the cost of plant introduction and contain ever expanding horizons of plant pathogens.

Plant Introduction in Environmental Pollution Control and Waste Land Development

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The pernicious weed *Parthenium hysterophorus* L., commonly known as congress grass, carrot weed, white cap etc, growing naturally since centuries in Latin America and many other countries, has become one of the seven most dreaded weeds of the world (Singia, 1992). In India, it is noticed only from mid-fifties and is presumed to have been accidentally introduced in Maharashtra. However, its spread throughout the country has been very rapid with abnormal density. Abandoned and wastelands, vacant sites, road sides, railway tracks, grave yards, back yards, cultivated lands etc, are the targets for the invasion by this dreaded weed. The consequences of the rapid and gregarious growth of parthenium, especially the ill effects on human, livestock and plants, have been well published to create public awareness. All the parts of the plant, particularly its pollen have allergic effects on other organisms. The weed can germinate, flower and set seeds within four weeks. A single plant can produce up to fourteen thousand seeds. Once established, it can survive severe droughts and frosts. Further, factors such as (i) the absence of natural agents that restrict the spread of this plant as in its original home, (ii) high fecundity, (iii) efficient seed dispersal mechanisms, (iv) monopolistic allelopathic impact on most other plant species, (v) unsuitability for grazing because of the presence of anti-feedants in the plant system and (vi) wide adaptability to varying soil and agroclimatic conditions have enabled this plant to invade a variety of growing environments particularly in situations associated with human activities.

Parthenium has been regarded as a beneficial plant too. It is used as a folk remedy against various afflictions such as ulcerated sores, certain skin diseases, facial neuralgia, for cleaning the blood and also as insecticide. It is reported that "parthenin", the principal ingredient of this plant possesses anticancer properties. Parthenium plants have been commonly used as centering material in the construction of buildings and bridges. Possibility that parthenium plants can be ensilaged after mixing it in certain proportion with conventionally used feeds, is also reported. The ensilaged parthenium is reported

to be devoid of the contact allergen/toxin parthenium and was palatable to live stock. The fibrous nature of the parthenium stem is a point that needs the attention of industrial researchers to see if it has potential in manufacturing paper and such other materials as helmet, molded furniture, door etc. In the years of drought when most plant species fail to grow, parthenium, by virtue of tolerance to drought, grows and brings down CO₂ level in the atmosphere. It is reported that 20 per cent parthenium leaf water extract when sprinkled on mulberry leaves improved the quality as well as quantity of cocoon due to steroids present in the parthenium plant. As felt at present, its harmful effects both from medical as well animal health and agricultural production point of view are serious matters for consideration.

The management of this weed has posed a serious challenge to the scientists, administrators and the public. Manual, chemical and biological approaches have long been attempted. The weed has defied all human efforts to control it. But positive results are seen through integrated management suggested from 1988 onwards in which plant introduction has played major role. The Integrated Parthenium Weed Management Technology (IPWMT) being adopted successfully in containing this weed includes botanical agents such as *Cassia sericea*, *C.tora*, *Tephrosia purpurea*, *Heptis spp.*, *Sida spp.*, *Mirabilis jalapa*, *Croton sparciflorus*, *Stylosanthus hamata*, *Tagetes erecta*, *Amaranthus spinosa* etc, beside releasing Mexican beetle (*Zygogramma bicolorata*), hand pulling and herbicide application. Proven botanical agents need to be introduced depending on their suitability to the ecological situations wherein parthenium has invaded in a menacing scale.

The Integrated Parthenium Weed Management Technology (IPWMT) involving the various methods suggested in the past could be effective in controlling parthenium. If a concerted effort is made to adopt IPWM, the results will be visible in the second year and by the third year the parthenium will come down to a negligible level. The newly suggested IPWMT envisages five steps viz., (i) Maintenance of natural biodiversity

i.e., not to disturb the existing flora to the extent possible, (ii) In places where cleaning and exposing of soil is unavoidable, planting of *C. sericea* or such proven botanical agents (BAs) at the start of rainy season. The growth of such plants can insulate opened up soils against invasion by parthenium. In already infested areas, planting of botanical agents may be taken up at the start of rainy season and parthenium plants which may grow along with BAs are to be removed in the initial one or two years, so that the antagonistic plant establishes well. Afterwards, the BAs will shed seed and perpetuate on their own. (iii) To watch for the commencement of rains and build up of Mexican beetles and when the beetles become available in large numbers, they have to be collected and released in parthenium-invaded areas. (iv) In situations where none of the above methods can be adopted as in case of gardens, flowers beds, lawns intensively cultivated agricultural fields, manual removal has to be taken up. In the manual method, it should be noted that the persons chosen for uprooting the weed should not be allergic to parthenium. (v) In situations where none of the above methods can be adopted like vast stretches of already parthenium invaded plots and where immediate relief is needed, it may have to be controlled through chemical sprays with the knowledge that it gives only temporary suppression and

does not ensure permanent control. Adoption of this technology in Karnataka has clearly demonstrated the success of this method in suppressing the growth of parthenium up to 90 per cent in some parts of north Karnataka and to an extent of fifty per cent in pockets of southern Karnataka, including in and around Bangalore city. Success is also seen in the neighboring states of Andhra Pradesh and Tamil Nadu.

The proven botanical agents are: *Cassia sericea* (Syn: *Cassia uniflora*), *C. tora*, *C. auriculata*, *C. occidentale* *Croton bonplandianum*, *Amaranthus spinosus*, *Tephrosia purpurea*, *Hyptis suaveolens*, *Sida spinosa*, and *Mirabilis jalapa*, *Stylosanthus hamata* and *Tagetes erecta*, the strongest being the first one. Thus, the introduction of identified botanical agents where the super weed has invaded and established in a dangerous proportion has a key role to play in checking the growth of this weed and wasteland development. The contribution of plant introduction can be enormous not only in crop production but also in maintaining biodiversity, weed control, pollution control and wasteland development. The biomass efficient plants among them, like *Cassia sericea*, *C. tora* also find several other uses like green manure, gum from seeds, and fodder from *Stylosanthus* etc, and can even be potential source of biofuel.

SHORT COMMUNICATIONS

Assessment of Genetic Divergence in Relation to Hybrid Breeding in Rice

SK Singh¹, Manoj Kumar², VK Sharma², N Kumari², VK Shah² and PB Jha¹¹Department of Plant Breeding, ²Department of Genetics, Rajendra Agricultural University, Pusa-848 125, Bihar**Key Words:** Rice, Restorer, Maintainer, Cluster Analysis, Divergence

Genetic diversity is considered as an important criterion while choosing the parents for realizing heterosis and recombination in breeding programmes. Within a limit, inclusion of more diverse parents in hybridization is believed to increase the chances of obtaining stronger heterosis in hybrids. In the present communication, an attempt has been made to ascertain the magnitude of diversity among some maintainer and elite restorer lines in order to provide a rational basis for the selection of suitable parental lines to develop heterotic combinations.

The experimental materials comprised 29 fertility restorers and 17 sterility maintainers of wild abortive cytosterility system (personal communication) in rice. The restorer lines IR 23352-7R, IR 33509-26-2-2R, IR 42266-29-4-4-4R, IR 43342-10-1-1-3-3R, IR 55838-B2-2-3R, IR 56381-139-2-2R, IR 58082-126-1-2R, IR 58103-62-3R, IR 59624-34-2-2R, IR 59669-93-1-3R, IR 59682-132-1-1-2R, IR 60819-34-2-1R, IR 60919-150-3-3-2R, IR 60997-16-2-3-2R, IR 61614-38-19-3-2R, IR 62030-59-1-2-2R, IR 62036-222-3-3-1-2R, IR 62037-12-1-2-2R, IR 62037-129-2-3-3-3R, IR 62161-184-3-1-3-2R, IR 62171-122-3-2-3-3R, IR 63870-123-2-2-2-2R, IR 63870-7-3-2-3-3R, IR 63875-196-2-2-1-3R, IR 63877-43-2-1-3-7R, IR 63879-195-2-2-3-2R, IR 65849-H-AC2-2R, IR 65514-5-1-2-19R, IR 65515-56-1-3-19R, (hereafter designated as R-1 to R-29, respectively) and the maintainer lines IR 58025B, IR 67684B, IR 68275B, IR 68280B, IR 68885B, IR 68888B, IR 68892B, IR 68897B, IR 68899B, IR 68902B, IR 69161B, IR 69626B, IR 69628B, IR 70362B, IR 70369B, IR 70372B and IR 70959B (hereafter designated as B-1 to B-17, respectively) were evaluated in randomized block design with three replications at the research farm of Rajendra Agricultural University, Pusa, Bihar during *kharif*, 2002. Seedlings of each entry were transplanted to the field in three rows spaced at 20 cm and inter-plant distance within a row was maintained at 10 cm. Observations for plant height, panicles per plant, panicle length, spikelets per

panicle, branches per panicle, panicle exertion, grains per panicle, spikelet fertility, panicle density, 100-seed weight and grain yield per plant were recorded on five random competitive plants from each entry in each replication, while days to 50% flowering was recorded on plot basis. Multivariate analysis was used to quantify genetic diversity and the entries were grouped into clusters (Rao, 1952). For numerical classificatory analysis (Sokal and Sneath, 1963), an average taxonomic distance (Sokal, 1961) was computed as a measure of dissimilarity. The method for tree building involved sequential agglomerative hierarchical nested clustering based on taxonomic distance. Dendrogram was constructed by unweighted pair group method using arithmetic average and the clusters were identified at the appropriate phenon levels.

Significant differences among the restorers and maintainers were observed for all characters. Using D^2 value obtained for each pair wide combination of entries, the restorer and maintainer lines were grouped into five clusters, Cluster A comprised 20 restorer and 7 maintainer lines (Table 1). Its intra-cluster distance was only next to the largest intra-cluster distance in cluster D, which had two restorer and two maintainer lines. Cluster C with the lowest intra-cluster distance accommodated only three maintainer lines. While Cluster B consisted of six restorer and five maintainer lines, cluster E was found to be monogenotypic and consisted of a maintainer line. Interestingly, the first two clusters comprised 38 entries, reflecting narrow genetic diversity among the lines under evaluation in the present study. The close genetic relationship was more apparent in the case of restorers as 26 lines were included in the first-two clusters. While the restorer lines were observed to be genetically more closely related, the maintainer lines were relatively more diverse. The similarity in parentage and fixed selection criteria might be the cause of less genetic diversity in these parental lines in general and restorer lines in particular.

Table 1. Composition of cluster based on generalized distance for twelve characters among restorers and maintainers

Cluster A: R1, R6, R7, R8, R9, R10, R11, R14, R16, R17, R18, R19, R20, R21, R23, R25, R26, R29, B2, B6, B7, B8, B9, B10, B12
Cluster B: R5, R13, R15, R24, R27, R28, B1, B3, B11, B13, B17
Cluster C: B4, B5, B14
Cluster D: R2, R4, B15, B16
Cluster E: R3

Average inter-cluster distances were greater than intra-cluster distances. The inter-cluster distance was maximum between clusters D and E. It was closely followed by a distance of cluster C and cluster B from cluster D. The greater inter-cluster distances indicated greater genetic diversity of the entries belonging to cluster D from those belonging to cluster B, cluster C or cluster E. A perusal of cluster means for different characters, indicated the superiority of cluster D over the others in respect of panicle length, panicle exertion, spikelet fertility, 100-grain weight and grain yield per plant. Similarly, it was evident that cluster B had the highest cluster mean value for spikelets per panicle, branches per panicle, grains per panicle and panicle density. But for days to 50% flowering and panicles per plant, cluster C had the lowest and the highest mean value, respectively. While cluster C recorded the lowest cluster mean for a majority of the yield contributing characters, cluster B, D and E had higher cluster means for most of these characters. Considering inter-cluster distances in conjunction with cluster means and clustering pattern, crossing of B15 and B16 with R3 is suggested as it may give high heterotic rice hybrids. Similarly, the crosses involving B15 and B16 with R5, R24, R27 and R28, in addition to the crosses involving B1, B3, B11 and B13 with R2 and R4 could be predicated as superior heterotic combinations.

Basically the entries, were classified into one multigenotypic and one monogenotypic groups. While truncation at 60 dissimilarity units created four diverse groups (Table 2). At this phenon level, clusters A, B, C and D consisted of 22, 20, 3 and 1 entries, respectively. Cluster A was divided into sub-clusters AI and AII at 50 units of dissimilarity with 19 and 3 entries, respectively. Similarly, cluster B got divided into sub-clusters BI, BII and BIII with 18, 1 and 1 entries, respectively. While, cluster C split into CI and CII with two and one entries, respectively. An increase in phenon level

Table 2. Composition of clusters based on dissimilarity coefficients for twelve characters among restorers and maintainers

	No. of clusters identified at phenon levels*			Entries included in each cluster
	60%	50%	40%	
A	AI	Aia		R1, R6, R7, R8, R9, R16, R17, R18, R19, R20, R22
(22)	(19)	(16)		R25, B6, B8, B9, B12
		AIIb		B2, B14, R11
	AII	AIIa		B5, R10
	(3)	(2)		
		AIIb		B4
		(1)		
B	BI	Bla		R2, R5, R12, R13, R14, R21, R23, R26, R27, R28
(20)	(18)	(14)		R29, B3, B13, B17
		BIVb		R15, R24, B10, B11
	BII	BII		R3
	(1)	(1)		
	BIII	BIII		B1
	(1)	(1)		
C	CI	CI		B15, R4
(3)	(2)	(2)		
	CII	CII		B16
	(1)	(1)		
D	D	D		B7
(1)	(1)	(1)		

Figures in parentheses indicate number of entries in respective clusters

*Phenon levels indicate 60, 50 and 40 units of dissimilarity coefficients

by drawing the phenon line at 40 dissimilarity units, which allowed only increasingly similar entries to be clustered together, further enhanced the number of constellation of entries. It was thus possible to discern subtle differences between genotypes grouped in different clusters and/ or sub-clusters at different phenon levels. While the grouping of genotypes in different clusters through dendrogram was fairly in good agreement with the clustering through D² analysis, the discrepancy for some of the entries could be attributed to the difference in the methods of analysis. A further comparison of clustering patterns based on different methods showed that dendrogram clustering gave an additional advantage of distinctly discriminating the genotypes and identifying sub-clusters of the major groups at different phenon levels.

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Exploiting Alien Germplasm Resources against Biotic Stresses in Wheat

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Key Words: Wheat Alien, Crosses, Mapping/ Tagging

Wheat is truly global, being one of the few crops grown over most of the world. There are hundreds of wild species, landraces, and local cultivars within the *Triticum* species that constitute the wheats of the world. The role of germplasm in wheat improvement is well established. A highly successful phase of germplasm utilization was initiated with incorporation of dwarfing and photoperiod insensitivity genes from Japanese and Italian germplasm into widely adapted, rust resistant genetic background at CIMMYT. Finally, exploitation of Norin 10 dwarfing gene ushered Green Revolution in India. This very success was based on strategic exploitation of genetic resources.

Wheat, being the most important food crop of the world, has attracted most attention and it has been hybridized extensively with 'alien' species belonging to several related genera (Sharma and Gill, 1983 and Islam and Shepherd, 1990). The prospect of transferring desirable traits like disease and pest resistance drew attention of early workers to attempt wide hybridization resulting into introgression of alien genes to cultivated wheat species. More recent considerations are to transfer nematode and disease resistance genes from barley to wheat. Wild relatives have contributed a great deal to the improvement of cultivated wheat. Dwarf alien germplasm resources possessing various important traits have already been transferred or are potentially transferable (Gautam *et al.*, 1998, Nanda *et al.*, 1998 and Friebe *et al.*, 1996).

Recently protoplast fusion and regeneration alone has widened the wide hybridization range by facilitating union of wheat x alien species that were not possible earlier by direct crossing. Wide crosses have already moved into cellular and molecular approaches where the diagnostic techniques are a boon for effecting alien transfers. There are four major groups of markers with applications in wheat wide crosses-morphological, genetic, cytological and biochemical. Combined use of these markers adds to efficiency.

The fact that several of the resistance genes mapped in wheat have been introgressed from alien species explains the success of tagging them since a higher level of polymorphism is detected compared to segments where

no alien DNA is transferred. In the last decade, a large number of genes of various functions have been mapped to specific wheat chromosomal regions. Several mapping/ tagging strategies using mostly RFLPs and RAPDs have led to these results. A number of RFLP and RAPD linked markers were then converted to PCR-based, more robust markers, such as sequence tagged sites (STSs), sequence characterized amplified regions (SCARs) or allele specific amplicons (ASAs) (Hoisington *et al.*, 2003).

There seems every possibility that biotechnology may soon overcome the constraints related to the actual transfer of desired alien genes into their respective hosts. The enormous array of genetic stocks in *Triticum* offers remarkable opportunities for alien gene transfers. There is need of enforcing crop improvement protocols based upon the utilization of genetic diversity, crucial for durability of stress resistances and tolerances and for the ensuring sustainability. The useful variability from the wheat germplasm needs to be constantly explored and introgressed into cultivated wheats for ensuring adequate food and nutritional security to the ever-increasing global population.

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Characterization of Sorghum Germplasm Introduced from Brazil

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Key Words: Sorghum, Exotic, Evaluation

Sorghum is of African origin (Kimber 2003) and largest diversity of cultivated and wild sorghum is in Africa (deWet 1977). More than 11,000 exotic germplasm have been introduced in India from 46 countries of the world.

A total of 60 accessions of sorghum exotic collections introduced from Brazil and supplied by NBPGR (Regional Station), Hyderabad is characterized at National Research Centre for Sorghum (NRCS), Hyderabad to identify the promising lines to acclimatize with Indian conditions. The accessions were sown in 3 m single row with 60 cm width and plant-to-plant 10 cm distance in augmented block with 3 checks (CSV 16, M 35-1 and EP 47) during *rabi* (2003–04). The important 13 agromorphological characters were studied. The first step in the exploitation of genetic variability is the characterization of the germplasm for morpho-agronomical traits, resistance to biotic/ abiotic stresses, etc. based on the list of sorghum descriptors released by IBPGR and ICRISAT (1980, 1993), and Mahajan *et al.* (2000).

The results showed maximum variability on days to flowering, leaf length, plant height, earhead length,

stem fresh weight, stem dry weight, and grain yield. The descriptive statistics on quantitative characters of new *rabi* sorghum germplasm is presented in Table 1.

The qualitative characters on exotic collections introduced from Brazil characterized at Hyderabad showed maximum frequency observed on good seedling vigour (48 acc.), semi compact earhead (21 acc.), loose earhead shape (23 acc.), brown seed colour (37 acc.), small seed size (23 acc.), straw glume colour (22 acc.), all non-lustrous seed, bicolor race (37 acc.), awn absent (49 acc.) and above 100 percent glume coverage (46 acc.).

In these collections, about 50 percent of the accessions were resistant to aphids. It is also observed that complete *ms* line in 4 acc., fertile and sterile lines in 29 acc. (two types) and fodder type–36 acc.

A total of 6 accessions have been rated as very good based on all characters viz., EC-507650, EC-507651, EC-507653, EC-507656, EC-507682, EC-507860. A total of 25 lines have been identified as potential donor for longer and wider leaves for high biomass, longer and wider earhead and 100-seed weight for high yield (Table 2).

Table 1. Descriptive statistics on quantitative characters of exotic collections introduced from Brazil (60 accessions)

Characters	Range	Minimum	Maximum	Mean	SE	SD
Days to 50% flowering (days)	22	69	91	77.00	0.78	6.20
Number of leaves	7	4	11	7.00	0.23	1.86
Leaf length (cm)	174	42	216	80.18	5.63	44.67
Leaf width (cm)	6	4	10	6.13	0.24	1.89
Plant height (cm)	177	68	245	151.00	5.63	44.71
Stem thickness (cm)	1	1	2	1.33	0.04	0.29
Earhead length (cm)	23	17	40	26.98	0.66	5.24
Earhead width (cm)	7	4	11	7.89	0.22	1.74
Brix (%)	12	2	14	8.00	0.37	2.91
Stem fresh weight (g)	1250	250	1500	693.81	37.27	295.82
Stem dry weight (g)	800	200	1000	423.98	23.13	183.59
Grain yield (g)	54	13	67	29.87	2.45	14.91
100-seed weight (g)	3	1	4	1.94	0.10	0.71

Table 2. Promising lines identified from exotic collections introduced from Brazil (60 accessions)

S.No.	Character	Collector number	No. of acc.
1	Longer leaves (>200cm)	EC-507678, EC-507679, EC-507680, EC-507685	4
2	Wider leaves (>9cm)	EC-507653, EC-507671, EC-507675, CSV 16 (check)	3
3	Longer earhead (>35cm)	EC-507677, EC-507678, EC-507685, EC-507803, EC-507835	5
4	Wider earhead (>10cm)	EC-507601, EC-507650, EC-507652, EC-507653, EC-507800, EC-507803, EC-507860, EC-507865	8
5	High yield (>60g/ plant)	EC-507601, EC-507860, EC-507878	3
6	> 100-seed weight (>4g)	EC-507671, EC-507675, CSV 16 (check)	2
Total			25

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Potential Quarantine Pests of Cereals for India

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Key Words: Quarantine Pest, Pathway, Pest Risk Analysis, Cereals

The international exchange of seed in agricultural trade is more extensive now than ever before. But this has also increased the probability of introducing new and dangerous pests or their virulent races along with the movement of plant genetic resources. Internationally there are several examples of spread of important pests, causing havoc with profound political and social impacts. These include: introduction of flag smut (*Urocystis agropyri*) from Australia to Mexico with wheat intended for milling and used for sowing, loose smut of wheat (*Ustilago tritici*) detected for the first time in Laos on wheat imported from Israel and in all probability, bunt of wheat (*Tilletia caries*) introduced into USA from Australia and the Karnal bunt (*Neovossia indica*) first reported in USA in 1996. India also had more than its share of pests introductions causing huge economic losses. The introduction of exotic weeds such as *Lantana camara* from Central America in the 19th century, *Parthenium hysterophorus* from Central and South America and *Phalaris minor* from Mexico in mid 20th century have become a threat to the crop production, environment and the human health.

The National Bureau of Plant Genetic Resources (NBPGR), New Delhi, India is a nodal institution, which has a mandate of germplasm exchange for research and its quarantine processing. When measured in terms of total weight, germplasm material is relatively much

smaller compared with commercial shipments. However, the diversity of germplasm poses special problems. For example, different lines are expected to have different levels of resistance to pests and pathogens. Ever since its inception a large number of pests viz., insects, nematodes, fungi, bacteria, viruses and weeds have been intercepted during quarantine processing of introduced material.

Phytosanitary measures are extremely important to facilitate safe import of plants and plant products while protecting them from the ravages of destructive pests. These are also essential as part of risk management strategies adopted during pest risk analysis (PRA), preparation as per the Sanitary and Phytosanitary Agreement of WTO. The International Plant Protection Convention (IPPC) which develops standards has divided PRA preparation in 3 stages viz., initiation, risk assessment and risk management, the compilation of which should be fully documented in the event of a review or dispute arises.

The Division of Plant Quarantine has planned to bring out a series of publications on the potential quarantine pests in various crop groups. In this context, the present publication is an attempt on potential quarantine pests of cereals comprising the species and wild relatives of *Avena*, *Hordeum*, *Oryza*, *Triticum*, *Zea* and *Triticale*. The various parameters taken into account were pest/

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smaller compared with commercial shipments. However, the diversity of germplasm poses special problems. For example, different lines are expected to have different levels of resistance to pests and pathogens. Ever since its inception a large number of pests viz., insects, nematodes, fungi, bacteria, viruses and weeds have been intercepted during quarantine processing of introduced material.

Phytosanitary measures are extremely important to facilitate safe import of plants and plant products while protecting them from the ravages of destructive pests. These are also essential as part of risk management strategies adopted during pest risk analysis (PRA), preparation as per the Sanitary and Phytosanitary Agreement of WTO. The International Plant Protection Convention (IPPC) which develops standards has divided PRA preparation in 3 stages viz., initiation, risk assessment and risk management, the compilation of which should be fully documented in the event of a review or dispute arises.

The Division of Plant Quarantine has planned to bring out a series of publications on the potential quarantine pests in various crop groups. In this context, the present publication is an attempt on potential quarantine pests of cereals comprising the species and wild relatives of *Avena*, *Hordeum*, *Oryza*, *Triticum*, *Zea* and *Triticale*. The various parameters taken into account were pest/

synonym(s), disease/ common name, host range, pathway of introduction, geographical distribution, economic impact and phytosanitary risk involved. While compiling the information emphasis is laid more on the identification of pathway in imported commodity that may allow the introduction and/ or spread of quarantine pests.

The information is primarily collected from the Crop Protection Compendium of CAB International (2003), supplemented with the other available CAB literature and also included the pests under the Schedules V And VI of Plant Quarantine (Regulation of Import into India) Order, 2003 dealing with the lists of plant and plant materials for restricted import only by authorized institutions with additional declarations and special conditions. A brief summary of the number of Plant Quarantine Pests (PQPs) in six genera of cereals and their wild relatives is given in Table 1. Some of the major PQPs for India include: *Acarus siro*, *Barley stripe*

mosaic virus, *Clavibacter michiganensis* sub sp. *nebraskensis*, *Ditylenchus africanus*, *Striga hermontheica* and *Tilletia controversa*. Some of the pests which are known to cause significant damage worldwide include: *Acidovorax avenae*, *Aphelenchoides besseyi*, *Claviceps purpurea*, *Maize chlorotic mottle virus*, *Rumex crispum*, *Sitophilus granarius* and *S. zeamais*.

However, the pest risk from South-Asian countries include: *Drechslera maydis* (Race 'T'), *Pseudomonas fuscovaginae*, *P. viridiflava* and *Veronica persica* from Nepal; *Ahasverus advena*, *Burkholderia glumae*, *Cryptolestes ferruineus*, *D. maydis* (Race 'T'), and *Richardia brasiliensis* from Sri Lanka; *Thalapsi arvense* and *V. persica* from Bhutan; *C. ferruineus* and *D. maydis* Race 'T' from Bangladesh.

The present publication would be of great significance and use by quarantine personnel and researchers and would serve as a ready reckoner while issuing permits stating

Table 1. Number of potential quarantine pests for India in cereals

Crop	Insects	Nematodes	Fungi	Bacteria	Viruses	Weeds
<i>Avena</i>	34 (17)	4 (-)	4 (4)	5 (4)	2 (2)	12 (9)
<i>Hordeum</i>	36 (18)	2 (-)	4 (2)	5 (4)	3 (3)	16 (10)
<i>Oryza</i>	68 (26)	5 (1)	5 (4)	4 (3)	-	13 (8)
<i>Triticum</i>	33 (11)	5 (1)	6 (4)	6 (4)	2 (2)	18 (11)
<i>Triticale</i>	5 (2)	-	3 (1)	4 (4)	-	-
<i>Zea</i>	59 (28)	5 (2)	7 (5)	7 (5)	2 (2)	919 (12)

Figures in parentheses denotes the number of pests not known to occur in India

additional declarations required for import in addition to supplementing information for analyzing pest risk(s).

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Utilization of Introduced CIMMYT Inbred Lines for Hybrid Maize Breeding in India

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Key Words: Maize, Introductions, Inbred Lines, Combining Ability

Successful hybrid breeding in cross-pollinated crops like maize, primarily involves continued upgrading of genetic divergence among component inbred lines. This is to maximize heterotic potential for grain yield and related traits. One way of bringing this, is through introduction and utilization of exotic germplasm in hybrid maize breeding. The current investigation is an effort in this direction.

Indian Maize breeding programme in the public sector under the aegis of Directorate of Maize Research (DMR), has a very active collaboration with the Maize Programme of International Maize and Wheat Improvement Centre, CIMMYT, Mexico. In the late 1990's materials generated by CIMMYT for hybrid maize development started to be introduced into India. Initially self bulks and later on early and advanced inbred lines from the tropical and sub tropical maize programme of CIMMYT were introduced. At the Maize Winter Nursery, DMR, Hyderabad over 250 maize inbred lines/ S3 bulks from CIMMYT were introduced in 1997 and 1998 Winter (*rabi*) season (Maize Winter Nursery Monitoring Book, 1997-98). These introductions were

acclimatised at this neutral environment for four seasons. Finally based on agronomic desirability and grain type 15 inbred lines (Table 1) were selected for use in winter nursery breeding programme. The inbred lines were first selected for potential use as male or female inbred parents for generating hybrids. For male parent suitability, the criteria was based on the tassel characteristics like length of main spike and number of secondary branches, size of tassel and spatial orientation of branches, apart from ease of pollen dehiscence. For female parent selection, the criteria was ease of silk emergence, full husk cover, ear size, kernel boldness, and kernel color. The combining ability of these inbred lines vis-à-vis the adapted lines used in the Indian maize programme was assessed. 15 of the best acclimatised inbreds from CIMMYT were crossed to two widely used inbred tester lines CM111 (flint grain type) and CM 202 (yellow dent grain type). The 30 test cross hybrids and parents there of were evaluated in a completely Randomised Block Design with two replications across two *khari*f seasons at ARS Amberpet, Hyderabad. Each plot comprised 2 rows of 5M length each with a spacing

Table 1. List of the 15 promising Introduced CIMMYT Maize Inbred lines and their important characteristics

S No	Inbred Line Introduction	Pedigree	Grain Type and characteristics*	Overall GCA Status+	Overall SCA status+ Cross with CM111 (T1) CM202 (T2)
1	L1	AMATCOHS129-1-1-1-2-1-1-1-BB-XXX	Of, Tall, M/ F	H	L H
2	L2	MBR-HC96-1-#-1-1-1-6-3# B-3b-B#BB-XXX	Oysd, Med, M	H	H L
3	L3	P590BC4F220-1-1-B-B-B#BB-B-XXX	Of, Tall, M/ F	M	M M
4	L4	P33C2 (STE)-102-2-B-2-B-1-3-B-B-XXX	Of, Short, M	H	H L
5	L5	CML228-B-XXX	Of, Tall, M/ F	L	M M
6	L6	CML336-89(TL864)/ (P47S3/ MP78/ 51B)B-24-1	Oysd, Med, M	L	L H
7	L7	CML371-X	Of, Tall, M/ F	L	H M
8	L8	89(TL8645)/ (P47S3/ MP78:518)B-24-1-1-4-1-3	Oysd, Med, M/ F	L	M M
9	L9	89(TL8645)/ (P47S3/ MP78:518)B-266-2-3-12-1	Yf, Tall, M	M	M M
10	L10	P33C2(STE)102-2-B-2-B-1-3-B-B-5B	Dof, Med, M/ F	M	M M
11	L11	P33C2(STE)-137-1-B-1-B-2-1-B-B-5B	Of, Tall, M/ F	L	L H
	12	L12	CML324-B-6B	Of, short, F	L L
H					
13	L13	CML373-6B	Of, Tall, M/ F	L	H L
14	L14	Int 5174 (ACC: HYD1998R)	Dof, Med, M	L	L H
15	L15	CML300	Dof, Tall, M/ F	H	L H

* Grain type: O=orange kernel color, Y=yellow kernel color f=flint, sd=semi-dent, d=deep color; Plant height= Tall(> 1M), Medium (0.7M- 0.9 M), Short (< 0.7M); M=Male parent suitable; F= Female parent suitable; + = based on overall combining ability status

Table 2. Pooled ANOVA for various traits studied across the seasons

Source	df	Mean squares			
		Days to 50 percent silking	Plant height (cm)	Test Weight (g)	Grain yield per plot (kg)
Replications	1	36.3**	580.8*	2.3	0.01
Seasons	1	90.1**	691.2**	76.6**	0.84**
Rep*seasons	1	0.033	132.3	1.2	0.1
Crosses	29	13.3**	291.9**	28.6**	0.3**
Line effect	14	17.6**	244.9*	37.6*	0.2*
Tester effect	1	83.3**	896.5*	7.8	0.02*
Line*Tester effect	14	4.1**	295.6**	21.1*	0.4**
Seas*crosses	29	1.1**	260.8**	0.9	0.3**
Seas* Line effect	14	0.9	284.8	0.8	0.3
Seas*Tester effect	1	0.01	472.1	1.3	0.24
Seas*Line*Tester effect	14	1.3**	221.6*	0.9	0.35**
Error	58	0.15	93.7	10.1	0.04
Total	119	4.65	192.1	12.8	0.172
CV		7.40	7.73	13.50	14.69

of 0.75 Mx 0.25 M. Data was recorded on days to 50 percent silking per plot (for maturity assessment), plant height in cm (for morphological assessment), test weight (100 kernel weight in g) an important grain yield related character) and grain yield per plot (adjusted to 15 % moisture) the most economical character. Pooled analysis of data was carried out after undertaking F variance test for homogeneity of error variances following Gomez and Gomez (1984) and Kempthorne (1957).

The test cross hybrids exhibited variation for all the characters studied as seen from the ANOVA presented in Table 2. Among crosses the line x tester interaction accounted for the most significant differences for all traits thus hinting at heterosis manifestation. The parents especially the lines showed significant differences for all the traits studied while the testers showed significant differences for all the traits except test weight. The season x treatment interaction was significant for days to 50 percent silking, plant height and grain yield.

The pooled estimates for status of overall general combining ability (GCA) effects (Arunachalam and Bandyopadhyay, 1979) across all the characters studied are given in Table 1. The inbred lines L1, L2, L14 and L15 had high overall GCA status. These lines can be utilized extensively in hybrid breeding programme. Overall SCA status (Table 1) computed based on Arunachalam and Bandyopadhyay (1979) showed the crosses of T1 with L2, L4, L13 and the crosses of T2 with L1, L6, L11, L12, L14, L15 as having high SCA status.

The heterosis computed over the mid- parent value indicated that for days to silking the crosses L15 x T2 (50 days) was the earliest followed by L14 x T2 (50.5 days) as also L1 x T2, L10 x T2, L11 x T2 and L12 x T2. For plant height the crosses L14 x T2 (153.5 cm) and L1 x T1 (151.5 cm) exhibited maximum mid-parental heterosis. For test weight the crosses L8 x T2 (31.6g) and L2 x T2 (30.68g) showed maximum heterosis. For grain yield per plot the crosses L7 x T1 (1.56 kg) and L2 x T2 (1.44kg) exhibited maximum heterosis over the mid parental value. The best crosses for grain yield are being tested extensively at multiple locations. Based on the overall heterosis and combining ability the 15 inbred lines were grouped into two groups as those belonging to Tester 1 (CM 111) or Tester 2 (CM202). Within each of these groups the lines will be crossed for further enhancement of per se performance through line recycling procedure.

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ABSTRACTS

Utilizing Hexaploid Synthetics for Widening the Genetic Base in Indian Wheats

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Wheat is consumed by more than 60 percent of Indian population in one or the other form. The crop occupies nearly 27 million ha of area, around 70 million tonnes of production and now India stands at second position next to China in the world. However, the ever increasing population of India will need at least 109 million tones of wheat by 2020 AD to meet the domestic requirement. The chances of marginal increase in area under wheat are miniscule and thus the only option left with is the increased productivity. During the last three decades, the wheat production has shown continuous increase at the rate of about one percent per annum even after having a wide array of diverse varieties released for different agro-climatic as well as production conditions. The last quantum jump in yield was attained with the release of variety PBW 343, which presently occupies about 20% of wheat area in the country. Having such a large area under single variety has been a concern for wheat researchers in view of possible threats from various diseases and insects.

The availability of genetic variability in the material is a necessity to make any breeding programme vibrant. The genetic variability is directly correlated with the selection efficiency not only for yield alone but for other biotic and abiotic factors also. In India, a large number of crosses are attempted every year and nearly 600 genotypes developed on active wheat breeding centers are put under testing at national level for yield, disease and quality attributes. Whereas, only few (4-7) genotypes are identified for release and maximum area is covered by few important varieties. This process is further narrowing down the variability. In each genotype was grown in six row plot of 3 m length keeping 23 cm spacing between the rows. Data on various traits were recorded on 10 randomly selected plants and then means were calculated. The data on spike length and spikelets per spike were taken on main tiller of the plants, whereas, the characters like days to heading, maturity and disease were recorded on plot basis.

The results of study revealed a wide range of variation for most of the traits studied. The range, mean,

coefficient of variation (CV) and standard deviation were taken as the parameters to estimate variability. Some of the synthetics have shown longer spike (15.8 cm), bold grain (52 g), high tillering (200/ m), more spikelets/ spike (25) and more seeds per spike (70) as compared to local check (PBW 343). Around 20 synthetics were found resistant to yellow and brown rusts and leaf blight. In addition, some of these accessions have shown promise for root length (23 cm), root spread (13 cm) and root dry matter (1.86 g) along with high shoot biomass. After three years of rigorous evaluation for various yield contributing traits, resistance against rusts and leaf blight, tolerance to heat and salinity, promising lines have been identified and selected.

The Directorate of Wheat Research initiated hybridization programme involving these promising synthetics with modern varieties in a view to widen the genetic base for traits of economic importance. For this purpose, the bread wheat varieties like PBW343, C306, K9107, K9006, WH542, GW273, HUW468, HUW234 and a set of durum varieties like HI8498, PDW233, PBW34, A-9-30-1 have been hybridized with synthetic wheat lines. The segregating materials of different generations are now being evaluated and shared for their wider use at national level. Though there is still need to improve the threshability and grain attributes, the improvement for many of the above mentioned traits is very much visible in the selections made from segregating material. In addition to straight crosses, back crossing approach has also been utilized to further improve the agronomic base of segregating materials. The work done so far has helped to identify sources of economic traits and to widen the genetic base to some extent. Nevertheless, there also exists a good scope for their use in improving some of the other traits like pre-harvest sprouting tolerance, salinity tolerance, and stay green habit to counter the heat stress. The extensive use of synthetics in breeding programme will certainly help wheat breeders to further raise the yield potential of new cultivars and moving closer to meet the anticipated demand of wheat production in the country.

Enriching Genetic Diversity in Wheat for Eastern Gangetic Plains

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India has firmed up its position as the second largest producer of wheat in the world after China. During 2003-04, the production of wheat was recorded to the tune of 71 million tones on the area of 26.4 million ha with an average productivity of 2.7 t/ha. It is projected that India must produce 109 million tones of wheat by the year 2020, when the population will be more than 1.3 billion. Among the six mega wheat growing zones, the northwest and north east put together, covers around two-third of the total wheat area in the country. The north eastern plains zone (NEPZ) comprising east UP, Bihar, Jharkhand, West Bengal and Assam accounts for more than 9.0 million ha, has the yield potential of 4.5 t/ha in comparison to the realized yield levels of about 3.0 t/ha. This simply means that there exists a yield gap of around 1.5 tones per ha over a sizeable area. This zone has however very diverse cropping systems, but rice-wheat is one of the most widely followed cropping sequences. The wheat sowings in this area are delayed due to the late harvesting of rice crop and again in the month of March, the wheat crop suffers from the high temperature and thus very short winter is available to wheat crop. Moreover, a different flora and fauna of weed and diseases are faced by the crop and hence the area has various small but diverse niches. Hence, for these conditions the requirement of varieties/ genotypes is also diverse.

The All India Coordinated Wheat Improvement Project has developed a large number of varieties for this zone but only few of them could percolate to the farmer's field. A preliminary survey based on farmer's feed back revealed that there was a need to develop wheat varieties with maturity duration of 100 days, good grain attributes, resistance to diseases (particularly leaf blight and brown rust) and moderately high yield. All this needs an easy access to the large number of diverse germplasm possessing desired attributes to tailor suitable genotypes for the area. Accordingly, the Directorate of Wheat Research, Karnal in close collaboration with CIMMYT, South Asia Regional Office, Nepal initiated a programme in which the germplasm from the SAARC countries namely India, Nepal and Bangladesh is pooled to constitute a nursery named "Eastern Gangetic Plains

Screening Nursery (EGPSN)" during the year 1997-98. The main goal of this nursery is to identify, select and share elite germplasm of appropriate maturity, high yield potential blended with tolerance to leaf blight, leaf rust and heat stress.

During the last eight years, a total of 1,140 genotypes were procured and shared with centers namely Shillongani, Cooch Behar, Pusa, Ranchi, Sabour, Faizabad, Varanasi and Kanpur to strengthen their wheat improvement programme. Through this nursery, every year about 150 genotypes are provided to the centers with pedigree and selection details for their evaluation and use. At DWR, Karnal these lines are evaluated for leaf blight and rusts resistance under both natural and controlled conditions and the information generated is provided to the centers so that they can selectively use the genotypes in their crossing programme. These efforts have been very fruitful in identifying the leaf blight resistant genotypes up to the level of 35 score. In all, more than 50 promising genotypes including Chirya 1, Chirya 3, Chirya 7, Mayoer, BL1473, BL1724, NL835, BL2034, BL1982 etc., were found highly tolerant to the leaf blight disease even at hot spot locations and are being utilized extensively in the hybridization programme. Some of the lines namely Bhrikuti, Achyut, Chirya 3 etc., have shown promise to both yield and resistance, are also good combiners as evident by the performance of segregating populations. It is worth to mention that few genotypes could show the yield potential up to 7.0 t/ha under well managed conditions. Since the germplasm is collected from different gene pool and the pedigree details also confirm the diversity, the high probability of getting heterotic combinations has been observed. The segregating populations coming out of these crosses are also being shared with centres located in eastern region through segregating nursery and shuttle breeding programme of DWR.

This approach in our view will help in bridging the yield gaps, increase the diversity in the material and provide additional production over such a large area to meet the projected demand of wheat for ever increasing population of India.

Utilization of Barley Introductions in India

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Genetic variations in crop plants are very important for human welfare. Plant genetic resources (PGR) constitute the basic raw material, required essentially for the crop improvement programme. The rapid spread of improved crop varieties throughout the world has replaced many of the genetic resources essential to their continued improvement. Exchange of plant genetic resources has played an important role in broadening the genetic base of plant breeding. CIMMYT and ICARDA, the two international organizations are pioneer in the area of germplasm improvement and exchange for crops like wheat, barley, maize etc. They have catered the need of our national programme by supplying various germplasm of barley and wheat in the form of international trial and nurseries. The Indian barley programme has exploited these trials/ nurseries to enhance the genetic base of the material over last several years. Apart from these two international institutes, number of organization in Europe and America also has large barley collection and we could acquire materials from these collections through exchange of germplasm. Some of these introduced materials have been released in India as direct introduction for different production condition and number of them has been used in the hybridization programme for improvement of Indian barley varieties. Direct introductions such as Clipper in 1969 from Australia, and Alfa 93 in 1995 from Argentina, both two rowed with better malting quality were released by CVRC for cultivation in NWPZ. These varieties performed well in irrigated timely sown condition in Punjab, Haryana, Western UP and Rajasthan. However, these varieties are late in maturity and have poor straw strength with about 36.2 q/ha yield. Another two-rowed variety BCU73 with good malt quality was introduced from Australia via ICARDA and was released by CVRC in 1997 for commercial cultivation in India. This variety is bold seeded and gives high yield (38 Q/ ha) under proper management condition and is still under commercial cultivation. Recently released new malt barley variety DWR28 (with 41.4 q/ha grain yield) have been developed through hybridization programme utilizing BCU73 as one parent.

Apart from these entries, number of other introductions were made as feed barley like HBL113

which is a selection from exotic germplasm Zyphzee from USA (released for cultivation in Northern Hill Zone in 1995 by CVRC while another variety Sonu (a selection from cross EB233/ GIZA117) was released by SVRC for rainfed condition in Himachal Pradesh. Two six rowed husk less varieties LSB2 (a direct introduction as USA94 in 1971) and Dolma (a direct introduction as USA115 in 1974) were released by CVRC for rainfed condition in hills to be used for human consumption.

Also numbers of barley varieties namely Kailash, Ranjeet, DL-88, Himani, BHS-169, Karan16, BG-105, BH-75, RD-31, RD-57, Rajkiran, RD-2052, Geetanjali, NDB-1173 and DWR28 have been released over the years by both CVRC and SVRC having one of the parents as exotic material.

The programme has been receiving a number of international trials/ nurseries from ICARDA and CIMMYT regularly for many years. During last five years more than 2256 barley genotypes were evaluated at DWR for different traits out of which nearly 200 accessions have been selected for utilization in our breeding programme. A number of germplasm accessions and released varieties from countries like USA, Canada, Australia and other European countries were also received and evaluated during last decade which are good sources for malting quality, resistance to different diseases and pests. The entries like Bonus, Shebec, Canut, Caruso, Betzes, Quilmes, Pampa, Quilmes 27-1, Chariot, CDC McGWIRE, CDC BOLD, CDC DOLLY, CD SISLER, CDC CANDALL, CDC MANLEY, FARMINGTON, UC933, UC937, UC969, UC960, UC1047, Keel, Gairdner, Galleon, Schooner, Sloop SA, Sloop VIC, Dhow, AC Ranger, Trochu, Kasota, BOB Barley, Drummond, VIVAN were received during last few years and are being utilized in the on-going breeding programme for different purposes.

Emphasizing the need of germplasm evaluation recently the programme has started evaluating more than 5000 accessions of barley germplasm collections (both indigenous and exotic); under ICAR funded Adhoc Research Project involving 9 barley network centres. In the first year, 2003-04 crop season, a preliminary

evaluation of 1700 accessions was made for different DUS traits and resistance to biotic (yellow rust, leaf blights, covered smut, leaf stripe, aphid and cereal cyst nematode) and abiotic stresses (drought, heat, cold and salinity). Resistance sources and donors for different traits will be identified during three years evaluation and will be used in the barley-breeding programme in the country.

Realizing the importance of germplasm, focused efforts are needed to enrich the barley genetic resources through new explorations and introductions in form of various international trials and nurseries and also as specific indents for novel variability. Looking at the importance of genetic resources, efforts are to be intensified to counter the future challenges by coordinating different activities under biodiversity maintenance and conservation.

Introduction of Rice Germplasm—A Boon for India

BC Patra and SR Dhua

Central Rice Research Institute, Cuttack

India is supposed to be a part of the homeland for cultivated rice. Tremendous amount of variability existed in the landraces of rice germplasm, which has been estimated to be more than 15,000 accessions. However, in the process of evolution and natural selection some of the characters were favored and some other characters got eliminated. Thus there was and has been a necessity of introducing rice cultivars from other geographical regions for the purpose of increasing the yield.

The first recorded introduction of rice cultivars into this country was that of the *indica* type rice germplasm of Chinese origin mainly for cultivation in temperate hill regions. The cultivars like CH2, CH45, CH47, CH972, CH988, CH1007, CH1039 performed very well in the western Himalayan region and some of them are still popularly cultivated in these areas. The varieties like CH4, CH45, CH55, CH62 and CH63 also proved to be very good donors for better yield and early maturity duration.

The systematic introduction of exotic rice germplasm for the purpose of genetic improvement started with the inter-racial hybridization work which was initiated during 1950-1964. The exotic *japonicas* were introduced for crossing with the native *indicas*. The *indica* cultivars were tall and application of nitrogenous chemical fertilizer resulted in pronounced vegetative growth with no yield advantage. Hence the Food and Agriculture Organisation (FAO) launched an international programme of *Japonica-indica* hybridization to incorporate the fertilizer responsive characters of japonica rice into the genotypic background of *indica* rice. The Indian Council of Agricultural

Research for the Indian states launched a similar programme. The only variety, which came out of the Indian Programme, was ADT27. Under the FAO programme a variety Mahsuri was developed through selection of *indica* x *japonica* derivatives in Malaysia. This was later introduced into India and has been popularly cultivated in many states.

The limited success of *japonica-indica* project was ascribed to defective selection of the *japonica* parents. With judicious selection of the *japonica* parents, *japonica-indica* hybrid derivatives resulted in the development of varieties like Annanda, Pallavi, Utkal Prabha, Jagriti etc. which have been released for general cultivation with the farmers in this country. Some of the *japonicas* performed well in the Himalayan region and one of them Norin 18 was released for general cultivation in Himachal Pradesh. Later, Ponali types were introduced into India and some of them like Tainan 3, Kaoshiung 22, Taichung 65 etc. were released with or without further selection and/ or mutation.

After evaluating exotic collections for selecting a suitable donor for breeding work in high altitude areas of Kashmir and other Himalayan temperate regions, four Chinese varieties including CH1039 and three Russian varieties including R3073 were selected for the valley and hilly region. CH1039 was found to be a higher yielder until 1954 when *indica* x *japonica* hybridization programme started and one of the few successful crosses namely Rikku137 out yielded CH1039 in many locations. In another attempt, after a thorough multi-location screening and evaluation of a large number of rice germplasm,

evaluation of 1700 accessions was made for different DUS traits and resistance to biotic (yellow rust, leaf blights, covered smut, leaf stripe, aphid and cereal cyst nematode) and abiotic stresses (drought, heat, cold and salinity). Resistance sources and donors for different traits will be identified during three years evaluation and will be used in the barley-breeding programme in the country.

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only two Chinese varieties CH13 and CH45 were found resistant to Brown spot disease which was the root cause of Bengal Famine in 1943. CH47 and CH51 were found resistant to yellow stem borer.

Introduction of *javanica* rice germplasm were also attempted and utilization of such a variety like Urangan for hybridization with a *indica* rice germplasm T90 resulted in the development of one of the most popular rice variety of Orissa CR1014.

The introduction of Taichung (Native) 1 from the semi-dwarf mutant Dee-geo-woo-gen of Taiwan in the

1960s was the most significant introduction in the history of rice breeding in India. This was the single variety adaptable to whole of India starting from Kashmir to Kanyakumari. Because of superior response to the high level of nitrogen fertilizer, this variety out yielded significantly both in *kharif* as well as *rabi* season.

Apart from these, with the establishment of International Rice Research Institute in the Philippines, several exotic germplasm including the breeding lines, cultures are being introduced every year to our country in different collaborative research programmes.

SHORT COMMUNICATIONS

Genetic Improvement of Dolichos Bean (*Lablab purpureus* (L.) Sweet) through Use of Exotic and Indigenous Germplasm**P Mahadevu and M Byre Gowda***AICRP on Pigeonpea, University of Agricultural Sciences, GKV, Bangalore-560 065, Karnataka***Key Words: Dolichos, Genetic Resources, Photosensitivity, Growth Habit**

Dolichos bean (*Lablab purpureus* (L.) Sweet) is a multi purpose crop grown for green and dry seeds, green pods, fodder and cover crop. The crop is mainly grown as field crop in the states of Karnataka, Tamil Nadu, Andhra Pradesh, Madhya Pradesh and Maharashtra and as a garden crop in many parts of India. The garden types (*Typicus*) are perennial, grown for green pods as vegetable and require cool season. Determinate and busy varieties are also available in this category. The field types (*Lignosus*) are exclusively grown as dry land crop mostly in low rainfall areas as a mixed crop with finger millet, sorghum and castor. The existing local varieties are long duration, photosensitive and low yielding (5-6 q/ ha) types.

Major research efforts in improving field bean crop have been done at the University of Agricultural Sciences, Bangalore. New genetic stocks introduced from USA, Hungary, and Belgium became indirect source for photo-insensitivity and determinate growth habit (Sreekantaradhy *et al.*, 1973). Exotic genotypes 'US 67-31' and 'US 67-44' of USA were observed to be photo-insensitive by Shivashankar *et al.*, (1971) and were incorporated in breeding programme. Hybridization between the exotic and indigenous types led to the evolution of HA-1 from the segregating material of the cross 'Local Avare' and 'Red typicus'. Further, selection in the segregating material generated from 'HA-1', and 'US 67-31' resulted in identification and release of 'Hebbal Avare-3 (HA 3)', which besides being photo-insensitive and early, is with determinate growth habit and green pod yield up to 100-120 q/ ha (Shivashankar and Kulkarni, 1992). This variety became very popular in all Dolichos growing areas in India and utilized for further crop improvement (Kabir *et al.*, 1992). The genotypes with protein content of 30 % as compared to 24 % in HA 3 have also been identified (Viswanathan *et al.*, 1972). However, the green pods of this variety are flat and devoid of 'Sogadu', the characteristic odour and hence with less consumers' preference.

Systematic attempts have been made for collection of Dolichos gene pool in different parts of peninsular India and evaluation for utilisation in genetic improvement. Wide genetic variations observed in morphological types and cultivated land races in traditional Dolichos growing areas (Basavarajappa and Byregowda, 2000).

In the present study, an attempt was made to transfer high sogadu character with constricted pods from indigenous germplasm to HA 3. Hybridization involving HA 3 with 14-1 and 'Local mani avare', which were collected previously as well as during the year 2003 by our team, were carried out by using HA 3 as female parent. Based on the morphological and visual observations, we could successfully isolate segregate plants with high sogadu and constricted pods with determinate growth habit and photo insensitivity. The new genotype was found to be superior with the other salient features, such as average number of pods (71/ plant), high green pod yield and grain yield

Similarly, exotic Dolichos bean in Australia became an important annual forage legume in tropical and subtropical regions. Introduction of two cultivars i.e., Rongoi from Kenya in 1962 and 'Highworth' from Coimbatore (India) in 1976, made an inroad into Australian sustainable cropping systems as legume forage crop. These varieties are being used as short term summer growing forage species in semi intensive livestock and crop-livestock farming systems of Queensland (Pengelly and Maass, 2001).

Dolichos bean combines a great number of qualities that can be used successfully in various conditions. With its ability to out yield conventional crops especially during the dry season and enhanced nutritive value as a fodder crop, Dolichos bean is of great significance for introduction into new areas in the tropical and subtropical regions of the world.

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Evaluation of Winged Bean Germplasm

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Key Words: Winged Bean, Evaluation, Germplasm

Winged bean (*Psophocarpus tetragonolobus*), also called as God-sent vegetable, originated in South-East Asia perhaps Papua New Guinea and is an important leguminous vegetable in Bangladesh, Burma Thailand, Vietnam, Malaysia, Indonesia, Ghana, Nigeria and Sri Lanka. It is commonly grown in Southern India. All parts of the plant like immature pods (2.9-21.5% protein), tender shoots (2.8-5.6% protein), flowers (2.92% protein), young leaves (3.24% protein) and tuberous roots (8-20% protein) are consumed as protein, calcium and iron rich vegetable (Shanmugavelu, 1989; Long *et al.*, 1993; Neeliyara *et al.*, 2001). Boiled ripe seeds are also consumed as protein (31.8 %), fat (17.5 %), energy (757 KCal/ 100 g) and calcium (86.3 mg/ 100 g) rich food (Neeliyara *et al.*, 1999). To fight protein malnutrition of the vast population, its cultivation and use as food in Jharkhand was the need of the hour. Keeping this in view, nine germplasm of winged bean were introduced from NBPGR, Regional Station, PKV Campus, Akola (Maharashtra) and evaluated at HARP, Ranchi to know the genetic variation for green pod yield and its components in addition to some qualitative characters and also to identify the promising

lines suitable for cultivation in this Chotanagpur plateau region of Jharkhand.

Nine germplasm lines were grown in RBD with three replications with a spacing of 100 cm x 60 cm during *kharif* seasons of 2001, 2002 and 2003. Recommended cultural practices were followed to raise a successful crop each year. The observations were recorded on plant height, number of branches/ plant, days to 50% flowering, pod length, pod breadth, pod weight, number of pods/ plant and green pod yield/ plant. The analysis of variance for mean data considering a single year's mean value of three replications as a single replication was calculated by the method suggested by Panse and Sukhatme (1985).

The analysis of variance for eight characters indicated non-significant differences among the nine genotypes of winged bean for all the characters studied except number of branches/ plant. Maximum and minimum number of branches/ plant were recorded in EC-178331 (3.74) and AKWB-1 (2.77), respectively. However, the characters like plant height, number of pods/ plant, days to 50% flowering and pod weight exhibited considerable

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range in their expression, which indicated the scope of improvement in these characters through selection. The maximum plant height was recorded in genotype Mysore Local (253.02 cm) and minimum in NBRI Sel. (209.19). EC-178313 (61.32) and NBRI Sel. (49.17) recorded the maximum and minimum numbers of pods/plant, respectively. AKWB-1 was the earliest and took 79.89 days to come to 50 % flowering stage whereas the latest flowering took place in 84.66 days in EC-178331. The maximum and minimum weight of pod were recorded in AKWB-1 (17.38 g) and Mysore Local (14.06 g), respectively. In respect of green pod yield, AKWB-1 (1.1 kg/ plant; 183.33q/ ha) and EC-142665 (1.08 kg/ plant; 180q/ ha) were the top performing entries. Khurana *et al.* (1990) similarly evaluated 12 introduced winged bean lines at Hisar (Haryana) and reported the maximum green pod yield >100 q/ ha. In respect of pod shape, flat on sides, rectangular and semi-flat shaped pods were produced by four, three and two lines, respectively. The green, semi-flat podded line AKWB-1 was the earliest (79.89 days) and topped in respect of green pod yield (183.33 q/ ha) and green pod weight (17.38 g). The line also exhibited better performance in respect of plant height (233.45 cm), pod length (16.74 cm), pod breadth (2.29 cm) and number of pods/ plant (59.92). The green, flat podded line EC-142665 also

exhibited better performance over general mean in respect of green pod yield (180 q/ ha), plant height (242.01 cm), pod length (17.52 cm), pod weight (16.80 g) and number of pods/ plant (60.96). Hence, the promising winged bean germplasm lines AKWB-1 and EC-142665 can be promoted for cultivation among the vegetable growers of Chhotanagpur region of Jharkhand to ensure nutritional security to the people of this region through large-scale production and consumption of this protein rich leguminous vegetable.

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Screening of ICARDA's Lentil Material for Rust Resistance in India

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Key Words: Lentil, Resistance, Rust, *Uromyces fabae*

Lentil (*Lens culinaris* Medik.) is an important pulse crop grown worldwide. Its ability to thrive well on relatively poor soils under diverse agro-climatic conditions has ensured its survival as a crop species to the present day. High protein content coupled with unique aroma of its culinary preparations impart a special position to human diet world over. The Indian subcontinent is the largest lentil-producing region in the world. However, the productivity of lentil has remained static for the past several years. In the recent years the severe incidence

of rust in major lentil growing areas has been identified as a main production constraint of lentil. The lentil rust is caused by the fungus *Uromyces fabae* (Pers) de Bary. Under epidemic conditions it can cause up to 70-100% yield losses (Accatio, 1963-64, Seplveda, 1985). Although effective chemical control measures are available to the some extent, development of resistant varieties is the most economic and eco-friendly means to control the disease. The systematic evaluation of germplasm and advanced breeding lines are essential

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component of resistance breeding. Therefore, the present work was conducted to evaluate diverse lentil genetic materials received from ICARDA, Syria.

A set of 255 lentil accessions was received from ICARDA, Syria in the form different nurseries (LIEN-L-04, LIEN-S-04, LIEN-E-04, LIDTN-04, LIABN-04, LIRN- 04) during *rabi* 2003-04. Another 55 accessions comprising earlier introduced materials from ICARDA and a few local varieties were also included in the experiment. Thus, total 305 accessions were evaluated at HPKV Regional Research Station, Dhaula Kuan, H.P., which is a hot spot for lentil rust. All the materials were grown in a single row plot of 2.5 m length along with checks in augmented plot design. With a view to facilitate proper screening, the row-to-row spacing was kept as 50 cm while plant-to-plant distance was maintained as 3-4 cm. The recommended agronomical practices were followed to raise a good crop except the application of any measures of disease control. Additionally, an infector variety was planted all around the experimental block to ensure enough inoculum for rust development. The natural epidemics of disease have been exploited for screening against rust. The disease started appearing in the first week of February, as yellowing white (muddy coloured) pycnia and aecial cups developed on lower leaf surface. The first week of March 2004 disease symptoms were clearly visible. Therefore, data on rust incidence were recorded twice, initially on 12.3.2004 and finally on 31.3.2004, as per standard procedures.

The dynamics of rust development on selected accessions revealed that the rust incidence varied from free (F) to 100S in the materials under study. A wide spectrum of rust incidence indicated the presence of adequate inoculum load, and, therefore, the data can be accepted for comparison. It was interesting to note that many genotypes which showed free reaction on initial screening (12.3.2004) were turned highly susceptible later (31.3.2004). These genotypes may be considered as fast rusting type. Some of such genotypes included ILL 9893, ILL 9845, ILL 9913,

ILL 9112, ILL 9888, ILL 9844, ILL 4401, ILL 7207, L 4649, L 7706, and L 7711 etc. Likewise some of the genotypes exhibited moderate scores initially but attained highly susceptible response later. These genotypes can also be put under fast rusting group. Some of such genotypes were ILL 9891, ILL 9862, ILL 7979, ILL 9967, ILL 10000, ILL 8090, ILL 9958, ILL 9861, ILL 9945, ILL 9976, ILL 9924, ILL 10019, ILL 7618, ILL 9830, ILL 2580, ILL 7127, ILL 590, ILL 4401 etc. On the other hand few genotypes could maintain a very low level of rust incidence at both the stages. These can be considered as slow rusters. Some slow rusting genotypes included ILL 8184, ILL 9907, ILL 9926, ILL 9969, ILL 9921, ILL 7547, ILL 6821, ILL 9941, ILL 7177, L 7669, L 7510 and L 7512. Out of 305 genotypes evaluated, only 102 genotypes (33.4%) exhibited free reaction indicating the availability of very few rust resistant genotypes in lentil. However, some of these genotypes can be effectively used in lentil breeding for rust resistance based on their merit regarding other agronomic characters. Few other workers have also evaluated lentil materials for rust reaction and have reported almost similar results (Singh and Sandhu, 1988; Kumar *et al* 1997). It can also be emphasized that some of the popular varieties have also shown susceptible response. Therefore, immediate attention is required to develop rust resistant varieties. Another fact also needs a mention that the disease scoring should be done at appropriate stage (preferably two scorings) to avoid wrong classification of the genotypes.

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Interception of Bruchids in Introduced *Phaseolus* Germplasm

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Key Words: Bruchids, *Phaseolus*, Germplasm

Introduction of plant genetic resources has a significant role in improving agricultural production and plant quarantine is important in preventing the entry of exotic pests, which may accompany the planting material. The National Bureau of Plant Genetic Resources (NBPGR) is the nodal agency to undertake the quarantine of germplasm. The effective implementation of quarantine measures has resulted in the interception of number of exotic pests (Khetarpal *et al.*, 2001, Bhalla *et al.*, 2003). These include bean weevil (*Acanthoscelides obtectus*), cotton boll weevil (*Anthonomus grandis*), seed chalcid (*Bruchophagus gibbus*). *Phaseolus* species are important pulse crop and exchanged as seed. The import of *Phaseolus* spp. germplasm from different countries for crop improvement programmes is associated with the risk of inadvertent introduction of exotic pests. The risk is due to the hidden nature of the infestation caused by the bruchids (Coleoptera: Bruchidae), which infest the seeds while they are developing and maturing on plants, in transit as well as storage. The hatched larvae feed, grow, pupate inside the seed, which continue to grow in size and mature, and looks apparently healthy. Such seeds carrying hidden infestation, move across the countries unnoticed and pose a real quarantine risk.

At NBPGR, the specialized technique of X-ray radiography has been developed and standardised for the detection of such infestations (Wadhi, 1967). Therefore, in the present studies, all the *Phaseolus* germplasm imported from different countries for research work was subjected to quarantine examination through X-ray radiography to detect the associated pests and salvage the material so as to release only the pest free material.

During the last twenty five years (1980-2004), 3,815 samples of *Phaseolus* spp. viz., *P. acutifolius*, *P. angularis*, *P. coccineus*, *P. radiata* and *P. vulgaris* imported from over 35 countries were processed for quarantine clearance from entomological viewpoint. The seeds were exposed to X-ray radiography to detect latent infestation. The seeds were spread on the X-ray plate and subjected to X-ray screening. All the seed samples were exposed to soft X-rays generated at 22Kv, 3mA, at a distance

of 30 cm from the source for a period of 30 seconds. The envelope containing the exposed film was removed gently without disturbing the seed geometry and the film was developed/ fixed in a developer/ fixer prepared for the purpose. Infested seeds were marked on the X-ray plate and corresponding (infested) seeds were then hand picked from the seed sample with original geometry retained on the paper.

The infested seeds were detained and kept in the B.O.D. at a temperature of $28\pm1^{\circ}\text{C}$ and relative humidity 60-65% for one month for emergence of adults. Seeds without emergence holes were soaked in water for 12 hr and dissected to retrieve the adult insect or its immature stages. Adult insects emerged/ retrieved were identified by using the keys for identification of bruchids (Herford, 1935; Arora, 1977; Udayagiri and Wadhi, 1982). Identity was further confirmed by comparing the specimen with reference collection maintained at NBPGR, New Delhi.

X-ray radiography of all the samples of different species of *Phaseolus* revealed latent infestation of bruchids in their different developmental stages in 248 samples. The bruchids intercepted are presented in Table 1. Among the intercepted bruchids, *Acanthoscelides obtectus* is not yet known to occur in India and has been intercepted repeatedly from Colombia, Italy, Mexico, Netherlands, Peru, Slovakia and USA. *A. obtectus* originated in tropical South America, but has spread to most other warm and hot regions, including one unconfirmed report from India (Pajni, 1987), with the possible exception of Australia. The distribution map includes records based on specimens in the collections of the Natural History Museum, London, UK and the International Institute of Entomology, UK. *Bruchus pisorum* intercepted from Turkey and Hungary, reported to have a wide host range, has a limited distribution in India confined only to the northern India including Jammu and Kashmir and Punjab.

The remaining three bruchids intercepted i.e. *Callosobruchus analis*, *C. chinensis* and *C. maculatus* although reported from India pose a quarantine risk

Table 1. Interceptions of bruchids in the introduced *Phaseolus* germplasm

Insect Pest	Host	Source
<i>Acanthoscelides</i> sp.	<i>Phaseolus vulgaris</i>	USA
* <i>Acanthoscelides obtectus</i>	<i>P. vulgaris</i>	Colombia, Italy, Mexico, Netherlands, Peru, Slovakia, USA
<i>Bruchus pisorum</i>	<i>P. vulgaris</i>	Turkey, Hungary
<i>Callosobruchus analis</i>	<i>Phaseolus</i> spp.	Brazil
<i>C. chinensis</i>	<i>Phaseolus</i> sp.	Bangladesh, Colombia, Philippines
<i>C. maculatus</i>	<i>P. angularis</i>	Colombia, Taiwan, USA
	<i>P. radiata</i>	Taiwan
<i>Zabrotes subfasciatus</i>	<i>P. vulgaris</i>	Colombia
Immature/ larval stages	<i>P. vulgaris</i>	Colombia, USA
Unidentified bruchids	<i>Phaseolus</i> sp.	Taiwan

* Bruchids not known to occur in India

during import due to their high economic significance and possibility of presence of new biotypes. New strains having greater physiological adaptability pose a higher degree of risk. Both the species of *Callosobruchus*, cowpea seed beetle (*C. maculatus*) and adzuki bean seed beetle (*C. chinensis*), known to occur widely in tropical/subtropical conditions, possess biological strains (Applebaum *et al.*, 1968). The introduction of a mutant strain of such species in a new and climatically suitable environment could trigger off a population explosion.

Zabrotes subfasciatus is a major pest of *Phaseolus vulgaris* and *P. lunatus* but sometimes attacks the seeds of other legumes like cowpea, gram and pea. The pest originated in tropical and subtropical Central and South America, where it is an important pest but is now found in many other tropical and subtropical regions, especially Central and East Africa, Madagascar, the Mediterranean area and India. Strain difference in the ability of *Z. subfasciatus* to use various cultivars have been reported.

Besides, there are a large number of other bruchids, which infest *Phaseolus* seeds in different countries of the world but are not yet reported from India (Udayagiri and Wadhi, 1989). These include *Acanthoscelides argillaceus*, *A. caracallae*, *A. comptus*, *A. obvelatus*, *Bruchus atomarius*, *B. rufimanus*, *Caryedes paradisensis* and *Mimosestes mimosae* and so far not intercepted. These species pose a quarantine risk in the movement of *Phaseolus* germplasm, which can be taken care of by using appropriate detection/ disinfestation technique such as X-ray radiography.

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Utilization of Exotic Germplasm in Improvement of Pulses

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Key Words: Exotic, Germplasm, Pulses, Utilization

The extent of variability in genetic resources collection of crops, and the effectiveness of its use are crucial for crop improvement programmes. This is more so in case of pulses since about 80 percent of these are grown on marginal lands characterized by moisture, temperature and fertility stress. Collectively, these groups of crops are notoriously sensitive to the vagaries of weather and climate, as a result they have been largely selected for features of adaptive value. Pulses have faced serious genetic erosion in their past evolutionary history since a large part of their genetic variability has been lost in the process of their adaptation to stress environment. Incorporation of diverse gene pools (from geographically diverse materials expected to have been subjected to different selection pressures), using intensive hybridization, would make it possible to recreate some of the lost variability in respect of productivity and other desirable traits. The National Bureau of Plant Genetic Resources

has made considerable efforts in facilitating the free flow and exchange of pulse crop germplasm to strengthen the National Crop Improvement Programmes. Germplasm introduced in India comprising cultivated, elite lines, breeding lines, wild species and commercial varieties have played a significant role in the development of varieties and hybrids in pulse crops and figure prominently in the list of promising materials, original source material and parental lines of improved cultivars (Gautam *et al.*, 2000, Shanmugam *et al.*, 1995, 2003). The National Genebank at NBPGR holds 5,412 accessions of exotic pulse crop germplasm in the long-term storage facility. These comprise chickpea (1,758), pigeonpea (157), green gram (449), lentil (484), pea (622), cowpea (633), French bean (562), *Lathyrus* (163), moth bean (22), horsegram (8), guar (40), faba bean (228), adzuki bean (77), rice bean (175), winged bean (43), scarlet runner bean (26), sword bean (1) lima bean (2) and lablab bean (2) (Table 1).

Table 1. Traits available in exotic pulse germplasm and varieties released in different crops using exotic lines

Crops	Traits	Varieties released using exotic germplasm
Chickpea	Resistant to Ascochyta blight, Fusarium wilt, grey mold, leaf miner and pod borer, cold and drought tolerance, high yield and bold seeds, earliness, tall stature, erect growth habit, high nodulation, multiple resistance, photo insensitive, high seed protein content, kabuli types	C104, L550, L144, BG1003, BG203, BG209, BG261, BG244, BG267, BG391, BG1053(K), Gaurav, PhuleG 12, PBG1, BGD72
Pigeonpea	Early and medium duration, high yield, short stature	Sharda, Mukta, Pusa Ageti, Hy1, Hy2, Hy4, Hy5
Green gram	Resistant to Tungro mosaic virus, Cercospora leaf spot, powdery mildew and bruchids, wide adaptability, early, tolerant to drought, flood and heat, photoperiod insensitive, high yield, short and long duration, bold seeds and long pods	PS-16, Pusa 105, Vishal, RMG62, RMG492, Jalgaon 781
Urd bean	Resistant to bruchids, bean fly and yellow mosaic virus and high yield	
Lentil	Early, good plant vigour, bold seed, resistant to vascular wilt, Ascochyta, leaf minor, winter hardy, multiple resistance, high yield, drought tolerant	Narendra masoor-1, Mota masoor
Pea	Earliness, dwarf plant type, high seed no./ pod, long pod, powdery mildew, Ascochyta and Fusarium wilt resistant, drought tolerant, sugary pod, high yield, high seed protein content (>27%)	HPF4, KPMR522, KPMR400 DDR23, Uttra, Pusa Pragati, Arka Ajit
Cowpea	Resistant to aphid, bruchid, thrips and striga, powdery mildew, mosaic virus and charcoal rot, adaptation to tropical conditions, early, drought tolerant, high grain yield, bushy and dwarf types, long pods, bold seeds, photo insensitive	Aseem, C 152, S288, Shweta, Pusa Sawani, Rituraj, Co2, Co4, PTB-1, S488, Pusa Phaguni
<i>Lathyrus</i>	Low neurotoxin content, high yielding and drought tolerant.	
Moth bean	High yield, high branching, suitable for green manure and forage, resistant to YVMV.	
French bean	High yield, resistant to bacterial blight and BCMV, dwarf, early maturing, good seed color	PDR 14, Shalimar Rajmah
Rice bean	High yielding, drought tolerant, earliness	CXM P12-1
Faba bean	High yielding, resistant to chocolate leaf spot disease Ascochyta blight, Fusarium wilt, root knot nematode and heat tolerant	
Lablab bean	Bruchid resistant and high yielding	
Horsegram	High productivity	Hebbal Hurli-2
Guar	Photo insensitive and dwarf types	Suvidha, Naveen

Introduction of wild species of various pulses viz. *Cicer reticulatum*, *C. echinospermum*, *C. canariensis*, *C. oxoydon*, *C. anatolicum* and *C. songaricum*; *Cajanus albicans*, *C. platycarpus*, *C. cajanifolia*, *C. cinereus*, *C. scarabeoides*, *C. kerstingii*, *C. judaicum*, *C. pinnatifidum*, *C. cuneatum*, *C. yamashitae*, *C. bijugum*; *Lens culinaris*, *L. orientalis*, *L. nigricans*, *L. odemensis*; *Lathyrus cicera*, *L. cilliolatus*, *L. ochrus* and similarly in other pulses, have enriched our collections and

contributed to germplasm enhancement and pre breeding.

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Performance of Exotic Pulses in Arid and Semi-Arid Region of India

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Key words: Exotic Pulses; Characterization; Promising Accessions

Pulses have been grown in India since time immemorial under various agro-ecological situations. This led to the development of enormous genetic variability during the course of evolution (Asthana, 1988). India is an important centre of diversity for several grain legumes (De Condolle, 1884; Vavilov, 1926; Zhukovsky, 1950). The important pulses grown in the arid and semi-arid region of India are chickpea (*Cicer arietinum*), cowpea (*Vigna unguiculata*), field pea (*Pisum sativum*), guar (*Cyanoopsis tetragonoloba*), horsegram (*Macrotyloma uniflorum*), mothbean (*V. aconitifolia*), mungbean (*V. radiata*), pigeonpea (*Cajanus cajan*) and Urd bean (*V. mungo*). National Bureau of Plant Genetic Resources, New Delhi has been endeavouring to build up the genetic resources in pulses from India as well as from abroad. Present communication deals with characterisation, preliminary evaluation and identification of promising accessions in exotic cowpea, guar, mothbean and mungbean germplasm.

Four hundred and twelve exotic accessions comprising of cowpea (269 accessions), guar (12 accessions), mothbean (48 accessions) and mungbean (83 accessions) including two wild species of guar (*Cyamopsis senegalensis* and *Cyamopsis serrata*) were introduced from Mexico, Nigeria, Srilanka, Taiwan, USA and erstwhile USSR during 1975-2004 through NBPGR, New Delhi. These accessions were characterized for various morpho-agronomical traits at NBPGR Regional

station, Jodhpur (26° 18' N and 73° E, altitude 224m) during *kharif* seasons of 1976-1977, 1978-1979, 1991-1992, 1994-1995 and 2004-2005 in an augmented design under rainfed (cowpea, guar and mothbean) and irrigated conditions (mungbean). Each accession was grown in two rows of 3m length, with inter and intra-row spacing of 60 and 15 cm, respectively. The data were recorded on five plants selected randomly from each of the accessions and observations were recorded on plant habit and height; size, shape and colour of leaves; days to 50% flowering and maturity; flower colour; number of branches; cluster per plant; pods per cluster and per plant; length of cluster, peduncle and pod; shape and colour of pod; presence of pod grooves and beak; size, shape and colour of seeds; seed hilum/eye colour; type of seeds; number of seeds per pod; pod and seed yield per plant and 100 seed weight. The data for individual plants were pooled and range, mean, standard deviation and phenotypic coefficient of variation were calculated for the observed parameters.

There was considerable variability in the introduced germplasm of each crop for most of the important traits (Table 1). Early maturing grain type accessions were EC 101929, EC 109493-2010-1 (cowpea); EC 37745 (guar); EC 100065 (mothbean); EC 520038 and EC 520041 (mungbean). Maximum number of branches was recorded in EC 36954 (guar); EC 100064, EC 100066 (mothbean); EC 512792 and EC 520009 (mungbean).

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Table 1. Variability parameters for important characters in exotic pulses

Character	Cowpea		Guar		Mothbean		Mungbean	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Days to 50 % flowering	40 – 60	48	35 – 45	41	32 – 90	66	32 – 61	49
Days to 50 % maturity	54 – 90	64	114 – 116	115	60 – 110	89	55 – 90	78
Plant height (cm)	14 – 80	25.1	48 – 107	78.4	11.7 – 35.4	26.2	12.8 – 45.4	31.9
Branches	1 – 10	5.6	2 – 9	6.0	2 – 8	5.0	1 – 6	3.0
Seed yield/ plant (g)	2.5 – 48.9	18.2	4 – 11	6.8	1.6 – 8.1	5.1	0.1 – 17.2	6.3
100 seed weight (g)	4.7 – 19.7	10.0	2.8 – 4	3.4	1.8 – 2.6	1.9	2.9 – 8.8	6.1

Accessions EC 101929, EC 109493-2010-1 (cowpea); EC 248A, EC 36954-P4-1, EC 36954-P5 (guar); EC 100064 (mothbean); EC 520037, 520038 and EC 520041 (mungbean) had maximum seed yield per plant. Highest 100 seed weight was recorded in EC 61395, EC 367682 (cowpea); EC 36954 - P4 -1, EC 36954 - P5 (guar); EC 100064 (mothbean); EC 512793, EC 520042 and EC 520043 (mungbean). EC 107183, EC 107191 (cowpea), EC 2484, EC 2448 – P3, EC 36951 and EC 36952 (guar) were identified as vegetable types. Bold and white coloured seeds were noticed in EC 367680, EC 367682 and EC 367683 (cowpea). Bhatnagar and Bhandari (1999) also reported some promising early maturing exotic collections of cowpea germplasm. In *Cyamopsis senegalensis* and *C. serrata* seeds shatter after pod maturation.

These promising accessions with desirable superior traits can be of immense value for the pulse breeding

programme in arid and semi-arid regions of India. In future, these accessions can also be screened for disease and pest resistance and various quality parameters.

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ABSTRACTS

Genetic Variability and Associations among Agro-Morphological Traits in Exotic Germplasm of Pea (*Pisum sativum* L.)

S Sardana, RK Mahajan, NK Gautum and Babu Ram

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Pea (*Pisum sativum* L.) is an important winter crop and believed to be evolved in Mediterranean basin. The success of any breedings programme depends upon the availability of diverse germplasm and their judicious utilization.

Therefore, efforts were made to augment the germplasm through introduction and their evaluation for yield and yield components. In present study 32 germplasm accessions were introduced from Germany, Japan, Russia, Syria, Taiwan, UK and USA.

Genetic variability parameters such as phenotypic and genotypic coefficient of variations (PCV and GCV), heritability and genetic advance were estimated for various agro-morphological traits. High estimates of PCV and GCV were observed for plant height, yield per plant, clusters per plant and primary branches where as moderate for seeds per pod, pod length and pods per plant, indicating wide variability in the material for these traits. However, there was little variability

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Grain yield showed significant positive association with clusters per plant, plant height, pods

per plant, primary branches and seeds per pod and low association with days to 50 percent flowering and days to maturity. EC334160 is sugar podded and early in flowering, EC398588, EC398599 and EC342007 were long podded and EC398588 possessed high yield per plant.

Characterization of Cowpea Germplasm Introduced from Indigenous and Exotic Sources

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Thirty seven germplasm accessions of cowpea (*Vigna unguiculata* (L.) Walp.), procured from NBPGR, New Delhi were characterized on the basis of morphological traits during *kharif*, 2002 at CCS Haryana Agricultural University, Hissar. Among 37 accessions, 22 have been designated with IC and NIC numbers indicating their native origin while, 15 have been designated with EC numbers indicating their alien origin. On the basis of market value of the accessions, 4 of the indigenous and 3 of the exotic sources were found to be fodder type, while rest of the accessions were grain type. However, among grain types, 6 accessions from indigenous and 7 from exotic sources were of early maturing types, while 17 belonging to normal maturity group had 12 from indigenous sources and 5 from the exotic ones. All the indigenous collections showed field resistance to CYMV while one of the exotic collections was found susceptible. Among indigenous collections, 16 accessions had violet flowers, 4 of intermediate type and 2 with white flowers, whereas among exotic collections, 13 had violet flowers and 1 each had white and intermediate

flower colour, respectively. As for as plant height is concerned, 4 were tall, 14 were medium tall and 4 were dwarf among the indigenous collections while, among exotic collections, 2 were tall, 7 were medium and 6 were dwarf in stature. Thirteen accessions were viny, and 9 were non-viny in growth habit among the indigenous sources while among exotic collections, 6 had viny growth and 9 had non-viny growth habit. Some of the accessions, namely NIC 22780, 22789, 22810 were observed as early maturing and high grain yielder; NIC 260A, 22815, 23010 as normal maturing and high grain yielder among indigenous collections while EC 367678 as high fodder yielder, EC 244018, 367680, and 367713 as early maturing and high grain yielder and EC 309500, 332354 as normal maturing and high grain yielder among the exotic collections were found to be very promising. Three accessions namely, IC 202824, NIC 23010 and IC 201073 had market traits as well. The promising collections mentioned above can be used in cowpea improvement programme.

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Contribution of Exotic Germplasm in Varietal Development of Mungbean and Urdbean in India

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Over a period of time several promising introductions in pulses were made from different countries. A total of 497 exotic collections of mungbean and only three exotics of urdbean have been included in Indian base collections. A majority of them were introduced from AVRDC, which is the largest repository of Asiatic Vigna species. Germplasm introduced in India were mostly sources for synchronous maturity, high yield and resistance to lodging and diseases. A total of nine promising introductions from AVRDC were extensively utilized in the development of some of the popular cultivars in mungbean. Pusa Vishal, a selection from AVRDC accession NM 2, released for NWPZ has been becoming popular because of its large seed size (6 g/100 seed weight). Selections made from exotic material introduced from China and Iran have led to the development of Shining Moong 1 and PS 16, respectively. These selections were widely used in crossing programme and subsequently few superior cultivars such as KM 1, Sunaina and RMG 62 were released. Most of the early maturing types are available in the base collections of

University of Philippines, Los Baños. The gene for yellow seed color was transferred to a high yielding cultivar of Philippines MG50-10A to produce MG50-10-Y which can be introduced for attractive seed colour. Excellent sources of resistance to Cercospora leaf spot and mottle virus have been identified in germplasm accessioned at University of Philippines. Several promising introductions for early and large seeded types (EC 118894, EC 118898), photoinsensitive (EC 318985, EC 318989, EC 319054), long podded with shining green coat (EC 393407, EC 393409, EC 393407) hold promise for development of mungbean improvement programme. An introduction from Taiwan, EC 245976, a potential source of bruchid resistance may prove useful in evolving resistant cultivars of urdbean. The possibilities of introductions for attractive seed colour, bold seeds, long pods and high number of seeds per pod may be explored from the other genetic resources centres of the world. Access to unique and potential valuable germplasm is key to sustained varietal improvement programme.

SHORT COMMUNICATIONS

Evaluation of Exotic Germplasm of Rapeseed-Mustard

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Key Words: Rapeseed-Mustard, Evaluation, Germplasm

The exotic germplasm of crop plants are one of the important sources of some of the agronomical traits for the development of improved cultivars. In the present study, 35 and 26 exotic accessions of *Eruca sativa* (rocket) and *Brassica carinata* (Ethiopian mustard), respectively, were evaluated for 14 agro-morphological and quality traits during 2002-2003. Both these annual species are among the seven cultivated oilseeds of India, belonging to family Brassicaceae. These accessions were acquired from Federal Research Centre of Agriculture,

Braunschweig, Germany through NBPGR, New Delhi. Among the 14 traits studied, the maximum variability is observed for seed yield per plant and the least variability is observed for oil content in both the crop species (Table 1 & 2). In rocket genotypes EC-447079 was identified as a useful donor for 1000 seed weight, harvest index and seed yield per plant. However, EC-447092 and EC-447123 were identified as donors for main shoot length and siliquae on main shoot in rocket and Ethiopian mustard, respectively. Identified promising

Table 1. Range, mean and coefficient of variation (cv) for different agro-morphological traits in Karan rai (*B. carinata*) germplasm

Character	Range	Mean $\pm$ Sem	CV (%)	Mean values of checks	
				PC 5	PBC 9902
Initial Flowering (days)	84-104	97.6 $\pm$ 1.03	5.4	71.00	89.50
50% Flowering (days)	95-120	108.7 $\pm$ 1.60	7.5	85.50	109.00
Plant height (cm)	73-156	121.08 $\pm$ 4.32	17.1	180.70	178.3
Primary branches (No.)	12-24	16.52 $\pm$ 0.71	20.5	12.60	12.80
Secondary branches (No.)	5 - 41.7	26.51 $\pm$ 1.94	35.1	15.20	16.30
Main shoot length (cm)	11.7-38.3	23.07 $\pm$ 1.52	31.5	26.50	30.50
Siliquae on main shoot (No.)	11.3-26.3	16.54 $\pm$ 0.81	23.5	18.70	14.40
Maturity (days)	146-158	152.7 $\pm$ 0.75	2.5	154.0	153.50
Silique beak length (cm)	0.3-0.7	0.42 $\pm$ 0.02	24.1	0.50	0.83
Silique length (cm)	2.9-4.9	3.90 $\pm$ 0.13	15.7	4.90	4.99
Seed yield/ plant (g)	1.39-14.3	6.67 $\pm$ 0.81	58.1	9.50	9.00
Harvest index (%)	6.4-23.8	11.86 $\pm$ 0.92	37.1	16.40	16.25
1000-seed weight (g)	2.0-4.0	3.04 $\pm$ 0.11	17.3	4.20	3.94
Seeds/ silique (No.)	8.3-25.4	19.09 $\pm$ 1.10	23.8	15.20	15.55

Table 2. Range, mean and coefficient of variation (cv) for different agro-morphological traits in Taramira (*E. sativa*) germplasm

Character	Range	Mean $\pm$ Sem	CV (%)	Mean values of checks	
				RTM 314	T 27
Initial Flowering (days)	55-71	64.9 $\pm$ 0.63	5.8	44.7	48.7
50% Flowering (days)	67-77	73.9 $\pm$ 0.36	2.9	58.7	64.0
Maturity (days)	123-130	126.2 $\pm$ 0.27	1.3	134.0	134.0
Plant height (cm)	56-102	75.9 $\pm$ 1.85	14.0	122.1	126.7
Primary branches (No)	4.3-11	7.4 $\pm$ 0.31	24.2	6.6	5.8
Secondary branches (No)	3.7-26.3	13.6 $\pm$ 0.94	39.8	8.1	6.6
Main shoot length (cm)	34.7-73.7	47.5 $\pm$ 1.39	16.8	30.1	34.7
Siliquae on main shoot(No)	16-37	24.6 $\pm$ 0.78	18.1	19.9	21.1
Seed yield/ plant (g)	2.8-9.4	5.0 $\pm$ 0.61	42.3	8.0	7.7
1000-seed weight (g)	2.0-4.0	2.7 $\pm$ 0.12	19.4	2.8	2.7
Harvest index (%)	16.7-37.3	24.2 $\pm$ 1.92	27.5	16.4	16.2
Protein content (%)	21.5-24.4	22.7 $\pm$ 0.14	3.5	23.3	23.1
Oil content (%)	34.6-37.9	36.1 $\pm$ 0.17	2.6	34.4	34.2

Genetic Variability in Exotic Ethiopian Mustard (*Brassica carinata* A Braun)

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Key Words: *Ethiopian mustard, Brassica carinata, Genetic Variability*

Oilseed brassicas are produced and marketed for seed and oil; any increase in these two by whatever means will increase the value of rapeseed and mustard group of crops to the end user. *Brassica carinata* A. Braun believed to be originated in Ethiopian highlands (Vaughan 1956) is another annual mustard with high potential as oil crop for Mediterranean (semi-arid) conditions and as a genetic resource for characters of agronomic importance. In its centre of origin, it is considered as a high yielding, disease- and pest- resistant crop (Getinet *et al.*, 1997). Traditionally, Ethiopian mustard is not grown in India. The cultivated Ethiopian mustard may have been taken from Ethiopia to India by traders along with others crops. Compared with other cultivated *Brassica* species, the range of variation of *B. carinata* is not very high. The collection maintained in the germplasm repositories in India, do not represent the wide genetic diversity. Cultivars of Ethiopian mustard developed so far are shunned because of very tall plant height (>2.5 m), long vegetative period, late in flowering (>80 DAS) and maturity (>160 DAS) with poor seed size (<4g). On average, oil contents of Ethiopian mustard are 3% to 6% lower than the Indian mustard [*B. juncea* (L.) Czern]. Cultivars of Ethiopian mustard have high erucic (*cis*-13-docosenic; C 22:1 n-9) acid (35-44%) in their oil (Westphal and Marquard 1980) and high total glucosinolate (70-159 micro mole/g seed) in their seed meal (Getinet *et al.*, 1996).

Mutation is both new creating and repetitive process. We present the range of variation observed in Ethiopian

mustard through plant genetic enhancement using induced mutagenesis in order to increase its value. A single plant selected from M₅ line cultivar Kiran (selection from HC 5) developed through mutagenesis (using 40 kR gamma rays followed by 1% EMS) for early to flower and reduced plant height was grown in 7 row plot of 5m x 3.5m with 20 x 45cm spacing during 2003-04 by sowing its M₆ seeds. Considerable variation in the 51 progeny of M₆ line was observed for nearly all characters (Table 1) including days to flower (52-61) and mature (141-166), seed yield per plant (7.3-218.2g), plant height (41-158 cm), plant phenotype, leaf form, node number (4-27), primary branches (4-26), 1000-seed weight (3.3-7.1 g), oil content (32.2-39.8%), erucic acid content (35.8-52.3%), linolenic acid content (7.5-26.2%), total glucosinolate content (50.0-101.1 micro mole/g defatted meal) and seed shape and coat colour. Variation from mutagenesis has not undergone selections. The rapid expansion in scientific knowledge about how Ethiopian mustard grows and behaves allows many aspects of the crop to be targeted for genetic enhancement. To expand the current acreage, *carinata* mustard has the potential to increase the production area.

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Table 1. Variability for agro-morphological and qualitative traits in Ethiopian mustard cv. Kiran (PBC 9221) during 2003-04

Trait	Range		Mean $\pm$ SEM	SD	CV %
	Min	Max			
Days to maturity	141	166	157.37 $\pm$ 0.780	5.571	3.5
Plant height (cm)	41	158	111.25 $\pm$ 3.505	25.035	22.5
Height to first primary branch (cm)	0	40	5.84 $\pm$ 1.166	8.33	142.6
Nodes number at first primary baranch	1	12	2.57 $\pm$ 0.33	2.377	92.5
Number of primary branch/plant	4	26	14.98 $\pm$ 0.759	5.423	36.2
Main shoot length (cm)	13	75	29.86 $\pm$ 1.608	11.489	38.5
Silique on main shoot	4	22	13.23 $\pm$ 0.634	4.532	34.3
Seed yield/plant (g)	7.3	218.2	43.33 $\pm$ 5.475	39.10	90.2
1000-Seed weight (g)	3.3	7.1	4.8 $\pm$ 0.125	0.897	18.7
Oil content (%)	32.21	39.90	36.46 $\pm$ 0.279	1.993	5.5
Protein content (%)	20.18	25.05	22.11 $\pm$ 0.144	1.027	4.6
Total glucosinolate content (micro mole/g defatted meal)	50.0	101.1	77.84 $\pm$ 2.080	14.860	19.1

Utilization of Exotic Germplasm for the Development of Groundnut Varieties

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Key Words: Groundnut, Germplasm, Utilization

To meet the food requirement of increasing population it is necessary to increase the agricultural production in food grains, oilseeds and agricultural production. As the potential for area expansion is limited, development and use of new varieties of seed and ensuring their availability to farmers are of crucial importance to increase production. Groundnut (*Arachis hypogaea* L.) is an important oilseed crop of tropical and subtropical areas of the world. India is the leading groundnut producing country with about 35 % of world's groundnut area and about 27 % production (second to China). It is a primary source of edible oil and with high protein content (Rajgopal *et al.*, 2002). Groundnut originated in the southern Bolivia/north west Argentina region in South America and is presently cultivated in 108 countries of the world. Important groundnut producing countries are China, India, Indonesia, Myanmar, Thailand, and Vietnam in Asia; Nigeria, Senegal, Sudan, Zaire, Chad, Uganda, Ivory Coast, Mali, Burkina Faso, Guinea, Mozambique, and Cameroon in Africa; Argentina, Brazil, USA and Mexico (Bandhopadhyay *et al.*, 2003).

To promote the effective utilization of Plant Genetic Resources, National Bureau of Plant Genetic Resources (NBPGR) is actively engaged in importing the important germplasm of various crops from different countries, which has resulted in introduction of a large number of oilseed germplasm since 1943. In addition NBPGR has made considerable efforts in facilitating the free flow and exchange of germplasm to strengthen the National Crop Improvement Programmes. Germplasm introduced in India comprising cultivated, elite lines, breeding lines, wild species and commercial varieties have played a significant role in the development of varieties and hybrids in oilseed crops and figure prominently in

the list of promising material, original source material and parental lines of improved cultivars (Dhillon *et al.*, 2004). The National Genebank at NBPGR holds, 7,283 accessions of exotic oil seed crop germplasm in the long term storage facility comprising of groundnut (1,480), rapeseed-mustard (294), safflower (2,727), sunflower (636), soybean (1,559), castor (326), linseed (104), niger (11) and sesame (146). This in turn has resulted in release of a number of new varieties as a direct selection/ collection or through hybridization. Most of the varieties contain constellations of useful genes, which can be further appraised to meet the requirement of changing scenario by utilizing the potentially valuable genes. Development of high yielding cultivars of desired duration with resistance/ tolerance to single or multiple stresses and developing stress management strategies are the main objectives of groundnut improvement programmes worldwide.

A total of 158 varieties of groundnut have been released so far either through All India Coordinated Research Project, State Agricultural Universities or State Agriculture Department since 1905 to 2004. Out of the 158 Groundnut cultivars released for cultivation in India, the early cultivars are all selection from exotic material (Table 1). They are direct selections, introductions or mutants. Some of the exotic introductions were used as one/ both parents. Some of the released cultivars have been used repetitively for the development of new improved varieties for example of the total cultivars, 15 cultivars had Robut 33-1 as one of the parents. Cultivar JL-24 contributed to the development of ten and M 13 was directly or indirectly involved in development of the seven (Table 2). GAUG 10 and TMV 10 in turn is a natural mutant of cultivar Argentine that is also used as a parent in development of another Cultivar. TG-1 and TG-2 are natural mutants whereas cultivar UF 70-103 is a direct

Table 1. Exotic germplasm used Indirectly for varietal development in groundnut (Hybridization)

S.No.	Cultivar Used	Varieties developed
1	M-13	B-95, BAU-13, Birsa Bold, GG-11, M-335, TAG-24, Somnath
2	Robut 33-1	BSRG-1, DRG-17, GG-20, HNG-10, ICGS-1, ICGS-11, ICGS-37, ICGS-44, ICGS-5, Kadiri-3, RG-141, TG-22, VRI-1, VRI-3
3	JL-24	AK-159, GG-3, GG-5, JGN-3, K-134, Kadiri-5, Narayani, Sneha, Snigdha, Tirupati-4, VRI-2

Table 2. Exotic germplasm used directly for varietal development in groundnut (Selection)

S.No	Cultivar Used	Varieties developed
1	RS-144	Dh-8
2	Robut 33-1	ICGS-1, ICGS-11, ICGS-37, ICGS-44, VRI-1, Kadiri-3
3	EC 94943	JL-24
4	Exotic 9	Jyoti
5	MK 374	Kadiri-2
6	T-28	Kaushal
7	EC 16664	MA-16
8	NC-13	M-13
9	Maldiyan Bunch	Polachi-1
10	Brazilian Culture	RS-138, RSB-87
11	ICGS-1	SG-84
12	EC1664	T-64
13	Tennse white	TMV-7,
14	ICGV-86011	ALR-2
15	TGS-2	TAG-24
16	EC 106983/3-1	Tirupati-1
17	Ugandian Culture	TMV-12
18	Gudiyatham bunch	TMV-2
19	Basse	TMV-3
20	North carolina	TMV-4
21	East Africa	TMV-11
22	Virginia bunch	TMV-6
23	Spanish mutant-1	RSHY-1

Table 3. Varietal Development by mutation/direct introduction of exotic cultivars

S.No	Cultivar Used	Varieties developed
1	Natural mutant from Argentine	TMV-10
2	X-ray mutant of Spanish Improved	TG-1
3	Mutant of Spanish Improved	TG-3
4	Introduction from USA	UF-70-103

introduction from USA (Table 3). Further more than 30 original genotypes have gone into pedigree of the hybridization derived cultivars as one of the parents.

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Genetic Variability in Exotic Germplasm of *Crambe abyssinica*

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The genus *Crambe*, consisting of 20 different species of herbaceous annuals is a member of family Cruciferae, tribe Brassicae. *Crambe* (*Crambe abyssinica* Hochst Ex. RE Fries) is a lesser-known oilseed crop, closely related to rapeseed-mustard. It is a potential source of industrial oil, because of its erucic acid (55-64%) rich seed-oil. Members of this genus have been under cultivation in Europe, Africa, Near East and West Asia and North and South America (Lessman and Meier, 1972). *Crambe* is cultivated during cooler season, which can tolerate low temperature up to -5°C (Hirsinger, 1989). It is an erect, herbaceous annual and stem is stiff, covered with fine, short hairs. The main stem branches close to the ground to form secondary branches. Leaves are glabrous and basically ovate/lyrate. The time of flowering depends upon rainfall and temperature. The inflorescence is a cyme, which with progressive growth become long and indeterminate flowering panicle with racemes of white flowers. The typical cruciferous

flowers have four white petals of about 3 mm length and six stamens, producing a small, brownish seed on each flower. Each seed is contained in a papery thin pod. Fruit is a capsule (silique), initially pale green but turn yellowish on maturity. Each capsule contains a single spherical brown seed. Although capsules usually have two embryos initially, only one develops into mature seed. The fruit is composed of approx. 40 per cent pericarp, 4 per cent testa, 6 per cent hypocotyl and 50 per cent cotyledons.

Crambe oil, due to good stability at high temperature, is very well suited as lubricant for steel casting. Derivatives of erucic acid can be used for various chemical applications such as slip agents, plasticizers, lubricants, softeners, anti-foamers, fixatives in perfumes etc. The seed oil of *Crambe abyssinica* has unparalleled diversity of fatty acid patterns that range from C_8 - C_{18} with medium chain triglycerides (C_8 - C_{14}) predominating, which is unique in plant kingdom.

Table 2. Exotic germplasm used directly for varietal development in groundnut (Selection)

S.No	Cultivar Used	Varieties developed
1	RS-144	Dh-8
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flowers have four white petals of about 3 mm length and six stamens, producing a small, brownish seed on each flower. Each seed is contained in a papery thin pod. Fruit is a capsule (silique), initially pale green but turn yellowish on maturity. Each capsule contains a single spherical brown seed. Although capsules usually have two embryos initially, only one develops into mature seed. The fruit is composed of approx. 40 per cent pericarp, 4 per cent testa, 6 per cent hypocotyl and 50 per cent cotyledons.

Crambe oil, due to good stability at high temperature, is very well suited as lubricant for steel casting. Derivatives of erucic acid can be used for various chemical applications such as slip agents, plasticizers, lubricants, softeners, anti-foamers, fixatives in perfumes etc. The seed oil of *Crambe abyssinica* has unparalleled diversity of fatty acid patterns that range from C_8 - C_{18} with medium chain triglycerides (C_8 - C_{14}) predominating, which is unique in plant kingdom.

Table 1.

Descriptors	Mean	Range of variation	Phenotypic CV (%)	Promising accessions
Days to 50% flowering	94.7	80.0-110.0	7.5	EC 499690 (80.0), EC 499705 and EC 499720 (80.0)
Days to mean maturity	129.5	119.0-136.0	2.4	EC 499708 (122.0), EC 499718 (122.0), EC 499699 (125.0), EC 499725 (126.0), EC 499741 (126.0)
Plant height	98.6	73.0-128.8	19.1	EC 499675 (124.0), EC 499741 (122.2), EC 499704 (118.6)
No. of primary branches	33.1	4.4-52.0	28.9	EC 499680 (52.0), EC 499676 (47.0), EC 400057 (45.6), EC 499678 (45.5)
Length of primary branch	85.0	24.0-117.2	21.1	EC 499741 (113.4), EC 499740 (104.6), EC 499675 (102.2), EC 499699 (102.0)
No. of fruits/primary branch	271.3	95.5-568.0	41.4	EC 499679 (568.0), EC 499677 (560.0), EC 499678 (540.5)
Length of main fruiting branch	161.1	7.2-44.3	58.0	EC 499684 (44.3), EC 499699 (42.8), EC 499705 (41.0)
No. of fruits/main fruit branch	20.7	8.2-57.2	45.3	EC 499684 (45.0), EC 499705 (45.0), EC 499690 (37.6), EC 499677 (35.0), EC 499678 (33.0)

The 72 exotic germplasm of *Crambe abyssinica* obtained from United States Department of Agriculture (USDA), Plant Introduction Centre, Ames, USA were grown during *rabi* season of 2003 at IARI, New Delhi in randomized block design with the spacing between the rows and within the rows of 45 cm and 10-15 cm respectively and 3 m row length. Ten plants were selected at random and observations on plant height, number of branches per plant, number of fruits per branch, length of primary branch and length of main fruiting branch were taken. The extent of variability were determined in 72 germplasm lines of *Crambe abyssinica*.

Wide range of variability was observed in plant height (73.0-128.8 cm), number of branches per plant (4.4-52.0), length of primary branch (24.0-117.2 cm), number of fruits per primary branch (95.5-568.0), length of main fruiting branch (7.2-44.3 cm) and number of

fruits per main branch (8.2-57.2). Promising accessions have been identified in each descriptor (Table 1). The accessions found promising in the present study may be utilized for developing varieties through direct selection or through breeding programmes.

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ABSTRACTS

Evaluation of Sunflower Germplasm

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Sunflower (*Helianthus annuus* L.) the oilseed crop native to North America was introduced in India during 1960s and has emerged as one of the major edible oilseed crops in the world. Sunflower cultivation is highly concentrated in Europe and among European countries, the erstwhile USSR is the largest producer of sunflower, followed by Romania, France and Yugoslavia. Sunflower is grown over an area of 21.21 m ha with a production

of 24.94 mt and 1174 kg/ ha average productivity. Till recently, the sunflower production was confined largely to the southern and central peninsula comprising Karnataka, Andhra Pradesh, Maharashtra and Tamil Nadu. Of late, its cultivation is getting extended to agriculturally advanced states in North India – Punjab, Haryana and Western Uttar Pradesh. Karnataka, Maharashtra and Andhra Pradesh are the major producers

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Plant height	98.6	73.0-128.8	19.1	EC 499675 (124.0), EC 499741 (122.2), EC 499704 (118.6)
No. of primary branches	33.1	4.4-52.0	28.9	EC 499680 (52.0), EC 499676 (47.0), EC 400057 (45.6), EC 499678 (45.5)
Length of primary branch	85.0	24.0-117.2	21.1	EC 499741 (113.4), EC 499740 (104.6), EC 499675 (102.2), EC 499699 (102.0)
No. of fruits/primary branch	271.3	95.5-568.0	41.4	EC 499679 (568.0), EC 499677 (560.0), EC 499678 (540.5)
Length of main fruiting branch	161.1	7.2-44.3	58.0	EC 499684 (44.3), EC 499699 (42.8), EC 499705 (41.0)
No. of fruits/main fruit branch	20.7	8.2-57.2	45.3	EC 499684 (45.0), EC 499705 (45.0), EC 499690 (37.6), EC 499677 (35.0), EC 499678 (33.0)

The 72 exotic germplasm of *Crambe abyssinica* obtained from United States Department of Agriculture (USDA), Plant Introduction Centre, Ames, USA were grown during *rabi* season of 2003 at IARI, New Delhi in randomized block design with the spacing between the rows and within the rows of 45 cm and 10-15 cm respectively and 3 m row length. Ten plants were selected at random and observations on plant height, number of branches per plant, number of fruits per branch, length of primary branch and length of main fruiting branch were taken. The extent of variability were determined in 72 germplasm lines of *Crambe abyssinica*.

Wide range of variability was observed in plant height (73.0-128.8 cm), number of branches per plant (4.4-52.0), length of primary branch (24.0-117.2 cm), number of fruits per primary branch (95.5-568.0), length of main fruiting branch (7.2-44.3 cm) and number of

fruits per main branch (8.2-57.2). Promising accessions have been identified in each descriptor (Table 1). The accessions found promising in the present study may be utilized for developing varieties through direct selection or through breeding programmes.

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ABSTRACTS

Evaluation of Sunflower Germplasm

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Sunflower (*Helianthus annuus* L.) the oilseed crop native to North America was introduced in India during 1960s and has emerged as one of the major edible oilseed crops in the world. Sunflower cultivation is highly concentrated in Europe and among European countries, the erstwhile USSR is the largest producer of sunflower, followed by Romania, France and Yugoslavia. Sunflower is grown over an area of 21.21 m ha with a production

of 24.94 mt and 1174 kg/ ha average productivity. Till recently, the sunflower production was confined largely to the southern and central peninsula comprising Karnataka, Andhra Pradesh, Maharashtra and Tamil Nadu. Of late, its cultivation is getting extended to agriculturally advanced states in North India – Punjab, Haryana and Western Uttar Pradesh. Karnataka, Maharashtra and Andhra Pradesh are the major producers

and together contribute 87 per cent in area and 72 per cent in production. There are over 29,500 accessions of sunflower available worldwide (FAO, 1996); 3 per cent of these are of wild species, 4 per cent land races or old cultivars, 54 per cent are advanced cultivars or breeding lines and 39 per cent are others. USDA has maintained over 3608 accessions of *H. annuus* which consist of 1445 cultivated *H. annuus*, 2092 accessions of wild annual species and 71 accessions of perennial *Helianthus* species. There are 750 accessions of sunflower germplasm conserved at -20° C in National Genebank at NBPGR, New Delhi. Cultivated sunflower is an annual and conspicuously different from the wild and weedy forms in having a single unbranched stem, large capitulum and medium to large seeds. The cultivated forms vary greatly from one another in height, stem girth, leaf number and size, duration of maturity, test weight and oil content. The stem may show different degrees of branching, ranging from mono stem nature with single head to highly branched forms with several heads. The stem is supported by a strong, deep central root system with well developed lateral roots reaching a soil depth of 1.5 m to 2.0 m. The leaves vary in number and are produced in opposite pairs at the lower portion of the stem and in alternate phyllotaxy in whorled form at the above. Sunflower germplasm, which includes, wild species, land races, local and improved varieties, CMS lines, Maintainer and Restorer lines, inbreds,

hybrids and breeding lines have been introduced from over 33 countries during 1948 to 2000.

A total of 205 accessions of *Helianthus annuus* were grown during *rabi* season of 2003 at NBPGR Experimental Farm, Issapur, New Delhi. The accessions were sown in an augmented block design at spacing of 50 x 15 cm and 3 m row length with five checks. The recommended agronomic practices were followed to raise a good crop. The observations were recorded on days to 50 percent flowering, days to mean maturity, plant height, stem thickness, number of leaves, leaf length, leaf width, head diameter and oil content.

Wide range of variability was observed in plant height (44.6-318.4 cm), stem thickness (0.8-4.3 cm), number of leaves (8.0-40.0) and leaf length (6.4-30.4 cm), leaf width (4.9-22.4), head diameter (4.0-22.4 cm) and oil content (32.51-51.38 percent). Promising accessions identified for short plant height were EC 512703, EC 512727, EC 512732, EC 512733, EC 512735, EC 512770, EC 512771 and EC 512772; for broad head size and short plant height were EC 494422; EC 494380 for early flowering and EC 512679, EC 494385, EC 494400, EC 494415, EC 494422, EC 494444, EC 512750, EC 512751 for broad head size. The accessions found promising in the present study may be utilized for developing varieties through direct selection or through breeding programmes.

Risk of Seed-transmitted Viruses Associated with Exchange of Soybean Germplasm and the South Asian Scenario

DB Parakh, RK Khetarpal, VC Chalam, AK Maurya and Shamsher Singh

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Soybean (*Glycine max* (L.) Merr.) is an important legume and oilseed crop of immense commercial value to South Asia. Given its nutritional and health related benefits, soybean has been gaining more prominence the world over with the advent of transgenic crops. South Asia accounts for 4 percent of soybean production in the world, of which, within the region, India's share was 99.52 percent during 2003. Soybean diseases, especially of viral origin, severely affect the yield. The crop is infected by 44 viruses, out of which 24 are seed-

transmitted. The yield-loss due to seed-transmitted soybean viruses ranges from 10 to 100 percent. The seed-transmitted viruses reported to be present worldwide include *Alfalfa mosaic virus* (AMV), *Arabidopsis mosaic virus*, *Bean common mosaic virus* (BCMV)-*Black eye cowpea mosaic virus* strain, *Bean pod mottle virus*, *Cowpea aphid-borne mosaic virus* (CABMV), *Cacao necrosis virus*, *Cherry leaf roll virus*, *Cowpea mild mottle virus*, *Cucumber mosaic virus* (CMV), *Grapevine fanleaf virus*, *Mulberry ringspot virus*, *Peanut stripe virus*,

and together contribute 87 per cent in area and 72 per cent in production. There are over 29,500 accessions of sunflower available worldwide (FAO, 1996); 3 per cent of these are of wild species, 4 per cent land races or old cultivars, 54 per cent are advanced cultivars or breeding lines and 39 per cent are others. USDA has maintained over 3608 accessions of *H. annuus* which consist of 1445 cultivated *H. annuus*, 2092 accessions of wild annual species and 71 accessions of perennial *Helianthus* species. There are 750 accessions of sunflower germplasm conserved at -20° C in National Genebank at NBPGR, New Delhi. Cultivated sunflower is an annual and conspicuously different from the wild and weedy forms in having a single unbranched stem, large capitulum and medium to large seeds. The cultivated forms vary greatly from one another in height, stem girth, leaf number and size, duration of maturity, test weight and oil content. The stem may show different degrees of branching, ranging from mono stem nature with single head to highly branched forms with several heads. The stem is supported by a strong, deep central root system with well developed lateral roots reaching a soil depth of 1.5 m to 2.0 m. The leaves vary in number and are produced in opposite pairs at the lower portion of the stem and in alternate phyllotaxy in whorled form at the above. Sunflower germplasm, which includes, wild species, land races, local and improved varieties, CMS lines, Maintainer and Restorer lines, inbreds,

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transmitted. The yield-loss due to seed-transmitted soybean viruses ranges from 10 to 100 percent. The seed-transmitted viruses reported to be present worldwide include *Alfalfa mosaic virus* (AMV), *Arabidopsis mosaic virus*, *Bean common mosaic virus* (BCMV)-*Black eye cowpea mosaic virus* strain, *Bean pod mottle virus*, *Cowpea aphid-borne mosaic virus* (CABMV), *Cacao necrosis virus*, *Cherry leaf roll virus*, *Cowpea mild mottle virus*, *Cucumber mosaic virus* (CMV), *Grapevine fanleaf virus*, *Mulberry ringspot virus*, *Peanut stripe virus*,

Peanut stunt virus, *Raspberry ring spot virus*, *Southern bean mosaic virus* (SBMV), *Soybean mild mottle virus*, *Soybean mosaic virus* (SMV), *Soybean stunt virus*, *Soybean stunt mottle virus*, *Tobacco black ring virus*, *Tobacco ring spot virus* (TRSV), *Tomato ring spot virus* and *Tobacco streak virus*. Out of 24, majority are not reported from Bangladesh (21), Nepal (21), Sri Lanka (19), Pakistan (18) and India (17). However, none are reported from Bhutan and Maldives. Seventeen are not reported from any of the South Asian countries. Most of these viruses have wide host range and are transmitted by insect vectors and South Asian countries need to be careful about these viruses. Even a low rate of virus transmission through seeds can be disastrous to the crop and yield losses may be as high as 100 percent if the insect vectors in the field also play an active role in spreading the disease. Quarantine regulatory measures will help in preventing the introduction of these viruses into the region.

As per the Plant Quarantine (Regulation of Import into India) Order, 2003 of the Destructive Insects and Pests Act (1914), the imported germplasm including transgenics are subject to quarantine processing at the National Bureau of Plant Genetic Resources, New Delhi. The Order requires additional declaration to be included in Phytosanitary Certificate for soybean seeds to be free from viruses viz., mosaic, dwarf, crinkle, chlorotic mottle, cucumber mosaic, stunt, poty, tobacco ring spot, tobacco streak and tobacco black ring viruses, to restrict the entry of these viruses/ their strains into India. About 5,364 accessions of soybean germplasm including transgenics were processed for associated viruses under quarantine during 1986-2004. Techniques used to detect seed-transmitted viruses include visual inspection, grow-out test, infectivity test, electron microscopy, double antibody sandwich-enzyme linked immunosorbent assay and dot immunobinding assay. Seven seed-transmitted viruses viz., AMV, BCMV, CABMV, CMV, SBMV, SMV and TRSV were intercepted in the imported germplasm. Transgenic soybean imported from USA was found infected with SMV.

BCMV, CABMV, SBMV and are not known to occur on soybean in India and were intercepted for the first time. AMV, CMV, SMV and TRSV having wide host range are known to be present in India. However, there are reports of worldwide distribution of different virulent strains of these viruses. Therefore, interception of these viruses and incineration of infected plants eliminated the introduction of exotic viruses and their strains into the country. Finally by eliminating shriveled, discoloured and deformed seeds during visual inspection and later uprooting the plants with suspected viral symptoms, possible introduction of viruses other than those detected were also eliminated. Harvest from virus-free plants was released to the indenters. The findings thus highlight the importance of plant quarantine in minimizing/ eliminating the risk of introducing destructive exotic viruses and their strains, along with germplasm.

Strict regulatory measures together with growing new introductions under containment or isolation and collection of seeds from only virus-free plants must be followed to eliminate the risk of introducing seed-transmitted viruses/ their strains if any, into South Asian region. Database on all soybean viruses, including information on host range, geographical distribution, strains, etc. is being prepared for its use as a ready reckoner by the quarantine personnel. The region should take note of technical guidelines for the safe movement of legume germplasm including soybean prepared by International Plant Genetic Resources Institute, Rome. The findings also highlight the importance of having antisera for all the 24 seed-transmitted viruses, especially for those not reported in South Asia, in the quarantine laboratories of the region to facilitate the interception of exotic viruses and their strains. A regional working group of experts for detection of soybean viruses thus needs to be formed to explore future cooperation in terms of sharing of expertise and facilities. This would help in avoiding the introduction of viruses not known in the region and also the movement of viruses within the region, while facilitating the safe exchange of germplasm.

SHORT COMMUNICATIONS

Performance of Date Palm Introductions under Hot Arid Environment

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Key Words: Date Palm, Arid Zone, Introduction

Date palm (*Phoenix dactylifera* L.) is an important fruit tree of arid and semi-arid regions. Fruits are either eaten fresh or in the processed form. In order to exploit the potential of the northwestern dry areas of India for date palm cultivation, a number of varieties have been introduced from Middle East countries, USA, Saudi Arab, Egypt, which are performing better in different parts of country (Chandra *et al.* 1990). Introduction of new varieties having better traits is a continuous process to increase productivity of crops. In India, date palm is mainly cultivated in western parts of Rajasthan, Kachchh region of Gujarat, parts of Punjab and Haryana state (Pareek and Muthana, 1978, Singh *et al.*, 2003). For commercial cultivation of date palm in this region, there is a need to have cultivars, which are early to medium maturing, rain tolerant, capable of tolerating high temperature and salinity. Accordingly, date palm cultivars in the form of offshoot as well seeds were introduced from Iraq to India and their performance in this region was evaluated and findings have been summarized in the present paper.

In India, maximum date varieties have been introduced from USA, Egypt, Iraq, Saudi Arabia, Oman etc (Anon., 1975). The seed/planting material i.e. offshoots were introduced through NBPGR, New Delhi to CIAH, Bikaner under germplasm exchange programme. The plants were raised under hot arid environment of India to evaluate the suitability of the exotic materials. One offshoot of each variety namely Shakkar (EC 402388), Braim (EC 402389) and Chip chap (EC 402390) were introduced from Iraq in 1997. Out of these, Braim and Chip chap are growing well and started flowering and fruiting after four years of establishment while, offshoot of variety Shakkar could not survive. The investigation was conducted at Central Institute for Arid Horticulture, Bikaner that is located in the northwestern part of the country. The soil of the areas is sandy, desertic, poor in nutrients and water holding capacity. The summer is very hot and annual average rainfall is also low (240 mm) and erratic. The ground water source is limited, deep and saline in quality.

The sucker of date palm cultivars viz. Braim (EC 402388), Chip chap (EC 402389) and Shakkar (EC 402390) was introduced from Iraq to India through NBPGR, New Delhi during the year 1997 (Anonymous, 1997-98). The sucker of cultivar Shakkar was small in size and rootless while other two were appropriate in size/weight and 3-4 roots were present. The imported plant material was kept under nursery conditions for six months for hardening and rooting before planting in the field. At planting, suckers were treated with Carbendazim (0.1%) and IBA 1000 ppm. The pits of 1x1x1 m size were prepared and filled with soil mixtures of sand + clay + FYM (1:1:1 ratio) and Methyl parathion dust (50g/pit). The offshoots were transplanted in field during the month of October. Plants were monitored regularly till establishment and irrigation was given as and when required. Seeds of seven date palm varieties from Iraq and one genotype from Tehran, Iran were introduced to India and seedling growth performance were evaluated. Observations on height of palm, size of leaves, pinnae, emergence of spathe, opening of spathe, fruiting, maturity of fruits and quality of fruit was assessed.

The vigorous plant growth was observed in cultivars Chip chap in comparison to Braim plant in respect of palm height, spread, leaf size, pinnae, and suckering also. Plant growth pattern in both the cultivars were at par to other germplasm planted in the same year at same site. It seems that the growth performance of both the cultivars is satisfactory under hot arid environment. However, plant growth depends upon genetic character of the genotype besides environmental conditions of growing sites. Similar view has also been expressed by Zaid (1999) while working on production technology of date palm.

In the first year of fruiting, 6.000 kg doka fruits/plant was harvested from Braim plant after five years of planting. However, Chip chap cultivar started flowering and fruiting in the year 2002 after four years of planting but the yield was very less. Only one bunch of 500g weight was obtained in the year 2002. During the year 2003, fruit yield (1.000 kg/plant) was obtained from

Chip chap plant. In both the cultivar, fruit colour was yellow and sweet in taste with average berry weight 7.74g and 8.32g for Braim and Chip chap, respectively. Bigger berry size was recorded in Chip chap than that of Braim cultivar, which possibly be due to genetic feature of the genotype in addition to environmental conditions. Doka (Khalal) stage was early in Chip chap cultivar. Bunch size was also bigger in Braim in respect of number of strands per bunch, number of fruits per strands. Fruit set also depends on the time of spathe opening, pollination, viability of pollens and receptivity of stigma besides climatic conditions. However, good percentage of fruit set (70-80 %) was also recorded in both the cultivars under arid conditions. The percent acidity was 0.17 and 0.22 in Braim and Chip chap, respectively. There was no much more difference in both the cultivars with respect to acidity (%), ascorbic acid and sugars contents. The seed size and pulp stone ratio was higher in case of Chip chap which might be due to genetic features of the variety.

The seeds of seven varieties viz., Khastavi, Sayer, Braim, Chip chap, Barhee, Khadrawy and Zahidi (EC 454540- 46) were procured from Iraq in the month of May, 2000. For evaluation, seeds were sown in polythene bags (30x12 cm.) filled with soil mixture in the nursery. The seed germination varied from 76 -100 per cent and seedlings growth was ranged from 57-95 cm after one year of sowing. There was no much more difference in number of leaves per plant (5.5-7.0) and collar diameter at ground level (5.5-7.0 cm) which seems that the initial growth performance of all varieties are similar. However, plant height (57.5- 95.5 cm) and length of primary leaves (52.0-94.5 cm) differed which may be due to genetic feature under similar growing conditions. As far as survival of plant is concerned, except Barhee and Chip chap, all varieties showed better establishment under field conditions. The growth of seedlings reveals that plants of Sayer, Braim and Chip chap are of slow growing type and rest are vigorous.

The seed of date palm (*Phoenix dactylifera*) EC 517310 was introduced from Tehran, Iran during June, 2003. The seed were sown in polythene bags (30x12 cm) filled with soil mixture of clay+sand+FYM (1:1:1 ratio) in the third week of June, 2003. The plants were raised in the nursery under agro-shade net condition. Observations on germination, time taken for germination and survival of seedlings was recorded and data is presented in Table 1. The germination of seed was cent per cent after 32 days of sowing. To control diseases,

Table 1. Performance of date palm (*Phoenix dactylifera* L.) seed introduced from Tehran, Iran

S.No.	Characters	Performance
1.	Germination (%)	100
2.	Days taken for germination	32
3.	Plant height (cm) 360 days after sowing	58.66
4.	Survival of plants under nursery (%)	100
5.	Average number of leaves/plant	9.66
6.	Length of leaves (cm)	45.77
7.	Collar diameter (cm)	5.66
8.	Date of transplanting of seedlings	August, 2004
9.	Survival (%) under field condition	66.66

spray of Carbendazim @ 0.1% was done at fortnightly intervals. Data presented in Table 1 shows that the initial performance of introduced seed material was satisfactory under nursery conditions. After a year, the plants were transplanted in the field for evaluation. The survival of plant was recorded 66.6 per cent after three months of planting under hot arid environment.

The study indicates that date palm offshoots can be introduced successfully from warm arid and semi-arid parts of the World. Both the introduced cultivars viz. Braim and Chip chap are found suitable to complete the flowering and fruiting (upto doka stage) before 20th July, hence they are able to avoid the rainy season in Western Rajasthan. The present study reveals that both the date palm introduction are suitable for cultivation under hot arid environment.

The seed material introduced from Iraq and Iran were evaluated under nursery. The survival and seedlings growth performance was good under arid environment. However, introduction of seed in case of date palm should be restricted because of dioecious plant.

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Priorities for Introduction of Fruit Crops in India

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Key Words: Fruit Crops, Introduction

India has diverse agro-climatic regions comprising tropical, sub tropical and temperate regions, where we can grow various kinds of crops including fruit plants. We have achieved a lot, particularly in the improvement of field crops and almost reached at peak. However, breeders are trying their level best to increase the income of the farmers by applying various latest techniques for improving the productivity. Hence, there is a need to diversify the Indian agriculture, and for this purpose the new fruit crops, which are nutritiously rich and can be grown on marginal lands should be introduced for their acclimatization/ adaptation in the country.

Keeping in view the importance of these new fruit plants, NBPGR is exploring the possibilities for introduction of these valuable fruit plants on priority. In the past, NBPGR introduced 5,687 accessions of 104 fruit crop species comprising temperate, tropical and sub-tropical fruit plants during 1976 to 2004. This process is continued and the details of introduction made from 1996 to 2004 are given in Table 1. Notable among them are new fruit crops like, kiwi fruit (*Actinidia chinensis*), nectarine, low chilling peach and apples, feijoa (*Feijoa sellawiana*) rich in vitamin C and also resistant to wilt, West Indian cherry (*Malpighia punicifolia*), a rich source of vitamin C and fruits are suitable for jelly preparation. In papaya, the useful cultivars like sunrise, HCAR-29, mardol and caw flora and several *Carica* species like *C. gondotiana*, *C. cauliflora*, *C. sphaerocarpa*, *C. guaciflora*, *C. monica*, *C. pubescens* and, *C. stipulata* which are source of resistance to various disease/pests and frost are promising introductions; Jacoticaba (*Myrciaria cauliflora*) bears black berries on the main trunk of the plant, good for jelly and alcoholic beverage; *Eugenia*, *Fortunella* spp., rambutan (*Nephelium lappaecum*), seabuckthorn

(*Hippophae rhamnoides*) rich in vitamin C, prickly pear (*Opuntia ficus-indica*), babaco (*Carica pentagona*) and paw paw (*Asimina triloba*); in nuts hazelnut, peacannut, macadamia nut have also been introduced (Gupta and Rai, 1996 and Singh *et al.*, 2001).

The priority will be given to introduce rare and nutritionally rich fruit crops like, african pear (*Dacryodes edulis*), black sapote (*Diospyros ebenum*), marula nut (*Sclerocarya birrea*), mangosteen (*Garcinia mangostana*) and chestnut (*Castanea dentata*) etc. (Arora and Rao, 1994). In addition, the trait specific and commercially important cultivars viz., shell dehiscence type of pistachio nut, thin shelled and regular bearer type of pecan nut, thin shelled and soft kernel type of walnut, paper shelled almond, good fruiting quality figs, high oil type olives, superior varieties of apple, peach, pear, plum and apricot along with their dwarf and drought resistant root stocks; in other fruits, frost resistant type currants, spineless stem type of gooseberry, winter hardy blueberry, good aroma type of crane berry, improved varieties of raspberry. In tropical fruits, coloured mango varieties, banana resistant to bunchy top virus, parthenocarpic and wilt resistant guava varieties, papain type cultivar and resistant to leaf curl virus of papaya; in arid fruits improved varieties of date palm and non cracking pomegranate are presented in this paper.

In the view of the overall importance of tropical fruit trees and their future potential in India, an attempt has been made to list some of the tropical fruits which have less diversity and can be introduced in India are given in Table 2.

There is also a need to give more weightage to new breeding objectives to get the desired results such as increased stress tolerance, biological efficiency with

Table 1. Import of germplasm of different fruit crops during 1996-2004

Import	Years									
	1996	1997	1998	1999	2000	2001	2002	2003	2004	Total
No. of accessions	90	87	226	347	389	166	356	343	143	2147
No. of genera	14	10	24	17	26	10	23	19	17	160
No. of species	28	16	28	12	82	38	20	26	24	274
No. of countries	7	7	39	3	11	06	08	13	12	106

Table 2. List of fruits crops to be introduced on priority

Fruit	Source Country	Traits/ Value
<i>Actinidia rubricaulis</i>	China	Cultivated, for edible fruits
<i>Alectryon excelsum</i>	New Zealand	Fruit testing like strawberry
<i>Anisophyllea laurina</i>	Tropical Asia, Tropical Africa	Edible, preserves as jelly and nutritionally rich
Alligator Pear (<i>Anona glabra</i>)	Sub-tropical America, W. Tropical Africa	Suitable for jelly making
Plum Mango (<i>Bouea macrophylla</i>)	Indonesia	Fruits eaten raw and cooked used as pickles
Odara Pear (<i>Chrysophyllum africanum</i>)	Tropical Africa	Fruits are much liked by the natives and are of an apricot colour and of pleasant acidic pulp rich in vitamin C
Ceylon Gooseberry (<i>Celastroides</i> spp.)	Srilanka	Good for jelly preparation
Surinam Cherry (<i>Eugenia michelii</i>)	Tropical America	Orange red to black fruit, eaten fresh, also used for jam making
Paniala (<i>Acourtia jangomas</i>)	Tropical Asia, Madagascar, S. Africa, Hawaii	Edible fruits, good for jam preparation
Indian Plum (<i>Flacourtia sepiaria</i>)	Tropical Asia; Hawaii	Fruits edible, sweet, mildly acidic, juicy and suitable for pies
Dulitan (<i>Madhuca obovatifolia</i>)	Philippines; Malaysia	Fruits resembles sapodilla, but larger in size
Marney (<i>Mammea americana</i>)	Tropical America	Fruits is edible used for wine, sauce and jam preparation
<i>Nephelium mutabile</i>	E. Trop. Asia	Fruits eaten fresh, some varieties are sweets and resemble like rambutan
Wild Cachima (<i>Rollinia mucosa</i>)	West Indies; Mexico; S. America	Fruit pulp is mucilaginous, mixed in ice cream
Caffir Marvolanut (<i>Sclerocarya caffra</i>)	S. Africa	The mature fruit smells like apple and the edible fleshy part is white, very juicy and taste like slight guava flavour. Stone also edible

reduced input etc. the plant breeders are now also forced to study the wild germplasm for getting sources of resistance for these traits so that the valuable/desired genes may be exploited to improve the productivity and quality of the fruits. To keep up with ever-increasing needs of our modern agriculture systems, the development of broad-based germplasm pool carry in genes for resistance to disease, insect, nematodes, tolerates to hostile environmental stresses and potential for high productivity of superior quality must be available to the plant breeders, if they are to be successful in developing competitive new varieties. These objectives will be kept in mind while introducing the germplasm from diverse sources.

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Evaluation of Mango Exotic Collections for Resistance to Hopper, *Idioscopus niveosparsus* Leth.

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Key Words: Evaluation, Mango, Mango Hopper, *Idioscopus niveosparsus*, Resistance

Mango (*Mangifera indica* L), the king of fruits is known in India for over 6,000 years and is indigenous to Malayan Archipelago (Butani, 1979). It is now cultivated in all tropical and subtropical countries. More than 400 species of pests attacking mango have been listed, of these about dozen insect species severely affect different parts of mango. Mango hoppers, *Idioscopus niveosparsus* Leth., *I. clypealis* and *Amritodus antkinsoni* (Leth.) are the serious pests which are considered to be a major constraint in mango production (Tandon and Verghese, 1985). They suck sap from inflorescence and tender shoots leading to 60-100 per cent flower drop. The honeydew excreted by hoppers attracts fungus, *Capnodium mangiferum* Cooke resulting in sooty mould which considerably hinders the photosynthetic activity of leaves. Among the three species of hoppers mentioned, *I. niveosparsus* is more predominant in Karnataka and Maharashtra region. Hence the present study was concentrated on this species. So far, insecticides have been the sole means of controlling mango hoppers. However keeping in view the myriad of problems like pest resistance, resurgence and environmental pollution associated with large scale use of chemicals in plant protection, considerable attention has been laid on the study of host plant resistance. Screening a large number of germplasm collections helps in finding resistance source. However, such systematic studies in case of mango hoppers, especially covering exotic collections are lacking.

With this background, field evaluation of ten exotic collections of mango viz., 'Carabao (G)', 'EC 95862', 'Kensington', 'Kitchner', 'LA Resource-2', 'LA Resource-2', 'Nom Dok Moi', 'Ostin', 'Sensation' and 'Tom Atkins' was carried out during 2001-03 at the Indian Institute of Horticultural Research, Bangalore, India. These collections were introduced during last ten years from different countries. Three trees of each collection, planted at a spacing of 10m x 10m, were selected for the study. They were kept free from any insecticidal application during the study period. Each tree was considered as one replication.

Visual counts of nymphs and adults of hopper, *I. niveosparsus* were taken from 10 panicles, randomly selected from all the directions. Data were recorded twice at 15 days interval during January-February. The observations on the morphology of inflorescence were also taken in terms of compactness (dense/scarce) and panicle length. Attempts were made to correlate the hopper incidence with inflorescence morphology. The data were subjected to ANOVA after effecting $\sqrt{n+1}$ transformation. Based on the pooled data of both the years, the varietal collections were classified into 4 susceptibility groups viz., least susceptible (0-2 hoppers/panicle) moderately susceptible (2-6), susceptible (>6-10) and highly susceptible (>10).

There were significant variations among genotypes in their susceptibility to *I. niveosparsus* (Table 1). The mean hopper population per panicle varied from the lowest 0.80 in 'LA Resource-1' to the highest 7.96 in 'EC 95862' in 2001-02 and from 2.40 in 'LA Resource-1' to 10.56 in 'Kensington' during the following year. The varieties 'Carabao (G)', 'EC 95862', 'Kensington', 'Kitchner', 'Nom Dok Moi' and 'Ostin' were on par with one another in their hopper susceptibility in both the years of the study. Based on the pooled means, 'EC 95862' (8.24/panicle) was found to be the most susceptible collection followed by 'Kensington' (7.92) and 'Ostin' (7.36). 'LA Resource-1' had the least hopper population (1.60/panicle) and was the sole representative in least susceptible group. Four genotypes viz., 'LA Resource-2', 'Nom Dok Moi', 'Sensation' and 'Tommy Atkins' were moderately susceptible while Carabao (G)', 'EC 95862', 'Kensington', 'Kitchner' and 'Ostin' formed the susceptible group. None of ten collections evaluated was in highly susceptible group. Earlier Nachiappan and Baskaran (1984) recorded significant variability in mango hopper preference to certain indigenous mango collections.

Panicle morphology seemed to have influenced the hopper preference to different collections (Fig. 1).

Table 1. Relative susceptibility of mango exotic collections to hopper, *Idioscopus niveosparsus*

Genotype	No. of hoppers/panicle			Compactness of inflorescence	Status
	2001-02	2002-03	Pooled		
Carabao (G)	6.14 (2.67)	6.98 (2.83)	6.56	Dense	S
EC 95862	7.96 (2.99)	8.52 (3.09)	8.24	Dense	S
Kensington	5.28 (2.51)	10.56 (3.40)	7.92	Dense	S
Kitchner	5.36 (2.52)	7.84 (2.97)	6.60	Dense	S
LA Resource-1	0.80 (1.32)	2.40 (1.84)	1.60	Scarce	LS
LA Resource-2	2.02 (1.74)	3.84 (2.20)	2.93	Scarce	MS
Nom Dok Moi	4.00 (2.24)	2.66 (1.91)	3.33	Scarce	MS
Ostin	5.20 (2.49)	9.52 (8.24)	7.36	Dense	S
Sensation	2.97 (1.99)	4.47 (2.34)	3.72	Dense	MS
Tommy Atkins	3.24 (2.06)	5.04 (2.46)	4.14	Scarce	MS
CD ($P=0.05$)	0.52	0.61			

S-Susceptible, LS-Least susceptible, MS-Moderately susceptible

* Values in parentheses are square root of $\sqrt{n+1}$ transformations.

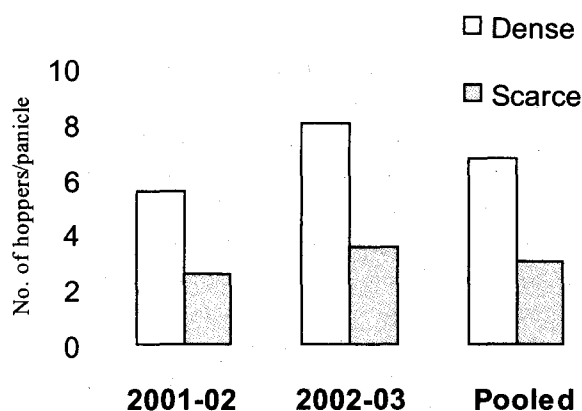


Fig. 1 Mango hopper incidence in relation to panicle compactness

Varieties with dense inflorescence had attracted more hoppers than those with scarce inflorescence. Dense bushy type inflorescence might have offered an ideal microenvironment for hoppers, besides presumable protection from chemicals, natural enemies and adverse climatic conditions. Though there were reports on the

nutrient content of panicle influencing hopper resistance (Nachiappan and Baskaran, 1984), role of morphological traits has not been thoroughly explored and hence these findings can be a pointer to a further step in mango hopper resistance breeding. The findings of the present study suggest that exotic collection; 'LA Resource-1' can be one of the options for hopper resistance source. Evaluation of newly introduced germplasm collections for resistance should be a continuous prioritized activity in order to achieve a long lasting stable solution to major pest problems.

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Performance of Exotic Mango Genotypes under Bangalore Condition

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Key Words: Mango, Co efficient of Variation, Evaluation, Exotic Collections, Morphological Traits

Introduction

Mango (*Mangifera indica*) is reported to be native of India and is under cultivation in India for more than 4000 years. Owing to allopolyploidy and cross pollination, India is home to more than 1000 varieties. Though the varietal wealth is quite rich, only about 30 varieties commercially grown and very few of these meet the export standards. This is because much of the indigenous gene pool is yet to be properly exploited for addressing the present day needs. It is believed that the large variability has hindered its improvement (Naik, *et al.*, 1958). Many of the indigenous varieties that were introduced from India during earlier times and their progenies have become commercial varieties elsewhere. Although, growth in mango is genetically controlled, the environmental interaction has brought about changes in growth pattern under different climatic conditions. Hence, some of the accessions behave differently when grown under different climatic conditions. Thus, as a part of crop improvement programme exotic introductions made from various part of the world are being evaluated in the field genebank. Most of these exotic accessions have excellent skin colour. Keeping in view the identification of donor parents for various horticultural traits, the introduced accessions were evaluated for different morphological and fruit quality traits.

Materials and Methods

The materials used for the study consisted of ten exotic accessions viz., Carabao, EC 95862, Kensington, Kitchner, La Resource 1, La Resource 2, Nom Dok Moi, Ostin, Sensation, Tommy Atkins and three popular Indian cultivars viz., Alphonso, Dasehri and Banganapalli collected and maintained in the Field Gene Bank at IIHR, Bangalore. The plants were of uniform age and standard package of practices were followed. The accessions were evaluated for a period of two years from 2001-2003. Observations on morphological and fruit quality parameters were recorded from fully matured fruits adopting randomized complete block design with three replications consisting of five fruits per replication. The means of all characters were subjected to statistical analysis.

Results and Discussion

The genotypes evaluated showed considerable degree of variation in the morphological and fruit parameters. The analysis of variance carried out for the accessions revealed that there was a significant variation for all the characters. The fruit shape was round in EC 95862 and Tommy Atkins, elliptic in Kensington and oblong in other accessions. Similar variation in fruit shape was also reported by Singh (1972) and Sharma (1987). Breeding varieties with attractive skin colour coupled with firm flesh and thick skin helps in meeting the domestic and international demand. The genotypes Ostin and Tommy Atkins possessed attractive red skin thus, could be selected for breeding varieties with attractive red blush. The flesh texture was firm in Kitchner, Nom Dok Moi, Sensation and Tommy Atkins, while the skin was thick to very thick in Kitchner and Sensation. Thus, the genotypes Sensation and Kitchner could be exploited in breeding varieties with good keeping quality. The fruit weight differed significantly among the genotypes. The variety Ostin recorded higher fruit weight (503.3g), which is at par with Tommy Atkins and the popular Indian cv. Banganapalli, while EC 95862 recorded the lowest fruit weight (155g). According to Chadha (1998) major emphasis in the hybridization programme has been large fruits with attractive red skin coupled with good keeping quality. Thus, the accession Ostin and Tommy Atkins could be exploited for breeding of fruits with better size coupled with attractive skin colour. The total soluble solids are an important trait in deciding the fruit quality. The TSS was high (20.7 B) in Nom Dok Moi which was at par with La Resource-2, EC 95862 and Alphonso. On the other hand Tommy Atkins and Kitchner recorded low TSS (15.5 B). Higher percentage of pulp recovery is a desirable trait in breeding (Chadha 1998). It was found to be more in Ostin, Nom Dok Moi and Kensington (>70%), which were at par with Alphonso. Some of the varieties and hybrids have been found to be suitable for processing as they have high pulp recovery coupled with other desirable traits (Doreyappa Gowda *et al.*, 1994; Yadav *et al.*, 1978 and Kalra *et al.*, 1994; Iyer *et al.*, 1991). Hence, selection

of such genotypes helps in higher pulp recovery for processing or for table purpose.

Poor fruit set has been an important constraint in mango improvement (Chadha 1998). The percentage of bisexual flowers is one of the important factors in deciding the fruit set. In the present study it was observed that the per cent bisexual flowers were more (>4.0%) in Kensington, Tommy Atkins and Sensation which were almost at par with the popular Indian cultivar 'Dasehri' (4.33%). Hence, these accessions could help in overcoming the problem of poor fruit set to some extent.

The Co-efficient of variation was more for the characters fruit weight (13.11%) and bisexual flowers (11.10%), which shows that there is wider variability for these characters which helps in selection.

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Field Screening of Strawberry Germplasm for Resistance against Foliar Diseases

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Key Words: Strawberry, Germplasm, *Fragaria x ananassa* Resistance

Strawberry (*Fragaria x ananassa* Duch) is an important soft fruit grown throughout the country. It belongs to family Rosaceae and is derived from the hybridization of two native American species namely, *F. chiloensis* Duch and *F. virginiana* Duch, which was first developed in France in the 17th century (Sharma and Vamdagni, 2000). Delicate in flavour and rich in vitamin and minerals, strawberry is now a favoured food in the diet of millions of people around the globe. It can also be processed into a series of products through various processes such as canning, drying, freeze-drying, candying, freezing and jam making etc. Strawberry is attacked by a number of foliar diseases (Bose, 1970; Lele and Phatak, 1965), amongst these, foliar diseases, leaf spot and blight are of utmost importance (Bhardwaj *et al.*, 1998). Keeping in view the seriousness of these foliar diseases, an attempt has been made to screen the various lines for durable resistance of strawberry.

Evaluation of Germplasm

Thirty-five genotypes of strawberry including commercial varieties, local collections and breeding lines were screened for resistance against foliar diseases under natural epiphytotic conditions. The experiment was laid out in a Randomized Block Design with three replications at the University research farm of Dr. YS Parmar University of Horticulture and Forestry, Nauni (30° 52'N, 77° 11'E, 1270 amsl) (Himachal Pradesh) during 2003. All the recommended agronomical practices were followed in raising the crop, except application of fungicides in controlling the leaf spots. The screening was done on the basis of consecutive observations on occurrence of the above diseases in each genotype throughout the growing period. A 0-5 point scale was used for recording the disease severity. The percent disease index (PDI) was calculated as per McKnney, (1923).

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Table 1. Reaction of strawberry germplasm to foliar diseases

Category	Reaction	No. of entry	Genotypes
0	Immune	Nil	—
1	R	8	Tore, Jatog special, Shimla special, No-7, No-5, Dilpasand, N R Round Red, V L
2	MR	15	Addie, Blackmore, Belrubi, Brighton, Catskill, Chandler, Confictura, Selva, Douglas, Elastha, Enta, Fairfax, Fen, Shastha, Phenomenal
3	MS	3	Seascape, Elesenta, North West
4	S	1	Florida

Based on PDI, the germplasm was categorized into different reaction classes: 0=immune (I), no leaf spots; 1=resistant (R), 0.1-5% leaf area infected; 2=moderately resistant (MR), 5.1-10% leaf area infected; 3=moderately susceptible (MS), 10.1-25% leaf area infected; 4=susceptible, 25.1-50% leaf area infected; and 5=highly susceptible, >50% leaf area infected.

The data presented in Table 1 revealed that none of the genotypes were found immune to foliar diseases, however, eight genotypes namely Tore, Jatog special, Shimla special, No-7, No-5, Dilpasand, N R Round Red and V.L. showed resistant reaction. Fifteen cultivars viz., Addie, Blackmore, Belrubi, Brighton, Catskill, Chandler, Confictura, Selva, Douglas, Elastha, Etna, Fairfax, Fern, Shastha and Phenomenal exhibited moderate reactions, while the remaining genotypes were either susceptible or highly susceptible. The germplasm observed

to be resistant would be utilized in breeding programme to develop foliar disease resistant varieties with desirable horticultural traits.

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Evaluation of Exotic Guava Accessions for Pectin and Tannin Content and their Correlation to Fruit Fly Damage

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Key Words: Exotic Collections, Fruit Fly, Guava, Pectin, Tannin

Guava, basically an exotic crop is one of the important fruit crops of India and is commercially cultivated throughout the country. The fruits are rich source of Vitamin 'C' and pectin and are much relished when they are mature green. Owing to its high nutritive value and good flavour, guava fruit has got great potentiality for processing. The fruits are made into a number of processed products and among them nectar, jam, jelly and juice have got good market. Several studies were carried out on the physico-chemical properties of guava. Murali and Verma

(1989) evaluated guava varieties for nectar. According to Singh and Dhawan (1983), Lucknow 49 is the best variety for jelly making. As the quality of the end product depends upon the quality of the raw materials, varietal evaluation for key quality parameters and selection is very important. Keeping this in view, the present study was undertaken to evaluate the exotic accessions of guava for pectin and tannin content which is a pre requisite for processing and also their relation with varietal susceptibility to fruitfly, *Bactrocera dorsalis* (Hendel).

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Materials and Methods

The present investigation was carried out at IIHR, Bangalore during 2001-2003. The materials used for the study consisted of seven exotic accessions viz., EC 147039, 9-35 EC 147036, 7-12 EC 147036, EC 147037, 7-39 EC 147034, G-6, EC 162904 and two popular Indian cultivars viz., Nasik and Smooth green. Fully matured fruits of slight colour turning stage were used for the study. Randomized complete block design with three replications was adopted, consisting of five fruits per replication. The pectin content was estimated as per methods of Bitter and Muir (1962) and tannin by A.O.A.C (1984). The data were statistically analyzed and treatment means were compared. The fruit fly damage was calculated based on the number of fruits infested, taken out of 50 fruits randomly harvested from each variety.

Results and Discussion

The perusal of data presented in Table 1 shows that there was a significant variability in pectin and tannin content and susceptibility to *B. dorsalis*, among different guava accessions. In general all the exotic accessions possessed attractive red flesh with firm texture which is a desirable trait for processing. As regards pectin, it ranged from 0.95% in EC 147037 to 1.57% in G-6 which is on par with the pectin (1.47%) recorded in EC 162904. Varieties rich in pectin are best suited for jelly making (Singh and Dhawan 1983). Hence, the varieties G-6 and EC 162904 could be exploited for jelly preparation. According to Dhingra *et al.* (1983) highest number of jelly unit was obtained from Sardar and Apple colour.

Among the accessions evaluated for tannin, the accession 7-12 EC 147036 recorded significantly lowest tannin (89.6 mg/100g). The next best accessions with low tannin content are 9-35 EC 147036, EC 147037 and

7-39 EC 147034. The variability present in the pectin and tannin content may be due to the differences in cultivar, location and cultural practices. Though, tannins play an important role in imparting astringency to the final product, it affects the fruit processing by giving coloration to the end product. Thus, the accessions viz., 7-12 EC 147036, EC 147036, EC 147037 and 7-39 EC 147034 with low tannin could be exploited in the processing industries. The demand for red and pink varieties are more in Europe market which are required for tropical fruit mixes (Anon1999). According to Salmah and Sulhaila (1987) the tannin level was high in immature fruits and remained at a constant low level after 10 weeks of fruit set. Esteves *et al* (1984) reported that the total phenols varied from 333 to 545 mg/100g at 100 days after full bloom in different guava cultivars.

Two collections viz., EC 147037 and EC 147039 were found to be least susceptible (< 10 % fruit damage) while 9-35 EC 147036 and EC 162904 were moderately susceptible to fruit fly damage. All the exotic collections were significantly superior to smooth green. The biochemical constituents of fruits like TSS, phenols etc., are reported to influence fruit fly infestation (Arora *et al.*, 2000). In the present study, a significant negative correlation ($r = -0.724$) was observed between tannin content and fruit fly damage. However, pectins were found to play no role in influencing the fruit fly preference to a variety as there was no significant correlation. As high pectin content is a desirable trait, this can be exploited without the fear of attracting more fruit fly infestation.

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Table 1. Pectin and Tannin content of exotic guava accessions and their relation to fruit fly damage

S.No.	Accession	Pectin (%)	Tannin (mg/100g)	Fruit fly damage (%)
1	7-39 EC 147034	1.18	123.7	27.66
2	7-12 EC 147036	1.28	89.6	29.66
3	9-35 EC 147036	1.08	92.3	15.67
4	EC 147037	0.95	115.2	1.67
5	EC 147039	1.29	181.2	6.67
6	EC 162904	1.47	208.47	18.33
7	G-6	1.57	183.15	20.33
8	Nasik	1.22	98.8	28.83
9	Smooth green	1.14	114.81	49.00

Salmah Y and M Suhaila (1987) Physico chemical changes in guava during development and maturation. *J. of the Sci. of Food and Agri.* **38(1)**: 31-39.

Singh JS and SS Dhawan (1983) Potentiality of various fruits for processing industry. *Ind. Fd. Packer.* **37(3)**: 47-55.

Performance of Indigenous and Exotic Semi-Soft Pear Strains and Varieties under Sub-Tropics

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Key Words: Asian Pear Varieties, Exotic, Indigenous, Semi-Soft Pear Strains

Pear is the most commonly grown fruit in the temperate region of India. Oriental pear is mainly grown in sub-tropics and lower hills of north-west India. The varieties like *Patharnakh* and *Gola* are commonly grown, which are high yielding, but are poor in quality, hence yet not accepted as table varieties. Although, soft pear varieties like *Le Conte* and *Baggugosha* are also grown, but on very limited areas, due to their shy and alternate bearing nature. Therefore, lot of efforts have been made for collected/introduced semi-soft pear strains and some Asian pear varieties from indigenous and exotic sources and evaluated for their suitability under low chilling conditions of Punjab.

The present study was conducted at Punjab Agricultural University, Ludhiana, during 2003 and 2004. The 13-year old trees of semi-soft pear strains code named strain I, II, III, IV, VII, VIII, IX, X, XI, XII, XIV, XV, XVI and Asian pear varieties viz. Yali, Shinseiki, Hosui, Nijisseiki and Kosui, were evaluated for their yield potential and fruit quality traits. The plants grafted on *Pyrus pashia* (Kainth) rootstock, were planted at 6.5 x 6.5 m apart. The number of fruits were counted one month before the harvesting of fruits. A sample of twenty fruits were collected randomly for recording the fruit weight and other quality parameters as per the standard procedures.

The results obtained during the studies are presented in Table 1. The data shows that the highest number of fruits per tree were harvested from strain II (685.2), followed by strain VII (665.2) and strain I (639.3), all these strains were statistically at par with each other. The strain XII produced the minimum (321.7) number of fruits. Among the Asian varieties, the Yali recorded highest number of fruits (672.2), closely followed by

Hosui (672.1) and minimum number was recorded in Shinseiki. Variation in fruit number was also observed in different semi-soft pear strains (Singh, 2002) and in Asian pear varieties (Singh, 1998). The yield per tree was highest (97.3 kg) in strain II, followed by strain VIII (91.8 kg), which was statistically at par with each other. The strain XII was found to be the lowest (44.4 kg) yielder. The soft pear varieties of Asian origin followed the same pattern as regards fruit number per tree. The highest yield of 87.4 kg was recorded in Yali, while lowest of 37.2 kg in Shinseiki. Likewise, Rathore (1982), Gautam *et al.* (1995) and Nath and Rai (2000) reported that different pear cultivars varied in yield under different agro-climatic conditions.

A significant variation was recorded in various quality parameters among all the semi-soft pear strains and Asian pear varieties. The average fruit weight was recorded highest (178 g) in strain XV and lowest (132 g) in strain VII. The variable fruit weight have been reported in pear cultivars and clones (Rathore, 1982, Sandhu *et al.*, 1994 and Nath and Rai (2000). Significantly higher (130 g) fruit weight was recorded in yali as compared to other Asian pear varieties, which were at par in their fruit weight. Griggs and Iwakiri (1977) also observed bigger fruits in Yali than others. The juice percentage varied from 51.0 in strain VII to 57.8 in strain VIII. All the Asian varieties had high percentage of juice content, maximum being (74.4) in Yali, followed by 74.3 in Nijisseiki and minimum (59.3) in Shinseiki. Singh (1998) also observed highest juice percentage in Yali.

The maximum (14.4%) TSS was recorded in strain XVI, followed by 14.0% in strain XV and minimum (12.90%) in strain XII. Among the soft pear varieties,

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The maximum (14.4%) TSS was recorded in strain XVI, followed by 14.0% in strain XV and minimum (12.90%) in strain XII. Among the soft pear varieties,

Table 1. Performance of semi-soft pear strains and Asian pear varieties (Average values for 2003 and 2004 years)

Semi-soft pear strains							
Strain No.	No. of Fruits/tree	Yield/plant (kg)	Fruit weight (g)	Juice (%)	TSS (%)	Acidity (%)	TSS/acid ratio
I	639.3	86.3	135	55.0	13.45	0.190	70.78
II	685.2	97.3	142	54.9	13.35	0.190	70.26
III	478.2	81.3	170	53.8	13.70	0.220	62.27
IV	358.1	59.8	167	55.1	13.60	0.220	61.81
VII	665.2	87.8	132	51.0	13.15	0.225	58.44
VIII	628.8	91.8	146	57.8	13.50	0.195	69.23
IX	366.2	57.5	157	53.6	13.67	0.220	62.13
X	428.9	71.2	166	54.5	13.50	0.225	60.00
XI	418.6	65.3	156	54.1	13.75	0.240	57.29
XII	321.7	44.4	138	55.8	12.90	0.240	53.75
XIV	389.7	67.8	174	55.3	13.85	0.195	71.02
XV	372.5	66.3	178	54.7	14.00	0.215	65.11
XVI	353.8	59.8	169	53.8	14.40	0.240	60.00
CD at 5%	65.0	17.6	8.8	1.84	0.182	0.010	5.82
Asian Pear Varieties							
Yali	672.2	87.4	130	74.4	11.40	0.141	80.85
Shinseiki	256.6	37.2	95	59.3	12.35	0.143	86.36
Hosui	672.1	53.1	79	71.1	11.45	0.132	86.74
Nijisseiki	551.6	52.4	95	74.3	12.20	0.170	71.76
Kosui	463.0	37.5	81	71.0	12.30	0.155	79.35
CD at 5%	15.4	18.3	18.8	0.55	0.558	0.010	4.32

Shinseiki, Nijisseiki and Kosui recorded from 10.9 to 12.4% in seeded pears (Griggs *et al.*, 1960). The acid content was highest (0.24%) in strain XI, XII and XVI, whereas, it was lowest (0.190%) in strain I and II. Contrary to TSS, the acid content was lower in Yali and Hosui as compared to other Asian pear varieties. The acidity was also noted to be variable in different pear cultivars (Rathore, 1982, Sandhu *et al.*, 1994 and Nath and Rai, 2000). The TSS/acid ratio followed the pattern to that of TSS and acid content in juice. The strains/varieties recorded highest TSS/acid ratio, which had higher TSS and lower level of acidity. On the basis of yield potential and fruit quality traits, among the semi-soft pear, strains I, II, VII and VIII, and Yali from the soft pear varieties of Asian origin have shown promise under Punjab conditions.

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Role of Exotic Germplasm in Citrus Cultivar Improvement

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Key Words: Citrus Rootstocks, Germplasm, Hybridization, Improvement

The germplasm of a crop is very important for its future improvement. The germplasm can be released after evaluation as new cultivar or it can also be utilized in breeding programmes to transfer one or a few desirable characteristics to the existing cultivars. Most of the commercial *Citrus* species are propagated on a rootstock, which imparts resistance/tolerance to many biotic and abiotic stresses and also determines the fruit quality of the scion variety. Rough lemon (*Citrus jambhiri* Lush.) is the most commonly used rootstock for citrus and particularly for mandarins in India, but it is susceptible to *Phytophthora* diseases and citrus nematode (Fouque et al. 1977, Whiteside and Knorr, 1979, Passos and Cunhasobrinho, 1981, Agarwal 1982). Rough lemon results in larger trees and fruits of the scion cultivars budded on it, however, fruits are poor in colour, palatability, TSS, asids and vitamin C. Trifoliate orange (*Poncirus trifoliata* (L.) Raf.) and its hybrid, Troyer citrange (*Citrus sinensis* x *Poncirus trifoliata*) are widely used as *Phytophthora* and nematode tolerant rootstocks. They are known for the quality fruit production of the scion cultivars, but are unsatisfactory as rootstocks for mandarins because of a tendency of reduced fruit size in years of heavy bearing. They are unsuitable in highly alkaline and saline soils and also require frequent irrigation. *Poncirus trifoliata* is often employed in most of the rootstock breeding programmes as a pollen parent because not only it carries a dominant marker in the form of trifoliate leaf, but also tolerance to tristeza, citrus nematode and *Phytophthora* spp. (Bitters et al. 1973).

Development of rootstocks having resistance to fungal, viral and nematode diseases with wider adaptability, better yield and fruit quality has considerable commercial importance. For a rootstock to be successful, it should result in longevity, high yield and good fruit quality of the scion variety. Our objective of utilizing rough lemon, trifoliate orange and Troyer citrange is to develop a rootstock similar to rough lemon, having favourable characteristics of trifoliate orange and Troyer citrange. If it is successful to develop a rootstock similar to rough lemon along with desirable characters from

trifoliate orange and Troyer citrange, it will be a boost to the Indian citrus industry. Keeping this in view, the present hybridization programme was carried out.

To combine favourable characters from trifoliate orange and Troyer citrange in the rough lemon, hybridization programme was started in 1990-91. The crosses were made in 1990-91 and 1991-92, involving rough lemon as female parent and trifoliate orange and Troyer citrange as pollen parents. The hybrid seedlings were separated from nucellar ones on the basis of trifoliate leaf marker inherited from male parent. The hybrid seedlings of rough lemon x trifoliate orange and rough lemon x Troyer citrange along with the parents were planted in the field in 1993 for their detailed evaluation. The hybrids exhibited wide variation in the progeny indicating a large variation in the F₁ itself (Dass et al., 1998). Hybrid seedlings were observed every year for plant vegetative characters. Fruit characters viz., fruit weight, skin thickness, number of seeds/fruit and juice percentage were recorded from 2001 to 2004. Ten fruits were evaluated in each hybrid and the observations were repeated four times. Seed characters were studied in ten replications were used for the experiments for recording seed germination and polyembryony. The germination was recorded after its initiation and thereafter every week for three months. After three months, ten seedlings were uprooted from each replication for recording seedling performance. The data were subjected to statistical analysis in completely randomized design. It is observed that segregation was taking place in the F₁ progeny, since different types of hybrids were recorded in the first generation itself (Furr, 1969). Maximum fruit weight was recorded in rough lemon (187.75 g). Large variation was recorded in the F₁ progeny for fruit weight in both the crosses, however fruits with lowest weight were observed in some combinations of rough lemon x Troyer citrange, where fruit weight was lower than both the parents, indicating transgressive segregation. In the hybrid 1.4 (rough lemon x Troyer citrange), skin thickness was lower than both the parents. Seed content was highest in trifoliate orange (42.34 seeds/fruit), but in the hybrids

1.2 (rough lemon x Troyer citrange), 2.2 rough lemon x Troyer citrange), 3.1 (rough lemon x trifoliolate orange) and 2.6 (rough lemon x Troyer citrange) was more rough lemon. The seed content/fruit is an important criterion for the selection of rootstocks and these hybrids are promising in this context. Juice content was at par with rough lemon (40.59%) in the hybrids 2.6 (rough lemon x Troyer citrange, 36.09%) and 1.4 (rough lemon x Troyer citrange, 47.05%).

Seed germination was comparable to rough lemon (98.00%) in the hybrids 3.4 (rough lemon x trifoliolate orange, 90.00%) and 3.1 (rough lemon x trifoliolate orange, 88.00%), but other hybrids also had a germination of >70 per cent. Polyembryony was at par with rough lemon (46.14% in the crosses 3.5 (rough lemon x trifoliolate orange, 54.05%, 2.6 (rough lemon x Troyer citrange, 41.03%), 2.2 (rough lemon x Troyer citrange, 47.22%) and 3.1 (rough lemon x trifoliolate orange, 45.45%). Both germination and polyembryony are important characteristics in citrus breeding. Germination is required for the establishment of the nursery and the polyembryony is important for the propagation of true-to-type rootstock seedlings. The nucellar seedlings are true-to-type to the mother plant, since they are not from zygotic origin. Further, citrus viruses are generally not transmitted through seeds, therefore higher nucellar embryony is important for the propagation of rootstocks through seed.

For a rootstock to be successful, it should have faster growth in the nursery. In the three months old seedlings of hybrids and their parents, maximum plant height was recorded in hybrids 2.6 (rough lemon x Troyer citrange, 20.87 cm) and 3.1 (rough lemon x trifoliolate orange, 19.36 cm) and this height was better than all the parents. So, these two hybrids are vigorously growing. Further, root length, stem thickness, leaves/seedling, fresh aerial (stem + leaf) and root biomass and dry aerial and root biomass were recorded highest in these hybrids, indicating their superiority over other hybrids and their parents. Their performance in the nursery was better than rough lemon, which is a vigorously growing parent. Quick growth and the absence of branching are convenient and economical properties for rootstocks destined for nurseries. Rootstock must exhibit a high rate of nucellar embryony to ensure the uniformity of the crop (Soost and Roose, 1996).

The citrus industry is one of the best examples of the classical monocultural syndrome for the potential

disaster – a perennial crop of a restricted number of genotypes growing in a relatively small area of contiguous, dense plantings that provides the optimum situation for rapid and catastrophic build up of parasitic organisms (Barrett, 1977). These hybrids will broaden the genetic base of our citrus industry once they are tested for biotic and abiotic stress tolerance/resistance.

The farmers cultivating Nagpur mandarin require a rootstock, which is similar to rough lemon in all aspects of plant growth, but has certain advantages in the form of biotic and abiotic stress resistance/tolerance and the fruit quality. The hybrid seedlings are performing well in the field and are comparable in growth to rough lemon. Hybrid 2.6 is also producing smooth-skinned fruits, which is a character inherited from Troyer citrange. In the development of these hybrids, the germplasm of trifoliolate orange and Troyer citrange has been used and it indicated that the germplasm would play an important role in the future breeding programmes for the improvement of citrus rootstocks. The hybrids developed are further being screened for their resistance/tolerance to *Phytophthora* spp. and citrus nematode and they are also being evaluated for testing the performance of Nagpur mandarin budded on them. Further studies are in progress.

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Evaluation and Utilization of Introduced *Musa* Germplasm in India

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Key Words: Banana, Evaluation, Germplasm, Utilization

Banana and plantains (*Musa* spp.) have got an important niche as a major staple food in India as well as other tropical countries. Their cultivation has become a source of livelihood for the marginal and small farmers across the world. In India, banana and plantains lie interwoven with culture and tradition. India boasts of its polyclonal germplasm with more than 20 varieties contributing to commercial cultivation and over 30 serving as choice cultivars (Uma *et al.*, 2002). But almost all varieties are threatened by a wide range of pests and diseases, and constitute the most significant constraint in *Musa* production. Important diseases of *Musa* include leaf spots diseases (Sigatoka complex) caused by species of *Mycosphaerella*, Fusarium wilt (Panama disease) caused by *Fusarium oxysporum* f. sp. *cubense*, bacterial wilts caused by *Erwinia carotovora* etc. Viral diseases like Banana bunchy top, Banana bract mosaic, Banana streak and Cucumber mosaic are economically important. Pests include nematodes (*Radopholus similis*, *Pratylenchus coffeae*, *Meloidogyne incognita* are important) and the borers (*Cosmopolites sordidus* and *Odoiporus longicollis*). Breeding for resistant cultivars and integrated pest and disease management are the only options for sustainable and economically viable banana production.

Banana is one of the toughest crops for improvement through breeding, due to inherent sterility. However, genetic improvement of diploids (by crossing and selection) started in the early 1930s on the principle that with a generally fixed female parental contribution, success of hybrids must depend totally on the positive genetic qualities transmitted by the pollen. Subsequently tetraploid hybrids were developed; Currently efforts are underway to breed new hybrids through classical breeding as well as biotechnological methods and to popularize them among growers. Various national and international breeding programmes like Fundación Hondureña de Investigación Agrícola (FHIA), Honduras, International Institute for Tropical Agriculture (IITA), Nigeria, Centre de Recherches Regionales sur Bananiers et Plantains

(CRBP), Cameroon, etc. have resulted in the release of more than 25 superior hybrids.

The International Network for Improvement of Banana and Plantains (INIBAP), Montpellier, France, is instrumental in developing a network for collection, conservation and distribution of germplasm and improved global hybrids. Additionally, an International *Musa* Testing Programme (IMTP) is a collaborative effort in which elite *Musa* varieties produced by breeding programmes, as well as promising germplasm accessions from the INIBAP collection, are evaluated in sites worldwide (Orjeda, 2000). IMTP has been running since 1990 as a partnership between National Agriculture Research Systems, INIBAP and breeding programmes. India is a partner in the IMTP in which many hybrids were evaluated. With the National Research Centre for Banana (NRCB), Trichy, Tamil Nadu, as the nodal center, India has four test centers to undertake trials of evaluation of global hybrids against *Fusarium* wilt, Sigatoka, nematodes, and performance in farmers' fields. This paper briefly describes the status of introduced hybrids and germplasm of *Musa* and their extent of utilization in India.

Exotic banana hybrids and cultivars were obtained from the world collection of banana held at INIBAP Transit Centre (ITC), Leuven, Belgium in the form of proliferating *in vitro* cultures. The cultures were quarantined at National Bureau of Plant Genetic Resources (NBPGR), New Delhi and conserved in its *in Vitro* Genebank. They were subcultured in Murashige and Skoog's (1962) medium with 3% sucrose, 1-3 mg/l N⁶-benzyladenine, 0.1-0.5mg/l IAA for bulking up. In a phased manner during 1994-2004, several hybrids (Table 1) and cultivars were supplied to the NRCB for field evaluation and trial in the farmers' fields.

During the second phase of IMTP, 21 accessions were screened against *Fusarium* wilt (*Fusarium oxysporum* race 4) and the results showed that the introductions namely Bluggoe, Burro Cemsa (ITC 1259) and Saba (ITC 1138), despite their greater rating for vascular

Table 1. Details of some of the promising global hybrids evaluated under the IMTP by NRCB, Trichy

INIBAP No.	NBPGR No.	Name of Hybrid	Parentage	Important Traits
<i>Source Institute: International Institute for Tropical Agriculture (IITA), Nigeria</i>				
ITC 1296	EC468354	BITA-2 (TMB x 1378)	Pisang Awak cv. Fougamou X <i>M. balbisiana</i> 1-63	Sturdy, high yielding with resistance to Black Sigatoka
ITC 1297	EC426459	BITA-3 (TMB x 5295)	AAB Laknau, cv. Laknau x Tjau lagada	High yielding with resistance to Black Sigatoka, suitable for culinary purpose
<i>Source Institute: Centre de Recherches Regionales sur Bananiers et Plantains (CRBP), Cameroon</i>				
ITC 1344	EC497313	CRBP-39	AAB – Plantain cv. French clair x M53 (4X)	Highly resistant to Black Sigatoka, possess good cooking qualities
<i>Source Institute: Fundación Hondureña de Investigación Agrícola (FHIA), Honduras</i>				
ITC 0504	EC501358	FHIA-01	AAB – Pome cv. Prata Ana X Prata Ana (Dwarf Prata) SH 3142	Resistant to Black Sigatoka, burrowing nematodes and race 1 and 4 of <i>Fusarium</i> wilt; tolerant to drought and cold, fruits have good apple flavour and long green life; suitable for cooking and beer making
ITC 0505	EC501359	FHIA-02	AAA – Cavendish cv. Williams x SH 3393	Fruits are sweet in taste similar to Cavendish bananas but possess a shorter green life. Susceptible to <i>Fusarium</i> wilt
ITC 0506	EC501360	FHIA-03	(Gaddatu x BB) x SH 2471- SH 3386 SH 3386 x SH 3320	Possess good resistance to Black Sigatoka, tolerant to marginal soil fertility and rainfall, performs well at both sea level and high altitudes; resistant to strong winds, drought and tolerant to cold; hybrid is highly suitable for homestead gardens
ITC 1264	EC407587	FHIA-17	Cultivar AAA – Gros Michel Highgate x SH 3362	Possess good resistance to Black Sigatoka and race 1 of <i>Fusarium</i> wilt
ITC 1319	EC467908	FHIA-18	AAB – Pome cv. Prata Ana x SH 3142	Resistant to Black Sigatoka; fruits are sweet acid in taste with apple flavour
ITC 1332	EC469509	FHIA-21	AAB – Plantain cv. AVP – 67 x SH 3142	French plantain is resistant to Black Sigatoka and has excellent plantain flavour; twice as productive as False Horn; recommended for home gardens
ITC 1265	EC468351	FHIA-23	cv. AAA – Gros Michel Highgate x SH 3362	Tolerant to Black Sigatoka and resistant to race 1 of <i>Fusarium</i> wilt
ITC 1418	EC467911	FHIA-25	SH 3648 (4X) x SH 3142 (2X)	Dwarf and sturdy with high level of resistance to Black Sigatoka; fruits are easy to peel, fast to cook and possess excellent texture and flavour both boiled and fried and long green life after harvest

discolouration performed well and yielded good bunches indicating their resistance to *Fusarium* wilt. Similar screening was done for Sigatoka leaf spot diseases (*Mycosphaerella* spp.) during the third phase of IMTP. Among the nine accessions tested, the exotic hybrids namely TMB 5295-1, FHIA-18, CRBP-39 and FHIA-21 were found to be resistant to Sigatoka leaf spot diseases. When the introductions were screened against the three major nematodes namely *Pratylenchus coffeae*, *Meloidogyne incognita* and *Helicotylenchus multicinctus*, none were found to be resistant or immune to all the three nematodes. However GCTCV 215 was found to be resistant to *P. coffeae* alone while Pisang Berlin (ITC 0611), Pisang Ceylon (ITC 1441) and FHIA-3 were found to be resistant to *H. multicinctus* alone.

Superior hybrids and clones were evaluated at NRCB, Trichy and the promising ones were identified and distributed for multilocation trials under the All

India Coordinated Research Project (AICRP)-Tropical Fruits for commercial cultivation (Anon., 2004). The varieties evaluated are detailed in Table 2.

Out of these varieties, FHIA-01, FHIA-03, FHIA-23 and Saba, which were found to be highly promising, have been taken to farmer's fields for large scale testing under various agro-climatic conditions across the country. The programme on evaluation of global hybrids in the farmers' fields is being partially supported by BAPNET/INIBAP, France. Under this three major hybrids namely FHIA-01, FHIA-03 and FHIA-23 have been multiplied and supplied by NRCB, Trichy to various farmers. FHIA-01 was widely tested in Maharashtra by a leading tissue culture industry and the fruits were evaluated for post-harvest processing and preparation of puree. FHIA-01 was found to be more suitable for processing with high sugar:acid ratio and low polyphenol oxidation of the pulp, which results in pulp browning. The consumers

Table 2. Promising exotic hybrids of *Musa* identified by NRCB for multi-location trials for commercial cultivation under the AICRP-Tropical Fruits

AICRP Centre	Hybrid No.
National Research Centre for Banana, Trichy, Tamil Nadu	FHIA-01, FHIA-03, FHIA-18, FHIA-23, FHIA-21, FHIA-25, CRPB-39, SH-3640
University of Agricultural Sciences, Arabhavi, Dharwad, Karnataka	FHIA-01, FHIA-03, FHIA-17
Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu	FHIA-01, FHIA-03, FHIA-17, FHIA-23
Kerala Agricultural University, Kannara, Kerala	FHIA-17, FHIA-18, FHIA-21, FHIA-25, CRPB-39
Acharya NG Ranga Agricultural University, Kovvur, Andhra Pradesh	FHIA-01, FHIA-03, FHIA-17
Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, West Bengal	FHIA-01, FHIA-03, FHIA-17
Rajendra Agricultural University, Pusa, Bihar	FHIA-01, FHIA-03, FHIA-17, FHIA-23

have popularly accepted FHIA-03 as cooking banana, as also the cultivar Saba. FHIA-23 is still being evaluated as a dessert cultivar, as substitute for local Cavendish clones.

In the evaluation trial conducted at NRCB, Trichy to assess the superiority of FHIA-01 over the indigenous hybrids and cultivars belonging to the Pome subgroup namely, H-1 and Pachanadan, FHIA-01 was found to be promising for many traits. Tolerance to wind damage was attributed to plant robustness, high yield, extended green and yellow shelf life, resistance to *Fusarium* and Sigatoka and tolerance to weevils.

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Status of Introduced *Musa* Germplasm at Banana Research Station, Kannara

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Key Words: *Musa*, Germplasm, Conservation, Genepool, Cultivars, Wild Species

Musa germplasm conservation and evaluation activities are in progress under the All India Coordinated Research Project on Tropical Fruits at the Banana Research Station (BRS), Kannara. The work aims to collect and conserve wild and cultivated germplasm, representative of the diversity existing in the *Musa* genepool for evaluation and subsequent use in breeding programme and to make available selected superior material to the farmers of Kerala. The center presently holds a germplasm of 256 accessions in its field genebank comprising indigenous and exotic varieties.

Since 1994, efforts have been made to enrich the germplasm collection through introductions and till 2004, 48 accessions have been received. Exotic germplasm

was procured by the National Bureau of Plant Genetic Resources (NBPGR), New Delhi, from the global *Musa* germplasm collection held at International Network for Improvement of Banana and Plantain (INIBAP) at its Transit Centre (ITC) in Leuven, Belgium.

Materials and Methods

Proliferating *in vitro* cultures of *Musa*, received from INIBAP, were multiplied at NBPGR, New Delhi and periodically supplied to BRS, Kannara during 1994-2004. The 48 accessions comprising 21 germplasm/reference cultivars, 6 wild species and 21 improved hybrids/variants were received in the form of small suckers or proliferating *in vitro* cultures which were regenerated to plantlets at the Center for Plant

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have popularly accepted FHIA-03 as cooking banana, as also the cultivar Saba. FHIA-23 is still being evaluated as a dessert cultivar, as substitute for local Cavendish clones.

In the evaluation trial conducted at NRCB, Trichy to assess the superiority of FHIA-01 over the indigenous hybrids and cultivars belonging to the Pome subgroup namely, H-1 and Pachanadan, FHIA-01 was found to be promising for many traits. Tolerance to wind damage was attributed to plant robustness, high yield, extended green and yellow shelf life, resistance to *Fusarium* and Sigatoka and tolerance to weevils.

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Table 1. Exotic germplasm and wild species of *Musa* evaluated at BRS, Kannara during 1994-2004

NBPGR No.	INIBAP No.	Name of accession	Sp./Group
Diploid			
EC 433558	ITC 0567	Amas (South Johnstone)	AA
EC 493717	ITC 0299	Guyod	AA
EC 446001	ITC 0093	Long Tavoy	AA
EC 454557	ITC 1254	Paka	AA
EC 468346	ITC 0611	Pisang Berlin	AA
EC 414340	ITC 0480	Pisang Buntal	AA
EC 468343	ITC 0312	Pisang Jaribuaya	AA
EC 414334	ITC 0258	Pisang Madu	AA
Triploid			
EC 448619	ITC 0365	Williams	AAA
EC 423202	ITC 1123	Yangambi KM5	AAA
EC 407583	ITC 1124	Njombe-N2	AAB
EC 454559	ITC 1257	Nkono Wa Tembo	AAB
EC 468365	ITC 1441	Pisang Ceylan	AAB
EC 493714	ITC 0109	Obino l'Ewai	AAB
EC 320552	ITC 1129	Big Ebanga	AAB
EC 320554	ITC 1133	Njock Kon	AAB
EC 320555	ITC 1135	Popoulu	AAB
EC 378248	ITC 0842	Pisang Kelat	AAB
EC 448611	ITC 0004	Pisang Nangka	AAB
EC 414356	ITC 1138	Saba	ABB
EC 448612	ITC 0020	Ice Cream	ABB
Wild Species			
EC 448627	ITC 0858	<i>M. acuminata</i> ssp. <i>banksii</i> x <i>M. schizocarpa</i>	<i>acuminata</i> x <i>schizocarpa</i>
EC 446017	ITC 0609	<i>M. acuminata</i> ssp. <i>malaccensis</i> type Pahang	<i>acuminata</i>
EC 423195	ITC 0253	<i>M. acuminata</i> ssp. <i>microcarpa</i> type Borneo	<i>acuminata</i>
EC 497300	ITC 0249	<i>M. acuminata</i> ssp. <i>burmannicoides</i> (Calcutta 4)	<i>acuminata</i>
EC 444055	ITC 0933	<i>M. maclayi</i> ssp. <i>maclayi</i>	<i>maclayi</i>
EC 444054	ITC 0917	<i>M. peekelii</i> ssp. <i>peekelii</i>	<i>peekelii</i>

Table 2. Exotic improved hybrids/variants of *Musa* evaluated at BRS, Kannara during 1994-2004

NBPGR No.	INIBAP No.	Name of accession	Sp./Group	Source Country
EC 467910	ITC 1344	CRPB 39	AAAB	Cameroon
EC 501358	ITC 0504	FHIA 01	AAAB	Honduras
EC 501360	ITC 0506	FHIA 03	AABB	Honduras
EC 467908	ITC 1319	FHIA 18	AAAB	Honduras
EC 467909	ITC 1332	FHIA 21	AAAB	Honduras
EC 467911	ITC 1418	FHIA 25	AAAA	Honduras
EC 407587	ITC 1264	FHIA-17	AAAA	Honduras
EC 407588	ITC 1265	FHIA-23	AAAA	Honduras
EC 497317	ITC 1442	GCTCV-106	AAA	Taiwan
EC 454560	ITC 1271	GCTCV-215	AAA	Taiwan
EC 497318	ITC 1443	GCTCV-247	AAA	Taiwan
EC 407585	ITC 1261	PA- 03-22	AAAB	Brazil
EC 407586	ITC 1262	PV- 03-44	AAAB	Brazil
EC 407591	ITC 1284	SH 3436-6	AAAA	Cuba
EC 407590	ITC 1283	SH 3436-9	AAAA	Cuba
EC 467907	ITC 1307	SH-3640	AAAB	Nigeria
EC 467905	ITC 1296	TMB x 1378 (BITA 1)	ABBB	Nigeria
EC 501367	ITC 1437	TMB2x 9128-3	diploid	Nigeria
EC 497314	ITC 1417	TMB3 x 15108-6 (PITA 16)	AAAB	Nigeria
EC 426459	ITC 1297	TMBX 5295-1	AAAB	Nigeria
EC 468361	ITC 1416	TMP2 x 2829-62	AA	Nigeria

Biotechnology and Molecular Biology, College of Horticulture, Vellanikkara, Kerala. The details of the introductions are given in Tables 1 and 2. Field establishment and subsequent evaluation were carried out at BRS, Kannara.

Results and Discussion

Characterization and evaluation of 32 accessions have been completed, while 16 recently received material are in the process of regeneration. The AA diploids and wild species selected based on bunch characters,

disease resistance and pollen fertility are included in breeding programme as pollen sources. Among plantains, the French plantain cultivars Njock kon and Nyombe and the False Horn plantain cultivar Big Ebanga showed good adaptability in Kerala. They also registered higher bunch yield in comparison to the local plantain cultivar Nendran. Selected plantain introductions are presently under on-farm evaluation. Yangambi Km5 (AAA) which exhibited very good establishment, has been identified and popularized as a dessert variety with acceptable bunch qualities and resistance to major fungal diseases and insect pests (Menon, 2000).

Fourteen improved hybrids were tested for yield parameters and reaction to Sigatoka leaf spot disease

under the International *Musa* Testing Programme coordinated by INIBAP. The hybrids FHIA-01, FHIA-03, FHIA-23, SH-3640, FHIA-17, FHIA-18, FHIA-21, FHIA-25, CRPB-39 and TMB 5295-1 had superior bunch features and recorded moderate to very high resistance to Sigatoka leaf spot (Menon *et al.*, 2004).

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Prospect and Potential of Introduction in Temperate Fruits in India

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Key Words: Temperate Fruits, Introduction, Commercial Production

Temperate fruit crops form one of the most important areas where introductions have played significant role. Temperate fruit belt in India comprises of temperate regions of Jammu & Kashmir, Himachal Pradesh and Uttaranchal and hills of Darjeeling, North East India, Nilgiris and Kodaikanal. Almost all the commercial cultivars of apple, pear, cherry plum, peach, apricot, pecan, persimmon and strawberry are of exotic origin. Actually, the present temperate fruit industry is based on the efforts made by western settlers/missionaries in the 19th century who introduced and cultivated exotic temperate fruit cultivars on a large scale. Subsequently, the responsibility of plant introduction was taken up by Government agencies like erstwhile Plant Introduction Station (now NBPGR Regional Station) Shimla, Agricultural/Horticultural Departments of State Governments. Resultantly, more than 5000 germplasm accessions and varieties of various temperate crops were introduced from about 25 countries. Some of the notable introductions made up to the middle of 20th century are still popular amongst the growers. A few examples are 'Delicious' apple (red strain), 'Bartlett' pear, 'Elberta' peach, 'Santa Rosa' plum and 'New Castle' apricot. Out of several hundreds of cultivars introduced, only a few selected ones viz. Starking Delicious, Red Delicious, Richared, Golden Delicious, Red Chief, Oregon

Spur of apple; Max Red Bartlett, Manning Elizabeth, China Pear of pear; New Castle, Royal and Nugget of apricot; Elberta, July Elberta, Alton, JH Hale of peach; Santa Rosa, Satsuma, Methley of plum; Non pareil, Drake, Merced, Ne-Plus Ultra of almond; Tioga, Torrey, Fern, Chandler of strawberry and Black Heart, White Heart, Early Rivers, Pink Early of cherry were accepted as commercial cultivars. The new plant species, which were introduced from abroad, got acclimatized and being cultivated successfully in temperate regions of India include kiwi (*Actinidia deliciosa*). Non-arid varieties of persimmon (*Diospyros kaki*) pecan nut (*Carya illinoensis*), pineapple guava (*Feijoa sellowiana*) and chinese ber (*Ziziphus jujuba*). NBPGR Regional Station, Shimla is pioneer in introducing and popularizing kiwi in India. Until now, this station has distributed more than 10,000 plants of kiwi to various departments and farmers. It is now evident that most of the commercial varieties introduced in the past do not meet the present day requirements of high yield, wider adaptation, regular bearing, dwarf stature, precocity, improved fruit quality, resistance to pests and diseases and so on. For example, Delicious apples are low yielding, prone to biennial bearing, not well adapted to adverse environments and European pears have late maturity and small fruits. Now there is a demand for

disease resistance and pollen fertility are included in breeding programme as pollen sources. Among plantains, the French plantain cultivars Njock kon and Nyombe and the False Horn plantain cultivar Big Ebanga showed good adaptability in Kerala. They also registered higher bunch yield in comparison to the local plantain cultivar Nendran. Selected plantain introductions are presently under on-farm evaluation. Yangambi Km5 (AAA) which exhibited very good establishment, has been identified and popularized as a dessert variety with acceptable bunch qualities and resistance to major fungal diseases and insect pests (Menon, 2000).

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new attributes in the market. For instance, red to deep red colour, crispness, large fruit size, smooth surface, low chilling in apple; red colour, early ripening in pear; reddish or yellow colour, small and free-stone in apricot; lateral cum terminal bearing habit, thin shelled nature, precocity, dwarf nature, white kernel in walnut; non-prickly and erect plant type, big-fruited and longer shelf-life types in strawberry; red/yellow flesh color, large sized non-hairy and seedless fruit, fruit with less inner core, early harvest in kiwi; non-astringent, red colored firm seedless fruit with longer shelf-life in persimmon; precocity, dwarf types in pecan nut. The new crops which also have the potential in the temperate region of India but needs through study include cherimoya (*Annona cherimoya*), (*Olea europaea*), pistachio nut (*Pista vera*), queensland nut (*Macadamia ternifolia*), raspberry (*Rubus idaeus*), gooseberry (*Rubus loganobaccus*), currants (*Ribes* spp.), blueberry (*Vaccinium* spp.), hazelnut (*Corylus*

avellana), chestnut (*Castanea sativa*), elderberry (*Sambucus* spp.), *Amelanchier* spp. etc.

Some measures for strengthening the potential use of these introductions include identifying locations analogous to the locations where the introduced species/varieties are being grown through sophisticated tools like Global Positioning System (GPS), overcoming establishment problems related to rootstock such as graft compatibility, their influence on the vigor and quality and understanding seed physiology. Experience of the past shows that many of the notable introductions could not be saved due to lack of suitable methods of conservation other than field genebanks. Alternate methods of conservation like cryo, *in vitro* need to be strengthened by developing suitable protocols. Mutual understanding between the parties involved particularly in light of Intellectual Property Rights (IPR) regimes is of dire need for worthy introduction.

SHORT COMMUNICATIONS

Bacterial Wilt Incidence and Field Performance of an Exotic Germplasm of Tomato

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¹ Department of Plant Pathology, College of Horticulture, Vellanikkara-680 654, Kerala**Key Words: Tomato, Bacterial Wilt, Field Screening, Artificial Inoculation**

Bacterial wilt of tomato caused by *Ralstonia solanacearum* (Smith) Yabuuchi *et al* is an important disease that limits tomato production in many tropical and subtropical regions of the world. Disease control is difficult because of broad host range, widespread distribution and vast genetic variability of the pathogen (Hayward, 1991). Identifying resistant sources and combining bacterial wilt resistance with other characters like large fruit size and high temperature fruit set should be the main objective of tomato improvement programmes in the tropics. (AVRDC, 1992). Existence of different strains, races and biovars has been responsible for the breaking down of resistance of varieties evolved through breeding programmes. This necessitates continuous screening of tomato germplasm for resistance to bacterial wilt and developing new resistant varieties. Under the above circumstances the present study was undertaken to screen an exotic germplasm of tomato for bacterial wilt resistance and to assess their performance.

The material for the present investigation comprised an international set of 36 reportedly wilt resistant lines from different parts of the world collected from Bundaberg Research Station, Queensland, Australia. Pusa Ruby, a universally susceptible check and a local resistant check Sakti were also included in the study. The thirty-six lines were evaluated in the wilt sick plots maintained at Agricultural Research Station, Mannuthy, Kerala for two consecutive seasons during 1999-2000 and 2000-01 in a randomized block design with two replications in 0.60 x 0.45m crop geometry. Each genotype was grown in a single row of 12 plants in each replication. Out of this, five randomly selected plants were utilised for recording biometrical observations. Wilt resistance was recorded at weekly intervals. The presence of bacteria in the wilted plants was tested through ooze test. The genotypes were rated for wilt resistance as per the scale suggested by Mew and Ho, (1976). Data for two seasons were pooled and statistically analysed. The wilt resistant genotypes identified were further

subjected to artificial inoculation by leaf clipping method (James, 2001) to confirm wilt resistance. Fresh bacterial ooze was collected from wilted plants in the field in 100ml of sterile distilled water and optical density (OD) of the suspension was adjusted to 0.3 at 600 nm containing 10⁸ cfu/ml. Twenty seedlings each of the genotypes found resistant in field trials were raised in sterilized growing media in plastic pots along with the susceptible check Pusa Ruby. When seedlings were 18-20 days old, artificial inoculation was carried out by making 3-4 cuts across the veins on the leaf blade of the top four fully opened leaves of healthy plants with a pair of sterilized scissors dipped in the freshly prepared bacterial suspension. The number of plants wilted was recorded separately for each genotype and percentage wilt incidence was calculated.

There was wide variation among the genotypes for wilt resistance in field screening (Table 1). Such wide variation in disease reaction could be due to strain differences in the pathogen and environmental effects on host and pathogen (Elphinstone, 1994, Hanson *et al.*, 1996). The susceptible check, Pusa Ruby showed 100 percent wilt incidence thereby confirming the presence of virulent inoculum in the field. Twenty-one lines including the resistant check Shakthi were found resistant to bacterial wilt (< 20 percent wilt incidence) in the present study during both the seasons. Only one genotype (LE 25) recorded 0 percent wilt. Fourteen lines expressed moderate resistance to wilt and rest were susceptible to wilt.

The twenty-one lines found resistant in field trials were also resistant to bacterial wilt under artificial inoculation. Here also the susceptible check showed 100 percent wilt incidence confirming virulence of pathogen in the inoculum. Fourteen genotypes did not show any disease symptoms while the remaining genotypes showed varying levels of disease incidence.

Pooled analysis of field data for the two years recorded significant differences among the 36 genotypes

Table 1. Bacterial wilt incidence in tomato genotypes under field screening

S.No	Genotypes	EC number	Fruit colour and shape	Bacterial wilt incidence (%)	*Disease reaction
1	LE 1	398693	Round, uniform	11.26	R
2	LE 2	398715	Oval, uniform	25.65	MR
3	LE 3	398695	Oval, uniform	4.41	R
4	LE 4	398697	Round, green shouldered	25.15	MR
5	LE 5	398692	Round, green shouldered	24.00	MR
6	LE 6	398700	Oval, uniform	9.32	R
7	LE 7	398684	Round, uniform	7.25	R
8	LE 8	398699	Oval, uniform	65.65	S
9	LE 10	378696	Oval, uniform	21.42	MR
10	LE 11	398688	Oval, uniform	8.00	R
11	LE 12	398710	Oval, uniform	10.80	R
12	LE 13	398718	Round, uniform	67.15	S
13	LE 14	398704	Round, green shouldered	13.95	R
14	LE 15	398694	Round, uniform	18.51	R
15	LE 16	398701	Oval, uniform	14.82	R
16	LE 17	398691	Round, green shouldered	44.64	MS
17	LE 18	398703	Round, green shouldered	56.90	MS
18	LE 19	398685	Round, green shouldered	18.51	R
19	LE 20	398711	Round, green shouldered	32.14	MR
20	LE 21	398707	Round, green shouldered	6.66	R
21	LE 22	398712	Round, uniform	4.00	R
22	LE 23	398686	Round, uniform	16.12	R
23	LE 24	398702	Pear, uniform	13.84	R
24	LE 25	398708	Oval, green shouldered	0.00	R
25	LE 26	398687	Round, uniform	11.67	R
26	LE 27	398714	Round, uniform	22.45	MR
27	LE 28	398713	Oval, uniform	22.22	MR
28	LE 29	398719	Oval, uniform	26.08	MR
29	LE 30	398716	Round, uniform	15.52	R
30	LE 31	398709	Oval, uniform	27.77	MR
31	LE 32	398698	Oval, uniform	20.00	R
32	LE 34	398689	Oval, green shouldered	33.33	MR
33	LE 35	398717	Oval, uniform	32.25	MR
34	LE 36	398705	Round, uniform	20.92	R
35	LE 66	H-7997	Oval, uniform	4.63	R
36	Shakthi	Released variety	Round, green shouldered	18.61	R
37	Pusa Ruby	Released variety	Round, uniform	100.00	S

*Mean of two seasons

Scale: 0 – 20% Resistant (R), 20 – 40%, Moderately Resistant (MR), 40 – 60%, Moderately susceptible (MS) and 60 – 80% Susceptible (S) for all the six quantitative characters studied (Table 2). Maximum variation was recorded for fruit yield (500.19-1399.50g) followed by number of fruits per plant (14.25-106.57). Minimum variation was recorded for number of locules. Eight lines out yielded the standard resistant check, Shakti. On the basis of resistance to bacterial wilt, fruit yield and fruit weight the lines LE 66, LE 12, LE 1 and LE 32 were found promising and could be utilised in further improvement programmes.

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Table 2. Mean performance of tomato genotypes (Pooled data)

S.No	Genotypes	Plant height (cm)	Days to flowering	Fruits/plant	Fruit yield (g)	Fruit weight (g)	Locules/fruit
1	LE 1	59.42	64.53	26.26	1158.92	44.96	2.41
2	LE 2	69.20	64.55	31.40	822.56	29.51	2.24
3	LE 3	53.90	64.56	33.18	1192.70	38.33	2.20
4	LE 4	82.62	64.26	53.72	893.21	16.84	2.08
5	LE 5	51.50	65.72	38.80	847.51	22.42	2.07
6	LE 6	55.75	65.00	21.83	782.28	36.28	2.26
7	LE 7	57.50	63.51	27.24	1093.18	39.90	2.19
8	LE 8	69.83	73.00	14.25	500.19	44.41	2.30
9	LE 10	98.25	67.78	31.08	594.85	20.45	2.15
10	LE 11	109.75	72.25	33.75	712.17	19.97	2.60
11	LE 12	71.25	64.50	34.55	1243.81	35.85	2.03
12	LE 13	41.50	69.05	18.25	576.88	32.17	2.05
13	LE 14	56.00	63.38	38.25	683.60	20.42	2.54
14	LE 15	61.17	68.93	28.36	949.00	33.45	2.07
15	LE 16	68.00	64.50	26.83	627.08	23.26	2.05
16	LE 17	56.00	69.05	23.25	816.66	35.26	2.00
17	LE 18	58.00	65.95	47.15	1013.75	22.17	2.40
18	LE 19	62.00	67.25	48.05	918.75	20.40	2.00
19	LE 20	53.50	66.40	16.83	971.75	58.17	2.19
20	LE 21	53.92	68.60	25.99	826.39	28.79	2.12
21	LE 22	42.50	65.75	26.12	673.81	26.40	2.22
22	LE 23	82.75	65.12	28.75	1016.28	35.31	2.01
23	LE 24	44.50	64.68	66.41	1064.00	15.62	2.15
24	LE 25	69.25	65.55	28.54	1003.50	35.62	2.25
25	LE 26	53.85	68.12	19.43	753.07	47.15	2.33
26	LE 27	61.00	66.15	21.40	896.10	42.67	2.21
27	LE 28	65.17	67.25	29.49	799.08	27.26	2.15
28	LE 29	50.00	66.75	47.65	1152.60	25.06	2.06
29	LE 30	64.00	68.55	28.48	969.04	34.01	2.30
30	LE 31	66.50	65.55	20.31	818.83	40.38	2.17
31	LE 32	66.00	68.60	43.42	1278.00	28.44	2.07
32	LE 34	84.00	67.00	19.26	664.66	44.11	2.42
33	LE 35	69.00	62.84	106.57	536.33	5.12	2.00
34	LE 36	67.00	70.80	26.32	937.75	50.27	2.20
35	LE 66	60.00	65.25	38.83	1399.50	30.49	2.19
36	Shakthi	67.50	65.25	39.44	942.17	28.27	2.16
	Se ±	4.93	1.15	2.91	68.08	1.88	0.09
	CV (%)	7.70	2.45	12.27	10.80	8.40	5.90

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Induction of Mosaic Resistance in Chillies through Introduced Germplasm

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Key Words: Chilli, Mosaic, Resistant, Selections

Chilli is an important vegetable in Kerala grown in garden lands, paddy fields and field bunds. The commercially cultivated chilli varieties belong to *Capsicum annuum* though in the homesteads *Capsicum frutescence* and *Capsicum chinense* are also cultivated. Chilli cultivation in Kerala is constrained by several biotic factors of which virus diseases are serious in summer and bacterial wilt in the rainy season. The important viral diseases that affect chilli in Kerala are the leaf curl and chilli mosaic. Management of disease through vector control is often not fully successful. A viable alternative is the development of resistant varieties. One of the accepted methods for inducing resistance to viral diseases is through breeding programmes using resistant sources.

A project was undertaken at Regional Agricultural Research Station, Pattambi, Kerala Agricultural University, to develop chilli varieties that are resistant/tolerant to mosaic caused by potato virus Y. One hundred and fifty six accessions of chillies both indigenous and introduced were screened for mosaic incidence. Artificial inoculation with virus isolates was done using carborandum leaf wipe method. The initial screening revealed that 11 of the accessions were resistant to mosaic of which six were introduced ones. The resistant sources identified from the introduced germplasm include Tam Mild Jalapino, Hildago Serrano, Tam Mild Chile 2, PI 163201, Tumpang and LV 2722. Five resistant sources were also identified from the indigenous collections (George and Jyothi, 2002). Twenty six accessions were tolerant which included six introduced ones. The details of the resistant and tolerant types are presented in Table 1.

Attempts were made to transfer the resistance to cultivated varieties. The varieties selected for crossing with resistant sources included Manjari, Ujwala, Jwalamukhi, Jwalasakhi (varieties released from Kerala Agricultural University) and KTPL 16 and KTPL 18. Seventeen cross combinations were developed. Twenty five plants were raised for screening and evaluation. Selections were made from the segregant population based on field resistance to mosaic and horticultural

Table 1. Identified sources of resistance/tolerance to chilli mosaic

S. No.	Accession No.	Name	Source	Reaction to mosaic
1.	CA109	Tam Mild Jalapino	Texas A&M University	Resistant
2.	CA 107	Hildago Serrano	Texas A&M University	Resistant
3.	CA 108	Tam Mild Chile 2	Texas A&M University	Resistant
4.	CA 118	IHR 384	IIHR, Bangalore	Resistant
5.	CA 119	IHR-517-1	IIHR, Bangalore	Resistant
6.	CA 121	Koppam Local	Kerala	Resistant
7.	CA 128	Pusa Jwala	New Delhi	Resistant
8.	CA 138	PI 163201	Malayasia	Resistant
9.	CA 141	Pusa Sadabahar	New Delhi	Resistant
10.	CA 142	Tumpang	Indonesia	Resistant
11.	CA 144	LV 2722	Indonesia	Resistant
12.	CA 64	EC 339052	NBPGR	Tolerant
13.	CA 65	SA 2225	NBPGR	Tolerant
14.	CA 66	578	NBPGR	Tolerant
15.	CA 69	643-1	NBPGR	Tolerant
16.	CA 73	582-1	NBPGR	Tolerant
17.	CA 75	CO-4	TNAU	Tolerant
18.	CA 76	PKM-1	Periyakulam	Tolerant
19.	CA 77	PKM-2	Periyakulam	Tolerant
20.	CA 79	Local	Kerala	Tolerant
21.	CA 81	Local	Kerala	Tolerant
22.	CA 87	Local	Kerala	Tolerant
23.	CA 91	Local	Kerala	Tolerant
24.	CA 97	Local	Kerala	Tolerant
25.	CA 101	Local	Kerala	Tolerant
26.	CA 111	IHR-1616-8	IIHR, Bangalore	Tolerant
27.	CA 112	IHR-1618	IIHR, Bangalore	Tolerant
28.	CA 113	IHR -1680	IIHR, Bangalore	Tolerant
29.	CA 115	IHR-582	IIHR, Bangalore	Tolerant
30.	CA 116	IHR 544	IIHR, Bangalore	Tolerant
31.	CA 117	IHR-1617 -5	IIHR, Bangalore	Tolerant
32.	CA 135	HDA 832	France	Tolerant
33.	CA 136	Criollo de Morelos 334	Mexico	Tolerant
34.	CA 137	Cili Langkap	Malayasia	Tolerant
35.	CA 139	Acc. 365	Italy	Tolerant
36.	CA 140	Perennial HDV	France	Tolerant
37.	CA 143	IR	Indonesia	Tolerant

attributes. Selection was continued up to the F6 generation. From the F6 population, resistant plants that yielded more than 100 g per plant were selected. Nine selections were thus identified. These selections were characterized as per the minimal descriptors (Srivastava *et al.*, 2001).

Table 2. Important characters of selections from crosses between resistant/tolerant sources and commercial varieties

S.No.	Crosses	Plant height (cm)	Plant canopy width (cm)	Colour of fruits	Fruit shape	Fruit number	Fruit length (cm) (g)	Average single fruit weight	Yield/ plant (g)
1.	*IR x Manjari	60.5	44.3	Deep Red	Long	49.8	6.7	1.8	101.0
2.	*LV2722 x KTPL 18	54.5	37.0	Red	Long	29.9	7.4	4.5	120.0
3.	*IR x Jwalamukhi	80.5	65.8	Deep Red	Long	33.2	10.5	2.8	104.5
4.	*Tumpang x Jwalamukhi	84.3	64.0	Red	Long	33.5	7.5	3.1	115.0
5.	*Tumpang x Manjari	46.5	25.0	Red	Long	46.6	7.5	1.9	107.0
6.	*IR x KTPL 18	75.5	51.0	Red	Long	37.0	13.5	4.6	175.7
7.	IHR 384 x Jwalamukhi	60.0	34.1	Deep red	Long	21.1	9.7	5.2	120.9
8.	IHR 384 x KTPL 18	86.0	54.0	Deep red	Long	37.0	7.5	4.1	164.0
9.	IHR-517-1x Jwalamukhi	47.5	28.8	Deep Red	Long	27.3	7.6	3.7	109.8

*introduced sources

The important characters of the selections are presented in Table 2.

The selections from the crosses IR x KTPL 18 and IHR 384 x KTPL18 recorded high yields. All the selections had long fruits and red to deep red colour. Single fruit weight was lowest in IR x Manjari and Tumpang x Manjari.

Conclusion

Screening and evaluation studies showed that mosaic resistance could be successfully transferred to cultivated varieties from three exotic sources and

two indigenous sources. The selections made are to be further evaluated for stability and improvement in yield characters.

Reference

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Performance of Exotic Collections of Cabbage in the North-western Mid-Hill Conditions of India

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Key Words: Cabbage, Evaluation, Germplasm

Cabbage (*Brassica oleracea* var. *capitata*) is an important vegetable having the largest area (0.28 m ha) and production (6.10 m ton) among the cole crops in India (Anonymous, 2002). Availability of germplasm with considerable amount of variability is a prerequisite for crop any improvement programme. It is also necessary to have information about the performance of the genetic materials in the environment where improvement work is to be undertaken. Therefore, the present investigation was aimed to collect germplasm of cabbage from the place of its origin or diversity and identify the promising collections under the mid hill conditions of India for their further utilization in breeding work.

Fifty germplasm of cabbage bearing EC No. 490156-490205 were obtained from the Horticulture Research International, Wellesbourne (UK) through NBPGR, New Delhi and put under evaluation during winter 2002-03 along with 5 others collected indigenously at the IARI, Regional Station, Katrain (32°N, 77°E, 1500 m above mean sea level). Plant-to-plant and row-to-row spacings were maintained at 45 cm each in a plot size of 3 m x 3 m. Each entry was replicated twice in a randomized complete block design and observations were recorded on 5 randomly selected plants for number of non-wrapper leaves, frame size, stalk length, head size index, gross plant weight and net head weight.

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Data were analyzed statistically following Panse and Sukhatme (1985).

All the lines except EC-490188 could germinate and establish in the field. Five lines EC-490158, 490161, 490181, 490187 and 490205 bolted directly without forming heads and, therefore, data on head characteristics could not be recorded. EC-490159, 490166, 490168, 490171, 490178-490180, 490182, 490184, 490186, 490194, 490197, 490198 and 490203-490205 bolted directly without forming heads and, therefore, data on

head characteristics could not be recorded. EC-490195 was found highly susceptible to black rot disease caused by *Xanthomonas campestris*. Sixteen lines viz., EC-490159, 490166, 490168, 490171, 490178-490180, 490182, 490184, 490186, 490194, 490197, 490198 and 490203-490205 were having the leaf and other characteristics of savoy cabbage types. EC-490198 and EC-490201 were obtained as F₁ hybrids.

It is pertinent from Table 1 that number of non-wrapper leaves were minimum in EC-490171 (13.0)

Table 1. Performance of exotic collections of cabbage for different characters

Hybrids	No. of non-wrapper leaves	Frame size (cm)	Stalk length (cm)	Head size index (cm ²)	Head shape	Gross plant weight (kg)	Net head weight (kg)
EC-490156	17.7	41.2	1.05	114.85	Round	0.68	0.38
EC-490157	17.0	36.5	0.70	78.30	Round	0.45	0.30
EC-490159	18.6	49.2	1.25	166.05	Round	1.48	0.69
EC-490160	16.9	37.5	1.10	134.00	Round	0.77	0.49
EC-490162	17.7	49.3	1.05	183.15	Round	1.60	0.893
EC-490163	17.7	42.0	0.70	139.10	Round	0.88	0.52
EC-490164	19.5	57.1	2.05	203.85	Round	2.02	0.58
EC-490165	17.7	39.5	1.20	119.20	Round	1.40	1.00
EC-490166	14.2	49.1	0.85	192.00	Oval	1.04	0.53
EC-490167	19.5	66.5	1.70	165.10	Oval	2.25	1.13
EC-490168	16.2	54.2	2.00	114.80	Oval	1.55	0.38
EC-490169	15.0	57.2	0.90	97.60	Flat	1.25	0.50
EC-490170	17.1	42.3	0.95	116.35	Round	0.64	0.37
EC-490171	13.0	52.2	0.65	175.70	Oval	1.07	0.49
EC-490172	15.3	37.5	1.25	116.65	Flat	0.77	0.45
EC-490173	15.8	41.0	1.20	181.90	Oval	0.92	0.68
EC-490174	19.5	45.7	1.50	134.20	Round	1.85	0.80
EC-490175	17.5	45.0	1.20	141.20	Flat	1.45	0.63
EC-490176	17.7	40.5	0.90	156.75	Round	0.94	0.94
EC-490177	15.1	43.2	1.20	114.80	Round	0.62	0.35
EC-490178	15.5	60.9	1.35	175.50	Oval	1.10	0.46
EC-490179	19.2	50.8	1.10	240.55	Round	1.80	1.04
EC-490180	14.5	53.5	2.00	235.50	Oval	1.85	1.20
EC-490182	14.2	52.5	1.75	220.85	Oval	1.45	0.67
EC-490183	14.1	43.8	0.80	226.50	Oval	1.28	0.83
EC-490184	21.0	54.0	1.55	172.70	Round	1.87	0.80
EC-490185	18.2	44.5	0.70	252.70	Round	1.48	1.02
EC-490186	17.6	55.2	1.70	306.45	Round	1.50	1.05
EC-490189	22.7	62.2	0.85	243.80	Round	2.77	1.00
EC-490190	17.0	36.2	1.05	111.80	Oval	0.61	0.39
EC-490191	18.0	40.8	1.30	187.40	Round	1.04	0.76
EC-490192	19.0	38.8	0.90	152.30	Round	0.82	0.63
EC-490193	16.7	44.0	0.60	156.80	Oval	1.05	0.78
EC-490194	13.3	42.0	2.10	146.75	Oval	0.91	0.48
EC-490195	14.4	42.4	0.75	184.20	Oval	0.98	0.65
EC-490196	17.2	42.4	0.55	176.90	Round	0.97	0.51
EC-490197	16.4	52.2	1.25	212.10	Oval	1.38	0.64
EC-490198	14.1	50.9	1.45	163.85	Oval	1.16	0.44
EC-490199	18.5	41.0	1.10	138.85	Round	0.93	0.63
EC-490200	16.0	43.1	0.80	158.65	Round	1.02	0.76
EC-490201	18.5	58.9	1.00	243.30	Oval	2.30	1.25
EC-490202	16.6	44.8	1.30	133.40	Round	0.94	0.52
EC-490203	15.6	48.0	1.45	173.85	Oval	1.15	0.51
EC-490204	18.1	53.7	1.75	295.60	Oval	2.25	1.20
EC-389796	18.4	41.4	0.75	144.75	Round	0.90	0.57
EC-389805	23.1	53.3	0.80	182.65	Flat	1.59	0.75
EC-389813-R	19.1	47.7	0.60	137.55	Round	1.17	0.67
EC-389813-F	23.5	49.9	1.35	168.05	Flat	1.48	0.58
Fieldman	19.2	49.0	1.15	160.10	Round	1.27	0.64
General Mean	17.3	47.5	1.16	170.22	—	1.25	0.66
SE±	0.82	3.82	0.11	8.58	—	0.16	0.12
CD at P=0.05	2.33	10.87	0.33	24.40	—	0.45	0.35

and maximum in EC-389813-F (23.5) whereas frame size ranged between 36.2 cm (EC-490190) to 66.5 cm (EC-490167). Minimum and maximum stalk length was recorded in EC-490196 (0.55 cm) and 490194 (2.10 cm), respectively. Maximum head size index of 306.45 cm² was recorded in EC-490186 and minimum of 78.30 cm² in EC-490157. Gross weight per plant ranged between 0.45 kg (EC-490157) to 2.77 kg (EC-490189). Maximum net head weight was recorded in EC-490201 (1.25 kg/head) and minimum in EC-490157 (0.30 kg/head). It is, therefore, evident that considerable amount of variability was available for all the traits under study.

Based on the overall performance with respect to head shape (round), compactness of head, early heading, smaller frame size (<50 cm) and average net head weight

(>0.75 kg/head), 7 lines viz., EC-490162, 490165, 490174, 490176, 490185, 490191 and 490200 were selected. Although EC-490201, 490204, 490180, 490167, 490186, 490179, 490183 and 490193 also had better net head weight but they had either oval head shape or resembled with savoy type of cabbage or both and therefore, not selected. Similarly EC-490189 and EC-389805 were also rejected due to their bigger frame size and flat head shape, respectively. The selected collections will be exploited in the on-going breeding programme on cabbage.

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Genetic Variability and Association Analysis in Exotic Cherry Tomato

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Indian Institute of Vegetable Research, Varanasi-221 005, Uttar Pradesh

Key Words: Cherry Tomato, Genetic Divergence, Intertrait Correlation

Tomato is one of the most widely grown and commercially important vegetable crops. The numerous varieties differ greatly in plant form and fruit type, the latter ranging from a small currant size through cherry, plum, and pear forms to the large, nearly round fruits. Tomatoes are a valuable source of minerals and vitamins, particularly vitamins A and C. The cherry tomatoes are widely used in salads, with dip as an appetizer or as garnishing. In order to incorporate desirable characters to maximize marketable yield, the information on the nature and extent of genetic variability in a population of cherry tomato for desirable characters and inter trait relationship are the basic requirement. The material of the present study consisted of thirty two exotic genotypes of cherry tomato and evaluated in randomized complete block design at research farm of IIVR Varanasi during 2004.

The observations on nine morphological traits were analysed statistically. The variance analysis showed that the genotypes differed significantly among themselves for all the characters under study. The phenotypic coefficients of variation (PCV) were

slightly higher than their corresponding genotypic coefficient of variation (GCV) due to environmental influence. The higher estimates of heritability coupled with the higher genetic advance for number of fruits per plant (98.9, 79.6) and plant height (98.8, 69.8) indicated that preponderance of additive effects and the direct selection would be rewarding for such traits. High heritability accompanied with low genetic advance for flesh thickness (99.2, 0.13) and number of locules (97.3, 1.2) is indicative of non-additive gene action.

Correlation studies showed that for most of the character pairs, genotypic and phenotypic associations were in the same direction and genotypic correlations estimates were higher than the phenotypic ones, indicating an inherited association between the characters. Yield per plant the most important economic trait, exhibited positive association with average fruit weight (0.53) and number of fruits per plant (0.38). The negative correlation was observed for number of fruits per plant with average fruit weight (-0.54), number of locules (-0.45) and flesh thickness (-0.34). Therefore simultaneous

and maximum in EC-389813-F (23.5) whereas frame size ranged between 36.2 cm (EC-490190) to 66.5 cm (EC-490167). Minimum and maximum stalk length was recorded in EC-490196 (0.55 cm) and 490194 (2.10 cm), respectively. Maximum head size index of 306.45 cm² was recorded in EC-490186 and minimum of 78.30 cm² in EC-490157. Gross weight per plant ranged between 0.45 kg (EC-490157) to 2.77 kg (EC-490189). Maximum net head weight was recorded in EC-490201 (1.25 kg/head) and minimum in EC-490157 (0.30 kg/head). It is, therefore, evident that considerable amount of variability was available for all the traits under study.

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improvement for all the traits associated with yield would be difficult in the population.

Multivariate hierarchical analysis revealed total of six clusters. It was concluded that 32 genotypes were mainly divided at first node into two clusters with 24 and 8 genotypes. Cluster with 24 genotypes was further divided into 3 groups with 9, 7 and 8 genotypes respectively.

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Studies on Genetic and Biochemical Parameters of Introduced and Indigenous Germplasm in Snap Melon (*Cucumis melo* L var. *momordica* Duth. and full.)

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Key Words: GCV, Genetic Advance, Heritability, PCV, Variability

Snap melon (*Cucumis melo* L. var. *momordica*) belongs to family cucurbitaceae and is grown in many parts of India. The tender fruits are used as a vegetable and ripe fruits are used as dessert. The fruits are rich in vitamins and minerals. Besides it has got enormous medicinal value. India, being a secondary centre of origin of snap melon, has accumulated a wide range of variability with respect to different quantitative and qualitative characters. The critical assessment of nature and magnitude of variability is a prerequisite for any efficient breeding programme and provides an opportunity to identify superior lines with desirable yield and quality characters. Heritability along with genetic advance will be helpful in assessing the reliability of a character for selection. Hence, the present investigation was undertaken to study variability, heritability and genetic advance for 19 important quantitative and biochemical characters in 30 genotypes of Snap melon.

The present investigation was carried out at the research farm of The Division of Vegetable Science, Indian Agricultural Research Institute, New Delhi, during the spring-summer season of 2003. The experimental

materials consisted of 30 indigenous and exotic genotypes of snap melon collected from different sources. The experiment was laid out in a randomized block design with three replications. Each treatment comprised ten hills and two plants were allowed to grow per hill. The observations were recorded on five randomly selected plants per replication for each entry on nineteen quantitative and biochemical characters. The analysis of variance were carried out as suggested by Panse and Sukhatme (1967) and were used for calculating other genetic parameters. Genotypic and phenotypic coefficient of variation was calculated as per the formula suggested by Burton (1952). Heritability in broad sense and expected genetic advance were calculated as per the formula given by Allard (1960) and Johnson *et al.* (1955), respectively.

The extent of variability present in thirty genotypes of snap melon was measured in terms of phenotypic variance (V_p), phenotypic coefficient of variation (PCV), genotypic variance (V_g), genotypic coefficient of variation (GCV), heritability (broad sense) and genetic advance (GA). A perusal of data in Table 1 revealed that maximum

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Table 1. Range, genotypic, phenotypic and environmental variances and coefficient of variation for 19 characters

S. No.	Characters	Range	Vg	Vp	Ve	GCV%	PCV%
1.	First male flower node	1.07-2.00	0.040	0.09	0.058	14.80	22.71
2.	First female flower node	3.20-4.40	0.046	0.20	0.16	5.91	12.58
3.	Days to first male flower appearance	31.40-39.40	3.96	6.34	2.38	5.81	7.36
4.	Days to first female flower appearance	36.47-48.40	6.28	11.29	5.01	5.93	7.95
5.	Days to fruit set from anthesis	2.0-3.20	0.10	0.16	0.063	14.58	18.46
6.	Number of fruits/plant	2.40-6.27	0.49	0.89	0.40	17.58	23.70
7.	Maturity period	18.93-27.97	5.52	7.87	2.35	10.25	12.24
8.	Fruit length (cm)	7.67-21.50	15.85	18.01	2.16	29.01	30.92
9.	Average fruit weight (g)	171.33-1303.33	64526.06	72432.62	7906.56	51.83	54.92
10.	Fruit diameter (cm)	5.23-12.0	2.76	3.33	0.57	20.84	22.91
11.	Flesh thickness (cm)	0.80-2.52	0.14	0.24	0.10	25.42	33.39
12.	Length of fruit cavity (cm)	3.37-8.07	1.26	1.57	0.31	22.41	25.04
13.	Yield/plant (kg)	0.72-5.23	0.81	0.97	0.16	47.93	52.73
14.	Vine length (m)	1.10-2.25	0.09	0.13	0.040	18.60	22.29
15.	Ascorbic acid (mg)	4.42-15.50	6.47	9.69	3.22	33.23	40.67
16.	Total carotenoids (μ g)	43.07-1860.33	137788.34	143690.48	5902.15	65.55	66.93
17.	Reducing sugars (%)	0.93-2.75	0.17	0.19	0.022	24.00	25.54
18.	Non-reducing sugars (%)	0.85-3.05	0.17	0.18	0.012	25.90	26.78
19.	T.S.S. (%)	4.67-9.0	0.90	1.07	0.17	15.83	17.25

Vg=Genotypic variance; Vp=Phenotypic variance; Ve=Environmental variance; GCV= Genotypic coefficient of variation; PCV= Phenotypic coefficient of variation

variation was exhibited by total carotenoids followed by average fruit weight at both genotypic and phenotypic levels. The variation was moderate for characters like fruit length and days to first female flower appearance both at genotypic and phenotypic levels. Rest all characters showed very low genotypic and phenotypic variance. Similar observations were reported by Kalloo *et al.* (1983) in musk melon and Rao *et al.* (1999) in cucumber for average fruit weight.

Further, GCV was less compared to that of PCV for all the characters indicating a considerable influence of environment on the expression of these characters. The GCV which gives a picture of the extent of genetic variability in the population, ranged from 5.81 percent (days to first male flower appearance) to 65.55 percent (total carotenoids). The GCV was considerably high for characters such as total carotenoids (65.55 percent) followed by average fruit weight (51.83%) and yield per plant (47.93 percent). Except for total carotenoids, this is in confirmation with the findings of Swamy *et al.* (1985) in musk melon, Rao *et al.* (1999) in cucumber, Jeeva and Pappiah (2002) and Pandey *et al.* (2003) in snap melon. The above mentioned characters having higher range of variation have a better scope of improvement through selection. Characters like ascorbic acid, fruit length, non-reducing sugars, flesh thickness, reducing sugars, length of fruit cavity and fruit diameter exhibited moderate values of GCV, which is also considered sufficient to make an effective selection. Characters such as total carotenoids, non-reducing sugars,

reducing sugars and fruit length had very narrow difference in PCV and GCV values which indicated least influence of the environment on their expression. In such a situation, selection can be effective on the basis of phenotypic alone with equal probability of success. With the help of GCV alone, it is not possible to determine the amount of variation that is heritable. Heritable variation can be found out with greater degree of accuracy when heritability in conjunction with genetic advance is studied (Dudley and Moll, 1969). The heritability estimates ranged from 22.10 per cent for first female flower node number to 95.90 per cent for total carotenoids (Table 2). Very high heritability estimate were observed for total carotenoids, non-reducing sugars, average fruit weight, reducing sugars, fruit length, total soluble solids, fruit diameter, yield per plant and length of fruit cavity indicating least influence of environment on these traits. High heritability estimate for length of fruit cavity, fruit length and average fruit weight were also reported by Kalloo *et al.* (1983) in muskmelon and high heritability estimates for characters like average fruit weight, yield per plant and fruit length were also reported by Jeeva and Pappiah (2002) in snap melon.

The heritability estimate was moderate for maturity period, vine length, ascorbic acid, days to first male flower appearance, days to fruit set from anthesis, flesh thickness, days to first female flower appearance and number of fruits per plant suggesting that environmental effects constitute a major portion of total phenotypic variation and hence direct selection for the characters will be less

Table 2. Heritability and genetic advance for different characters

Character	Broad sense Heritability (%)	Expected genetic advance	
		5% intensity of selection	As percentage of mean
1 First male flower node number	42.50	0.28	20.00
2 First female flower node number	22.10	0.21	5.73
3 Days to first male flower appearance	62.40	3.24	9.46
4 Days to first female flower appearance	55.60	3.85	9.10
5 Days to fruit set from anthesis	62.40	0.53	23.87
6 Number of fruits per plant	55.10	1.07	26.81
7 Maturity period	70.10	4.05	17.67
8 Fruit length	88.00	7.70	56.12
9 Average fruit weight	89.10	493.90	100.78
10 Fruit diameter	82.70	3.11	39.02
11 Flesh thickness	58.00	0.60	40.00
12 Length of fruit cavity	80.10	2.07	41.40
13 Yield per plant	82.60	1.68	89.83
14 Vine length	69.70	0.53	32.31
15 Ascorbic acid	66.80	4.28	55.94
16 Total carotenoids	95.90	748.80	132.22
17 Reducing sugars	88.30	0.80	46.24
18 Non-reducing sugars	93.60	0.85	51.82
19 T.S.S.	84.20	1.80	29.95

effective. It can be further inferred that such traits are governed mostly by non-additive gene action and can be exploited effectively through heterosis breeding.

Expected genetic advance and its estimate as percentage of mean for various characters (Table 2) revealed that total carotenoids, average fruit weight and yield per plant exhibited the highest genetic advance. Though characters such as non-reducing sugars, reducing sugars, fruit length total soluble solids, fruit diameter and length of fruit cavity had high heritability estimates, their GCV was comparatively less, resulting in less genetic advance. First male flower node number and first female flower node number possessed low heritability values along with low GCV resulting in low genetic advance. This confirms the findings of Burton (1952) that GCV together with heritability estimates would give a better picture of genetic advance to be expected from selection. It is clear from Table 1 and 2 that total carotenoids, average fruit weight and yield per plant possess high GCV, heritability and genetic advance. These characters could be effectively improved through selection as it has been suggested that characters with higher heritability coupled with high genetic advance would respond to selection better than those with high heritability and low genetic advance (Johnson *et al.*, 1955).

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Evaluation of Exotic Potato (*Solanum tuberosum* ssp. *tuberosum*) Germplasm in North-western Hills of India

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Key Words: Exotic Germplasm, Genetic Parameter, Late Blight, Potato, *Solanum tuberosum*

In North-western hills of India, potato is grown under temperate long-day condition of summer (April to September). Late blight is a serious problem in this region and under epiphytotic condition, yield loss can be as high as 90 percent. Resistance to late blight and high tuber yield are thus the major requirements of potato breeding in this region. Information on the nature and magnitude of variability of tuber yield, its components and resistance to late blight is a pre-requisite for an effective breeding program for hill region. For the improvement of a trait, the knowledge of genetic parameters, viz. coefficients of variation (GCV & PCV), heritability and genetic advance are important. The present study reports evaluation of 34 exotic germplasm accessions in order to identify potential parents for late blight resistance, high yield and to assess the nature and magnitude of genetic parameters of variability.

Ninety-eight accessions available in the germplasm repository of CPRI were evaluated (1-2 row trials/accession) at CPRS Kufri (37°N, 77°E, 2500^m above sea level) in non-replicated row trials for 3 to 4 years. Based on the evaluation results of these accession in row trials, 32 accessions were found promising for either late blight or tuber yield or both (data not reported). The present experiment was conducted with 32 accessions for 2 years i.e. 2002-2003 & 2003-2004 with Kufri Jyoti and Kufri Giriraj as controls in randomized complete block design with three replications and a plot size of four rows of 10 tubers each. Plants were spaced 20 cm apart and 60 cm between rows. The crop was dehaulmed at 110 days after planting. Normal cultural practices were followed. However, no fungicide was sprayed for late blight in order to screen the accessions

against this disease as suggested by (Dowley *et al.*, 1999).

Data on late blight incidence were recorded at three week interval. These values were used to compute area under disease progress curve (AUDPC) as per formula given by Shanner and Finney (1977). Accessions were grouped into classes based on AUDPC values viz., highly resistant (<30), resistant (31-100), moderately resistant (101-300) and susceptible (>300). At harvest, data were recorded on tuber number per plant, average tuber weight (g) and tuber yield (g/plant) at per plot basis. Data for both the years were analyzed separately. However, Bartlett's test indicated homogeneity of error variance and hence the results based on pooled analysis are presented for the characters except late blight since late blight did not appear during 2002-03.

Significant genotypic differences were observed for all the character studied. The genotype X year interaction was also significant for tuber number per plant, average tuber weight and tuber yield indicating that expression of these traits may vary from year to year. Six accessions were highly resistant to late blight, 23 were resistant, two were moderately resistant and three were susceptible. Mean, range, PCV, GCV, heritability and genetic advance for four characters are presented in Table 1. Variation was very high for AUDPC values while they were moderate to low for other characters studied. As expected PCV for all characters were higher than their corresponding GCV.

Heritability and genetic advance for all the characters followed the same trend as the genetic variation. High heritability coupled with high genetic advance for AUDPC

Table 1. Genetic parameters for yield and its components in potato

Characters	Mean $\pm$ SE	Range	PCV	GCV	Heritability (%)	Genetic advance (% of mean)	Correlation with tuber yield
Tuber number	4.59 $\pm$ 0.51	3.54 – 6.13	20.26	6.43	10.10	0.19	-0.20
Av. tuber weight	59.76 $\pm$ 7.44	39.77–103.24	30.04	20.90	48.40	17.91	0.72**
Tuber yield	261.74 $\pm$ 26.00	167.16–362.94	24.54	17.49	50.80	67.23	–
AUDPC	84.04 $\pm$ 31.58	19.30–489.42	134.48	126.33	88.30	205.48	-0.20

and tuber yield indicated that the direct selection would be highly effective for the improvement of these traits. On the other hand, little improvement would be possible for tuber number per plant. Average tuber weight had significantly positive correlation with tuber yield. Non-significant correlation was observed between yield and late blight. Previous studies also advocated selection of average tuber weight for achieving higher yields in potato (Maris, 1988).

Average performance pooled over two years showed that only six accessions CP Nos. 2038, 2063, 2070, 2076, 2083 and 2173 yielded significantly higher than the best control Kufri Giriraj. All of these accessions

were resistant to late blight and had acceptable tuber shape, eye depth and uniformity. Ten most promising accessions w.r.t. tuber yield and late blight are presented in Table 2. These accessions could be used as potential parents in late blight potato breeding programme. These accessions, however, need to be tested in large-scale multi-location trial to pickup a few best for commercial cultivation.

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Table 2. The most promising accessions (10) for tuber yield and late blight resistance

Tuber yield per plant				AUDPC (ascending order)			
CPRI accession No.	Donor's culture/ variety name	Source country	Value	CPRI accession No.	Donor's culture/ variety name	Source country	Value
CP 2063	B-71-240.2	Peru	362.94	CP 2038	Arran victory	Peru	19.30
CP 2173	MS 82.60	Peru	358.21	CP 3290	Hope Hely	Hungary	19.50
CP 2083	Pimpernel	Netherlands	354.47	CP 2076	2070 (4)	UK	24.75
CP 2070	DTO-33	Peru	343.37	CP 2015	Tollocan	Mexico	24.75
CP 2038	Arran victory	Peru	339.81	CP 3171	Bzura	Poland	26.17
CP 2076	2070 (4)	UK	335.96	CP 3191	25/40	Peru	28.50
CP 3360	TPS- 113	Peru	325.99	CP 2113	Mexiquense	Peru	33.00
CP 2015	Tollocan	Mexico	307.19	CP 2378	Poos .16	Peru	33.00
CP 3171	Bzura	Poland	305.92	CP 2063	B-71-240.2	Peru	34.50
CP 3366	TPS-13	Peru	287.61	CP 2305	Primicia inta	Peru	36.00
K. Jyoti	—	India	206.27	K. Jyoti	—	India	489.42
K. Giriraj	—	India	279.58	K. Giriraj	—	India	47.25
CD _{0.05}	48.85	CD _{0.05}	63.08				

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Evaluation of Exotic Potato Germplasm for Foliage Maturity and Flowering Characters under Field and Glass House Conditions

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Key Words: Foliage Maturity, Genetic Parameter, Germplasm, *Solanum tuberosum*

Flowering behaviour of various genotypes is important to make the desired cross of any genetic and breeding

work. It is essential that the parental genotypes flower over a sufficient length of time and that the flower

and tuber yield indicated that the direct selection would be highly effective for the improvement of these traits. On the other hand, little improvement would be possible for tuber number per plant. Average tuber weight had significantly positive correlation with tuber yield. Non-significant correlation was observed between yield and late blight. Previous studies also advocated selection of average tuber weight for achieving higher yields in potato (Maris, 1988).

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Flowering behaviour of various genotypes is important to make the desired cross of any genetic and breeding

work. It is essential that the parental genotypes flower over a sufficient length of time and that the flower

do not drop, but develop into fruits. The use of TPS for commercial cultivation of potato in some region (Gaur and Pandey, 1990), increases interest to the flowering and fruiting behavior of potato. Foliage maturity is important trait of commercial significance. However, evaluation of these traits under field conditions in North-western hills of India is difficult due to late blight disease and heavy rains prevalent in this region. If the crop is grown in glass house, crop can be protected from these problems. For the improvement of a trait, the knowledge of genetic parameters, viz. genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance are important. Information on the interrelationship among traits helps in formulating optimum selection procedure for their improvement. Little information is available in field vs. glasshouse performance for these traits in potato. Therefore, this study was undertaken to evaluate 121 potato genotypes under field as well as glass house conditions and to find out whether or not glass house test could be used as a substitute for field test.

A random sample of 121 accessions drawn from potato germplasm (*Solanum tuberosum*) available at Central Potato Research Institute, Shimla were grown at Central Potato Research Station, Kufri (Himachal Pradesh) during the summer season (April–September) of 2000-01 under field and glass house condition. Each accession had one row of five tubers each replicated two times in randomized block design. Observations on weeks to flowering, duration of flowering (in weeks), flowering intensity (1- shy, 2- moderate, 3- profuse) were recorded at weekly interval from flower initiation to end of flowering. Foliage maturity (time taken in weeks to 50% senescence) was recorded as (1-early: <13, 2-medium: 14-15, 3-late: 16-17 and 4-very late: >17).

Pollen quantity (1-nil, 2-low, 3-medium, 4-abundant) and pollen fertility (% stainability in 1 % acetocarmine solution) were recorded on five flowers per accession in the flowering genotype at peak of flowering. Separate slide were prepared for each flower. The stained pollen was considered fertile and the unstained one as sterile. Data for both the conditions was analyzed using software SPAR1 (IASRI, New Delhi).

Significant genotypic differences were observed for all the characters studied under glass house as well as field conditions. Out of 121 genotypes, only 96 flowered in both the conditions. Sixty-three did not bear any berry under field and 71 under glass house condition. Thirty-two accessions were male sterile under field whereas 30 showed male sterility under glass house. Gopal (1994) had also reported enough variation for these characters under field conditions. Range, mean, PCV, GCV, heritability and genetic advance (as % of mean) for seven characters based on 96 flowering genotypes are presented in Table 1. Parameters of variability followed same trend under both the conditions. Variation was high for number of self berries/plant and pollen fertility, moderate for flowering duration, flowering intensity and pollen quantity and low for weeks to flowering. PCV for all characters were higher than their corresponding GCV. High heritability coupled with high genetic advance and high CV for number of self berries/plant and pollen fertility suggested direct selection for the improvement of these traits. On the other hand, little improvement would be possible for weeks to flowering. These results are in agreement with earlier studies reported by Kumar and Gopal (2003).

Correlation coefficients between characters within condition and within character between conditions are presented in Table 2. Significant negative correlation

Table 1. Parameters of variability for foliage maturity and flowering traits in potato under field and glass house conditions

Characters	Range	Mean $\pm$ SE	PCV	GCV	Heritability (%)	Genetic advance	(% of mean)
Weeks to flowering	Field	7.00 – 9.00	7.97 $\pm$ 0.48	8.25	5.58	45.7	6.20
	Glasshouse	7.00 – 10.00	8.68 $\pm$ 0.56	9.00	6.25	48.3	7.20
Flowering duration (weeks)	Field	1.00 – 4.00	3.28 $\pm$ 0.86	47.712	39.82	69.6	22.40
	Glasshouse	1.00 – 7.00	3.31 $\pm$ 0.83	46.21	38.89	70.8	22.30
Foliage maturity (score)	Field	1.00 – 4.00	2.27 $\pm$ 0.49	39.50	33.05	70.00	13.00
	Glasshouse	1.00 – 4.00	2.26 $\pm$ 0.43	29.46	22.32	54.4	7.90
Number of self berries/ plant	Field	0.00 – 14.75	1.07 $\pm$ 1.12	140.18	210.49	76.8	40.60
	Glasshouse	0.00 – 12.40	0.74 $\pm$ 0.95	284.76	254.63	80.0	34.90
Pollen fertility (%)	Field	0.00 – 90.00	33.13 $\pm$ 9.80	92.76	87.92	89.8	56.88
	Glasshouse	0.00 – 95.00	32.45 $\pm$ 10.67	95.85	90.03	88.2	565.40
Flowering intensity (score)	Field	1.00 – 3.00	2.11 $\pm$ 0.43	29.77	21.61	52.7	6.80
	Glasshouse	1.00 – 3.00	2.15 $\pm$ 0.43	29.35	21.46	53.5	7.00
Pollen quantity (score)	Field	1.00 – 4.00	2.81 $\pm$ 0.37	36.74	34.37	87.5	18.60
	Glasshouse	1.00 – 4.00	2.86 $\pm$ 0.49	31.72	26.74	71.1	13.30

Table 2. Correlation co-efficients among flowering traits and foliage maturity in potato

Between characters within condition				Within character between conditions	
Characters		Field	Glass house	Characters	Field Vs glasshouse
Weeks to flowering	Vs. flowering duration	-0.232*	-0.280**	Weeks to flowering	0.330**
	Vs. foliage maturity	0.107	0.182	Flowering duration	0.524**
	Vs. No. of self berries/ plant	0.071	0.000	Foliage maturity	0.365**
	Vs. pollen fertility	-0.108	0.179	No. of self berries/ plant	0.623**
	Vs. flowering intensity	-0.391**	-0.222**	Pollen fertility	0.778**
Flowering duration	Vs. pollen quantity	0.024	0.068	Flowering intensity	0.705**
	Vs. foliage maturity	0.562**	0.543**	Pollen quantity	0.409**
	Vs. No. of self berries/ plant	0.321**	0.420**		
	Vs. pollen fertility	0.133	0.185		
	Vs. flowering intensity	0.545**	0.439**		
Foliage maturity	Vs. pollen quantity	0.036	0.103		
	Vs. No. of self berries/ plant	0.379**	0.358**		
	Vs. pollen fertility	0.192*	0.273**		
	Vs. flowering intensity	0.388**	0.193*		
	Vs. pollen quantity	0.152	0.215*		
No. of self berries/plant	Vs. pollen fertility	0.357**	0.303*		
	Vs. flowering intensity	0.153	0.148		
	Vs. pollen quantity	0.233**	0.239**		
Pollen fertility	Vs. flowering intensity	0.100	0.078		
	Vs. pollen quantity	0.662**	0.775**		
Flowering intensity	Vs. pollen quantity	-0.005	0.048		

* Significant at 5 % level;

** Significant at 1 % level

of weeks to flowering was observed with flowering duration and flowering intensity under both the conditions advocating that genotype flowering early, flowered for a short duration and had fewer flower per plant. Thus, simultaneous improvement would be difficult in these characters. Weeks to flowering had no association with foliage maturity indicating that foliage maturity can't be judged based on the initiation of flowering in genotypes. Flowering duration showed significantly positive correlation with foliage maturity, number of self berries/plant and flowering intensity indicating that genotype flowering for longer period had more number of berries flowered profusely and were late maturing. Significant positive correlations of number of berries per plant and flowering intensity with foliage maturity were also observed. Significant positive correlations were also observed between number of berries per plant and pollen fertility, number of berries per plant and pollen quantity and pollen fertility with pollen quantity.

Correlation coefficients between glasshouse and field study revealed significant positive correlations for all the characters though magnitude was low for weeks to flowering, foliage maturity and pollen quantity. This

showed that potato genotypes can be screened for foliage maturity and flowering traits in glasshouse if field evaluation is problematic. Genetic parameters and correlations as observed in this study also indicated that potential exists for the simultaneous improvement of flowering intensity and flowering duration, but associated with an increase in maturity period.

Acknowledgement

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Utilization of Exotic Introductions for Crop Improvement in Vegetables

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India has made a significant progress in vegetable production in last three decades. It is the second largest vegetable producer next to China. It ranks first in cauliflower production, second in onion and third in cabbage. NBPGR has made significant contribution towards introduction of vegetable germplasm with greater potential value. Exotic germplasm of different temperate, tropical and sub-tropical crops have been introduced by NBPGR from 40 countries. Moreover exotic introductions played an important role in the development of improved varieties in vegetable crops. Introduction in the form of wild species, breeding lines, primitive cultivars as well as commercial varieties have resulted in the development of indigenous varieties in introduced crops like tomato, chilli, capsicum, cauliflower, cabbage, carrot, turnip, pea (Chadha and Kalloo, 1993). NBPGR has assembled a total of 1,678 exotic germplasm accessions comprising various vegetable crops namely tomato (934), brinjal (232), okra (273), vegetable pea (15), vegetable soybean (12), cabbage (156), radish (26), carrot (6), methi (28) and spinach (9). A total of 52 new varieties have been developed utilizing the exotic germplasm in different groups of vegetables (Shanmugam *et al.*, 1995 and 2003), viz. solanaceous (31), cucurbitaceous (6) cole crops (5) and root crops (10). Some of the outstanding examples are as mentioned in Table 1. The utilisation of plant genetic resources in crop improvement rests mainly on identification of introduced germplasm for the specific traits possessed by them. Some of the resistant sources identified in different crops are given in the Table 2.

It is very well realized that the production, consumption and availability of vegetables have been increasing and shall increase in future also. Despite a large number of varieties and hybrids developed, the productivity of vegetable crops has not improved significantly. There are very few varieties and hybrids carrying high degree of resistance to various diseases, pests and environmental stresses. Multiple disease resistant varieties are yet to be developed therefore there is an urgent need to identify the potentially valuable traits which possess genes for resistance to be identified and incorporated in the crop improvement programmes to

Table 1. Exotic Germplasm used for varietal development in India

Crop Group	Crop	Varieties developed
Solanaceous	Tomato	Pusa Ruby (Sioux), Pusa Early Dwarf (Red Cloud), Pusa Red Plum (<i>L. pimpinellifolium</i>), Punjab Chhuhara (EC 55005), Pusa 120 (Hawaii line), Pusa Saurabh (V-685 Canada), Arka Vikas (Tip Top), CO-2 (USSR TYPE), HS101 (Exotic Culture), HS110 (Exotic Line), Hisar Anmol (<i>L. hirsutum</i> cv <i>glabratum</i>), NDTR-1 (<i>L. peruvianum</i>), Punjab Tropic (USA-216-17-BK-DS-D3-03-DBK CAUSTMIO), ATV-1 (EC 8819 Denmark), ATH1 (Hawaii-7992), Sonali (US 43-1, Tamuchico111), Pusa Gaurav (Glamour x Watch), Parbhani Yashashri (PI134417), Utkal Kumari (TipTop).
	Chilli	Sindhur (Hot Portugal), Bhagyaxmi (Thohian).
	Capsicum	Arka Basant (Sorksan), Arka Basanti (Titan), Arka Gaurav (Golden Calwender), Nishat1 (World Beater).
	Brinjal	Pusa Anmol (PPL), Junagarh Oblong (Black Beauty), Punjab Harayna Brinjal 4 (Pusa Purple Long), Arka Naveen (Supreme).
Cucurbitaceous	Cucumber	Pusa Sanyog (Japanese Gynoecious), Phule Shubhangi (Poinsette)
	Musk melon	Pusa Sharbat (USA 4), Punjab Sunher (Edsito)
	Water melon	Arka Jyoti (Gimoon Sweet), Pusa Bedana (EL-RA2),
Cole crops	Cabbage	Golden Acre (Copenhagen Market), Pride of India (Copenhagen Market), Pusa Mukta (EC 24855, EC 10109)
	Cauliflower	Pusa Snowball-1 (EC 12013, EC 12012), Pusa Shubhra (PI277275)
Root crops	Radish	Pusa Chetki (Denmark selection), Pusa Nishant (Singapore selection), Pusa Himani (Capsicum White), Pusa Reshmi (Green Top)
	Carrot	Pusa Kesar (Nantes), Pusa Yamdagni (EC 9981), Selection 21 (Nantes)
	Turnip	Pusa Swarnima (Golden Ball x Japanese White), Pusa Kanchan (Golden Ball)
	Sugarbeet	IISR Composite (US75, Dobrovicaka)

Table2. Sources of Resistance to major biotic and abiotic stresses identified in the introduced germplasm in some important Vegetable Crops

Crop and Stresses	Introduced source of resistance
Tomato	
Bacterial wilt	EC 467725-935, EC 438314-317, EC 182761-182874, EC 26511-13
<i>Fusarium</i> wilt	Pan American, Florida, PI 79532
Root knot Nematode	Nemared, VNF-8, Florida, Hawaii cross
Heat tolerant lines	EC 198416, EC 501573-83, EC 479027, 31, 34, 36, 139, 140, 141 and 143
Brinjal	
Bacterial wilt	EC 104107, Florida Market
<i>Phomopsis</i> fruit rot	EC 305069, 316274
Tolerance to frost	Black torpedo, Long Tom '4'
Tolerance to drought	Supreme, Violette round
Chilli	
Cucumber mosaic virus	EC 312342-312349
PBNV mosaic virus	EC 121490
Aphids	EC 28, 30 and 34
Okra	
YVMV	EC 133408, EC169333, EC 169334, Ghana red
Jassids	EC 305656, 305694, 305695
Pea	
Powdery mildew	EC 342007
Cucumber	
Downy mildew, powdery mildew	Poinsette (PM, DM)
Muskmelon	
Downey mildew, powdery mildew, Anthracnose	Crimson sweet, shipper
Cabbage	
Black rot	EC 24855, EC 28770, Cabbage Standby
Cauliflower	
Black rot	Aemel, Olympus, Lawyana
Onion	
Purple blotch	EC 328494, EC 328492, EC 328501, EC 321463

meet the ever increasing demand of the vegetable production in India.

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In vitro Conservation of Exotic *Allium scorodoprasum* Germplasm

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Introduction of new plant material from wide and varied sources is an integral part of plant genetic resources activity programme. Extensive efforts were made by National Bureau of Plant Genetic Resources (NBPGR) to introduce the exotic germplasm of *Alliums* from different parts of the world to strengthen the *Allium* germplasm resources activity.

Alliums, representing an important genus amongst bulbous crops, are mostly used as a vegetable, spice or as a medicine (Chandel and Pandey 1992). These are either propagated through bulbs as some species are seed-sterile or propagated through seeds as well as bulbs. Since, it is a cross-pollinated crop, propagation through seed results in a highly heterogenous progeny.

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Thus, species are selectively or exclusively vegetatively propagated by bulbs/cloves to maintain the desired genotypes.

Allium scorodoprasum (EC 32850), an exotic *Allium* species has been procured by the NBPGR from USSR. Commonly known as Spanish garlic, rocambolo or sand garlic, it is used as a flavouring agent in soups whereas the bulb is used in the treatment of abscesses, amoebic dysentery, bronchitis, cholera, influenza, skin diseases and tuberculosis. This species is being maintained in the field genebank of NBPGR Regional Station at Bhowali. Field collections are generally susceptible to vagaries of weather, insects and diseases. Routine handling from one season to another also results in annual loss of these collections under field conditions. The aforementioned problems necessitate the usage of tissue culture techniques for safe and pathogen-free conservation of *A. scorodoprasum* for short-to medium-term. Successful *in vitro* clonal multiplication is desirable for *in vitro* conservation. The *in vitro* maintenance is based on culture cycles consisting of explant establishment, plantlet regeneration and storage. Such cycles have been established for *A. scorodoprasum*.

Cultures were initiated from bulbous bases following surface sterilization with 1% HgCl_2 for 20 min and subsequent rinsing with sterile distilled water four times for contamination free establishment. Bulbous bases were cut transversely and implanted onto Murashige and Skoog's medium (1962) (MS) supplemented with 1.0 mg l^{-1} 1-naphthaleneacetic acid (NAA) and 4.0 mg l^{-1} 6-benzalaminopurine (BAP) for culture initiation. Multiple shoots were also obtained on the same medium and rooting achieved. After 5-6 subcultures, the proliferated shoots provided enough material for storage experiments. These cultures were maintained under 16 h photoperiod (30 $\text{mmol/m}^2/\text{s}^{-1}$) provided by cool white fluorescent lamps (Philips, Mumbai).

Shoots measuring 3-5 mm were transferred to glass culture tubes containing 15 ml of shoot multiplication medium or that with reduced strength of nutrients or mannitol supplementation, depending upon the experiment. The tubes were closed with either cotton plugs or polypropylene caps as closures. Low temperature storage was accomplished by maintaining cultures at 4°C. At periodic intervals, cultures from each treatment were examined visually and then transferred to fresh medium under standard culture room conditions. Survival of *in vitro* cultures was assessed by their ability of cultures to resume growth on fresh medium. Six to

eight week old plantlets with well developed roots were transferred to plastic pots and maintained under nethouse conditions.

There is relatively little information on application of *in vitro* techniques for *Allium* germplasm conservation (Astley, 1990). This was confirmed by reports concerning the IBPGR Database (Withers *et al.*, 1990). Short-, medium- and long-term conservation can be achieved in *Alliums* by maintaining cultures under normal/growth restrictive conditions or by using ultra low temperatures of liquid nitrogen (LN_2 ; -196°C). This has been clearly demonstrated in garlic (El-Gizawy & Ford-Lloyd 1987). Present study reveals that with the use of cotton plug as culture tube closures, cultures could be maintained for a period of 8 weeks on shoot multiplication medium whereas replacement of cotton plugs with polypropylene caps as closures could extend the subculture duration to 24 weeks under culture room conditions. Media manipulation or low temperature incubation was beneficial in extending the subculture duration to 48 weeks. Modification of nutrient medium by mannitol supplementation had little effect on increasing the shelf-life of cultures

The present findings on conservation of *A. scorodoprasum* are important because they offer the convenience of storing the germplasm for more than one growing season, without the need for subculturing *in vitro* or field maintenance

Acknowledgements

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ABSTRACTS**Characterization of Onion Germplasm for Various Traits****AS Dhatt, AS Sidhu and SS Bal***Department of Vegetable Crops, PAU, Ludhiana-141 004, Punjab***Key Words:** *Allium cepa*, Onion, Characterization, Germplasm

Onion, an important vegetable, has always registered its significance in the socio-economic and political system of India. After the enactment of the PPVFR Act a need has arisen to characterize the available germplasm on the basis of morphological and distinct features for registration of variety. This is more important in crops like onion, which is earning more than 75 percent foreign exchange in terms of value, of the total fresh vegetable export from India. Therefore, present investigation was conducted to characterize and evaluate onion germplasm for various traits. Seedlings of 36 genotypes (indigenous and exotic) were raised during

rabi season of year 2004-05. The observations were recorded on yield, bulb weight, bulb diameter (equator and polar), neck thickness, plant height, number of leaves, leaf length, leaf width, days to maturity, bolting, shelf life, bulb colour, leaf colour, and leaf erectness. The yield ranged between 117-380 q/ha, average fruit weight 40-67 g, equator dia 4.35-5.95 cm, polar diameter 3.58-4.73 cm, neck thickness 0.79-1.37 cm, plant height 48-70.60 cm, number of leaves 10.50-14.80 cm, leaf length 30.5-56.20 cm, leaf width 1-1.72 cm, maturity 131-154 days, bolting 0-12.2 percent and shelf life 30-150 days.

Hierarchical Cluster Analysis in Exotic Introductions of Chilli (*Capsicum annuum* L)**S Kumar, A Verma, M Rai and SK Rai***Indian Institute of Vegetable Research, Varanasi-221005, Uttar Pradesh*

Among the five cultivated species of *Capsicum*, *Capsicum annuum* L is most widely cultivated throughout the world for pungent (chilli/hot pepper) and non pungent (sweet pepper) traits. In India, chilli is an important commercial crop grown for various market types. The knowledge on the nature and extent of genetic variability for desirable characters was pre requisite for their proper utilization in breeding programme. Hence this study of fifty-seven exotic genotypes of chilli was conducted during 2003-04. The observations on nine morphological characters were recorded and data were analysed. The variance analysis showed that genotypes differ significantly among themselves for all the characters under study. The phenotypic coefficients of variation (PCV) were invariably slightly higher than their corresponding genotypic coefficient of variation (GCV)

due to environmental influence. The higher estimates of heritability coupled with the higher genetic advance for average fruit weight and yield per plant indicated that heritability of the trait is mainly due to additive effects and selection may be effective. High heritability accompanied with low genetic advance for fruit width and fruit length is indicative of non-additive gene action and the high heritability is being exhibited due to favourable influence of the environment rather than genotypes. Correlation studies showed that for most character pairs, genotypic and phenotypic associations were in the same direction and genotypic estimates were higher than the phenotypic ones, indicating an inherited association between the characters. Yield per plant the most important economic trait, exhibited positive association with number of fruits per plant and average

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fruit weight. The negative correlation observed for number of fruits per plant with fruit width, fruit length and average fruit weight.

Hierarchical cluster analysis was conducted for different sources for six quantitative characters. Distance between all pairs of genotypes was calculated using squared Euclidean distance method and genotypes were clustered based on Ward's method. Cluster analysis showed four clusters. It can be concluded that the genotypes were mainly divided at the first node into

2 clusters with 55 and 2 genotypes in different groups. Cluster with 55 genotypes was again divided into 2 groups with 38 and 17 genotypes. Since these clusters are group of individuals possessing similar characters mathematically gathered into the same cluster, these individuals are supposed to exhibit higher external heterogeneity. Hence hybridization involving the inter cluster representatives of clusters would be more useful in chilli breeding programme.

SHORT COMMUNICATIONS

Evaluation of *Stylosanthes* Germplasm Based on Seed Protein Profile

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Indian Grassland and Fodder Research Institute, Jhansi-284 003, Uttar Pradesh

Key Words: Polyacrylamide Gel, Seed Protein, *Stylosanthes seabrana*

Stylosanthes commonly known as Stylo is an important range legume. In early seventies this crop was introduced in India from Australia and South America. It provides nutritive forage for animals, improves soil fertility and as pioneering colonizers reclaim degraded lands (Chakraborty *et al.*, 1998). It is also considered a nurse crop in plantation on degraded lands. Therefore, *Stylosanthes* has been identified as an important forage crop by different government and semi government agencies. Since the time of its introduction, four species viz., *S. hamata*, *S. scabra*, *S. humilis* and *S. guianensis* were largely evaluated at different sites of India (Rai and Pathak, 1985; Rai and Patil, 1985; Ramesh *et al.*, 1997). *S. hamata* is almost naturalized in this country and has shown promise in terms of production and seed yield. Though *S. scabra* is hardy and late maturing, enough attention has still not been paid to harness its potential. In recent past through germplasm exchange programme Indian Grassland and Fodder Research Institute, Jhansi has received a reasonable numbers of germplasm largely consisting *S. hamata*, *S. humilis* and *S. scabra* from ILRI, Ethiopia. Additional set of promising lines have been received from Australia in 1998 under an ACIAR-ICAR collaborative program. Under this programme along with *S. scabra*, *S. hamata* and *S. guianensis*, a new species viz., *S. seabrana* was introduced first time in India. Though *Stylosanthes* accessions have been characterized using seed protein patterns (Robinson and Megarrity, 1975), the information pertaining to newly introduced species i.e., *S. seabrana* is lacking. In the present communication we report the identification of *S. seabrana* lines from the existing stocks of ILRI materials on the basis of morphology and seed protein patterns as well as variability study in terms of protein bands in identified *S. seabrana* accessions along with other species namely *S. scabra* and *S. viscosa*.

Six lines of *S. seabrana* (CPI 2523, 2534, 2539, 110372, 104710, 105546B) were grown at Central Research Farm of Indian Grassland and Fodder Research Institute, Jhansi in 3x4 m plot in three replications.

Forty-eight lines of *S. scabra* were placed in three rows, one meter each, without replications along with checks on every five-line intervals. Along with morphological attributes and flowering behaviors seeds from individual plant looking morphologically similar to *S. seabrana* was collected. The seed proteins were isolated following the procedure of Gardiner *et al.*, (1986). The SDS polyacrylamide gel electrophoresis was carried out following the procedure of Laemmli (1970).

Out of 48 lines of *S. scabra* 35 germinated and of that 10 lines was identified morphologically similar to *S. seabrana*. Though these accessions resemble *S. scabra* in many characters including growth habits, perenniality, and fruit shape. However, *S. seabrana* species showed prominent difference with respect to seedling vigour and flowering time. It flowers in advance (45-60 days), in comparison to *S. scabra*. In general *S. scabra* flowers very late in comparison to other species of *Stylosanthes* in Jhansi condition. These lines having similarity with *S. seabrana* also depicted distinctness in leaf morphology (smaller and thin), presence of prominent hairs on stem and stipule as well as low stickiness of stem and leaves in comparison to *S. scabra*. Protein profile of seeds of these lines along with *S. scabra*, *S. viscosa* as well as available *S. seabrana* lines was carried out using SDS polyacrylamide gel. *S. viscosa* was included in the study because it is one of the diploid progenitor of allo-tetraploid *S. scabra*. *S. seabrana* (*Stylosanthes*. sp. aff. *S. scabra*) have been reported as the second progenitor of *S. scabra* (Liu and Musial, 1997). Protein profile indicated the presence of many bands which was shared by all three species. Band number 2, 11, 13 20 and 21 was absent in *S. viscosa* but present in both *S. seabrana* and *S. scabra* lines indicated that these bands were shared by *S. seabrana* in *S. scabra* (Table 1). Protein band number 14, 19, 22 and 23 was present in both *S. seabrana* and *S. viscosa* but observed absent in *S. scabra*. Low level of variations in terms of seed protein profile was observed among

Table 1. Presence (+) and absence (-) of bands as revealed by SDS polyacrylamide gel from seeds of 19 accessions of *S. seabrana* and one each of *S. scabra* and *S. viscosa* line.

Accessions/ Species	Band number																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<i>S. scabra</i>																									
RRR 94-97	+	+	+	+	+	+	+	-	++	-	++	+++	++	-	+	+	+	+	-	+	+	-	-	+	++
<i>S. seabrana</i>																									
IG 369	+	+	-	+	+	+	+	+	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	-	++
IG387	+	+	-	-	-	-	-	-	++	-	-	+++	++	+	+	+	+	+	+	+	+	+	+	-	+
IG391	+	+	-	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	+	++
IG 370	+	+	-	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	-	+
IG 346	+	+	+	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	+	+
IG 355	+	+	+	+	+	+	+	+	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	+	++
IG 325	+	+	-	+	+	+	+	+	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	-	++
IG 339	+	+	-	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	-	++
IG 384	+	+	-	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	-	+
IG 352	+	+	-	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	-	+
EC 408403	+	+	-	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	-	++
EC 408404	+	+	-	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	+	++
EC 408405	+	+	-	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	+	++
CPI 110372	+	+	-	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	+	++
CPI 105546B	+	+	-	-	-	-	-	-	++	-	-	+++	++	+	+	+	+	+	+	+	+	+	+	+	++
CPI 104710	+	+	-	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	+	+
CPI 2523	+	+	-	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	-	++
CPI 2534	+	+	-	-	-	-	-	-	++	-	-	+++	++	+	+	+	+	+	+	+	+	+	+	+	+
CPI 2539	+	+	-	-	-	-	-	-	++	-	+	+++	++	+	+	+	+	+	+	+	+	+	+	+	+
<i>S. viscosa</i>																									
CPI 33941	+	-	+	+	+	+	+	-	++	+	-	+++	-	+	+	+	+	+	+	-	-	+	+	+	++

The relative intensity of bands are reflected with the number of + sign indicated in columns. Bands are arranged with respect to decreasing molecular weight as observed on 12% SDS denaturing polyacrylamide gel.

S. seabrana lines as limited number of protein bands which were present only in few lines of *S. seabrana* accessions and absent in both *S. scabra* and *S. viscosa* was observed (Table 1).

Six lines of *S. seabrana* evaluated at IGFRI, Jhansi showed good crop establishment as germination was more than 80 percent when seed was scarified using sand paper. Fresh and dry matter yield among six lines of *S. seabrana* (CPI 2523, 2534, 2539, 110372, 104710 and 105546B) ranged from 206q/ ha (CPI 110372) to 317 q/ ha (CPI 105546B) and 71.50q/ ha (CPI 110372) to 132.96 q/ ha (CPI 2534), respectively, in rain fed condition indicated a potential fodder crop to be utilized under different production systems (Fig. 1). Results also indicated yield differences among accessions and lines performing well, like CPI 2534, 2539 and 105546B can be promoted for large scale trials. Recent research has demonstrated a potential role of different species of *Stylosanthes* as a dried leaf meal and stylo meal block in commercial poultry and animal feed respectively (Phaikaew *et al.*, 2004; Pathak *et al.*, 2004).

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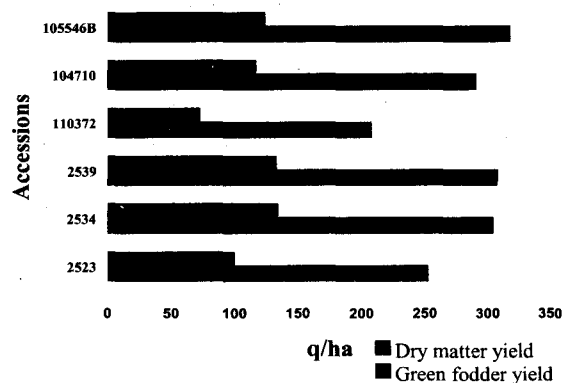


Fig. 1. Dry matter and green fodder yield of *S. seabrana* (CPI 105546B, 104710, 110372, 2539, 2534 and 2523) lines in second year of establishment

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Psyllid Resistance in *Leucaena leucocephala* Provenances and their Utilization in Fodder/ Fuelwood Production

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Key Words: *Leucaena*, Psyllid, *Heteropsylla cubana*, Fodder/ Fuel Wood Production

The genus *Leucaena* (Bentham) is reported to have 16 species (Brewbaker and Sorensson 1993)/ 17 (Hughes 1993), of which the most popular species introduced in India is *Leucaena leucocephala*. It has been one of most productive and versatile multipurpose tree legumes available to tropical agriculture. The limitations of leucaena most importantly include susceptibility to the psyllid insect pest-*Heteropsylla cubana*, (Shelton *et al.*, 1995). The damaging effect of the leucaena psyllid has halted promotion and new planting of leucaena in most regions.

The germplasm used around the world is genetically very narrow and mostly of one species (*L. leucocephala*). Clearly, susceptibility to psyllid attack, are partly caused by the lack of genetic diversity. Germplasm screening against natural infestation of 496 leucaena accessions belonging to fourteen species have been reported by Faruqui *et al.* (2002). The present study was undertaken to screen the promising leucaena provenances for reaction to psyllid and identify provenances with reasonable levels of resistance/tolerance and production potential.

The trial on *Leucaena* involving seven promising lines viz. S-10, S-14, S-22, S-24, K-29, K-601 and K-8 as control were subjected to field screening under natural infestation of leucaena psyllid. Round the year observations were recorded but the categorization has been made on the basis data recorded during Mid February to Mid March, a period where psyllid infestation

coincides with plant growth at Jhansi. These accessions have been classified in to three categories (resistant, tolerant and susceptible based on the guidelines framed by the NFTA (Wheeler 1988).

Each leucaena germplasm showed different level of infestation of this pest and the injury levels. Provenances S-14, S-22 and K-601 had low infestation (1-4 level) and injury levels (1-2) in both the systems. K-8 indicated the high level of infestation (7-9) and damage (7-8) levels and was considered as most susceptible. K-8 of course showed a very quick recovery during the periods with high humidity or low pest load making good the losses caused.

The infestation and damage was differently reflected in plantation put under repeated cutting for forage proposes as against those left uncut K-601 showed same level of resistance (injury level 1-2) in both the systems. Similarly, at peak infestation period S-22 and S-14 had low (3-4) infestation and damage score (2-3).

The frequent cut results in to new growth that attracts the psyllid. K-8 would be a good choice for a place, which has periodicity in the psyllid populations while K-601 would grow well in the locations even with high pest density based upon their production potential and response to psyllids. It is concluded that production potential under psyllid infestation should be an important criteria for provenance selection in leucaena for specific locations. The genetic diversity available in different

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Introduction and Evaluation of *Saccharum* Germplasm from Thailand

A William Jebadhas, VA Amalraj, KG Somarajan, N Vijayan Nair and N Balasundaram

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Key Words: *Saccharum spontaneum*, Germplasm, Evaluation

Saccharum spontaneum L, a wild relative of sugarcane has contributed significantly to the evolution of modern sugarcane varieties, which are complex interspecific hybrids involving two or more species of *Saccharum*. This species is characterized by profuse tillering with underground stolons. It contains very low sugar and high fibre. The species is resistant to diseases and pests and shows tolerance to abiotic stresses like salinity, water logging and drought. It exhibits the widest geographical distribution also. In view of the importance of this species in the breeding programmes, adequate attention has been given for its collection, conservation and characterisation. Within the country, organized attempts have been made to collect the available rich diversity of the species and to conserve it in the germplasm collection. The world collection of germplasm includes *Saccharum spontaneum* from its distributional areas in the country. Besides, accessions from other countries were also imported to augment the genetic diversity of the species. *Saccharum spontaneum* germplasm maintained in India is represented by the accessions from the Indian sub continent, South East Asia, China, Polynesian islands and Africa. Most of the *Saccharum spontaneum* collections available in the germplasm have been characterized and documented in two germplasm catalogues (Kandasami *et al.*, 1983 and Sreenivasan *et al.*, 2001).

The present study was an attempt to evaluate thirty-nine recent introductions of *Saccharum spontaneum* from

Thailand with respect to agronomically important characters. The thirty-nine clones of *Saccharum spontaneum* were imported from Thailand during 1999 and 2001 in two batches through the National Bureau of Plant Genetic Resources, New Delhi. The first batch of materials was quarantined in 1999 at Central Plantation Crop Research Institute, Kasargod for one year. The second batch was received in 2001 and was quarantined at Sugarcane Breeding Institute Research Centre, Agali for one year. Healthy seed materials were brought to Sugarcane Breeding Institute, Coimbatore during 2003 and were planted as two clumps per genotype in 2m long plots. Data on number of stalks per clump, stalk height, stalk diameter and internode length were recorded after 12 months. Intensity of flowering, pollen fertility and Hand refractometer Brix were also recorded. Mean, range and variation for different attributes are presented in Table 1.

Table 1. Mean, range and variation of 6 traits for 39 clones of *Saccharum spontaneum* imported from Thailand

Variable	Range	Mean	CV %
Stalks per clump	30 to 120	74.89	26.979
Stalk height (cm)	140 to 270	207.60	16.009
Stalk diameter (mm)	8.02 to 15.37	10.80	19.5213
Internode length (cm)	8.1 to 20.2	13.84	34.507
Pollen fertility %	62.7 to 99.9	94.38	23.888
HR Brix %	2 to 13.4	6.26	43.009

leucaena species needs to be classified on the basis of their utilization potential and suitability for specific regions at different resources levels.

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The clones studied exhibited moderate variability for different characters. Number of stalks per clump ranged from 30 to 120 with a mean of 75 stalks per clump. Stalk length ranged from 140 cm to 270 cm with a mean of 208 cm. Stalk diameter ranged from 6.02 mm to 15.37 mm with a range of 10.8 mm. The internode length ranged from 8.1 cm to 20.2 cm with a mean of 13.84 cm. The pollen fertility ranged from 62.7 to 99.9%. The mean pollen fertility was 94.38 %. Hand refractometer brix ranged from 2.0 to 13.4 % with a mean of 6.28%. Out of the thirty-nine clones evaluated thirteen clones did not flower. Of the twenty-six clones that flowered, all except one (MPTh 97-113 with 62.7% pollen fertility) had a high pollen fertility of above 80 %. Six clones recorded HR Brix of 10% and above at 12th month and the highest recorded was 13.4% in MPTh 99-458. The lowest Brix of 2.5% was recorded in MPTh 97-208.

The variability observed for the six characters was low to moderate. Variability for stalk diameter and stalk

height was low while that for internode length and H.R.Brix was moderate. MPTh 97-228 with stalk height of 275 cm and internode length of 13.77 cm is one of the superior clones, with moderate flowering intensity and 90.2 percent of pollen fertility. This clone could be useful in the breeding programmes. Another clone, MPTh 97-208 with stalk height of 250 cm and Internode length of 13.3 cm is also superior, but it did not flower. All these materials are being maintained at Sugarcane Breeding Institute, Research Centre, Agali.

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Introduced Germplasm and Varieties of Sugarcane

VA Amalraj, AW Jebadhas, NV Nair and N Balasundaram

Division of Crop Improvement, Sugarcane Breeding Institute (ICAR), Coimbatore

Key Words: Introduction, Germplasm, Saccharum, Sugarcane

Sugarcane (*Saccharum hybrids*) is a major cash crop of the tropical and sub-tropical regions of India. In the world, India ranks second in area and production of sugarcane. Sugarcane Breeding Institute, Coimbatore is the pioneering research center for developing improved sugarcane varieties. It is designated as one of the two repositories of world collection of sugarcane genetic resources. It is also identified as the National Active Germplasm Site by NBPGR. Sugarcane improvement programme throughout the world is closely linked with the exploration, collection, introduction and utilisation of both cultivated and wild genetic resources. The interspecific hybridisation involving cultivated and wild species forms the basis of varietal improvement programmes.

The two major centers of diversity for the cultivated species *S. officinarum* and the wild species *S. robustum*

are New Guinea and the adjoining island chains of Indonesian Archipelago. *S. officinarum* also known as 'noble cane', have soft, thick, juicy stems with high sucrose content. One introduced variety 'Poovan' has been under cultivation since long as chewing cane used during Pongal harvest festival. This species is generally used as female parent in all the basic hybridisation programmes and around 35 clones figure in the pedigree of commercial varieties. Number of clones of sugarcane germplasm introduced from different countries are given in Table 1.

Under an Exploration and Collection programme titled '*Spontaneum Expedition Scheme*' sponsored by the Indian Sugarcane Committee, over 500 clones of wild sugarcane germplasm mainly representing *S. spontaneum*, and *Erianthus* were collected by SBI from India and adjoining countries (listed in Table 1) from

The clones studied exhibited moderate variability for different characters. Number of stalks per clump ranged from 30 to 120 with a mean of 75 stalks per clump. Stalk length ranged from 140 cm to 270 cm with a mean of 208 cm. Stalk diameter ranged from 6.02 mm to 15.37 mm with a range of 10.8 mm. The internode length ranged from 8.1 cm to 20.2 cm with a mean of 13.84 cm. The pollen fertility ranged from 62.7 to 99.9%. The mean pollen fertility was 94.38 %. Hand refractometer brix ranged from 2.0 to 13.4 % with a mean of 6.28%. Out of the thirty-nine clones evaluated thirteen clones did not flower. Of the twenty-six clones that flowered, all except one (MPTh 97-113 with 62.7% pollen fertility) had a high pollen fertility of above 80 %. Six clones recorded HR Brix of 10% and above at 12th month and the highest recorded was 13.4% in MPTh 99-458. The lowest Brix of 2.5% was recorded in MPTh 97-208.

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Table 1. Basic Germplasm introduced from other countries (No. of clones given in brackets)

Species	Country
<i>Saccharum officinarum</i>	Indonesia, Papua New Guinea, Fiji, New Caledonia, etc. (773)
<i>Saccharum robustum</i>	Papua New Guinea (77), Indonesia (49)
<i>Saccharum edule</i>	Papua New Guinea (9), Indonesia (7)
<i>Saccharum spontaneum</i>	Bangladesh, Burma, China, Congo, Algeria, Egypt, Fiji, Guam, Indonesia, Kenya, Nepal, Uganda, Sri Lanka, Phillipines, Singapore, Vietnam, Israel, Mauritius, New Guinea, Thailand, Japan, Malaysia, Russia, Taiwan. (138)
<i>Saccharum sinense</i>	China (7), Japan (1)
<i>Erianthus spp</i>	Indonesia (86), Thailand (6), Burma (4), Nepal (4) Fiji (4), Papua New Guinea (5), Vietnam (2)

1947 to 1956. Only one clone collected from Java appear in the pedigree of most varieties.

During 1966-1973, under US PL480 project, attempt to introduce disease resistance and hardiness from Indian "Spontaneums" into foreign commercial varieties was made. Commercial varieties from Hawaii and Puerto Rico were crossed with selected *S. spontaneum* clones and 150 hybrids were selected from the derived population. These were designated as (IA) Indo-American clones. Some of these clones are found in the pedigree of commercial varieties Co 7908 and Co 8318. 130 Indo-American clones and 585 Foreign hybrids are being maintained at Kannur centre of SBI.

Many foreign clones, especially POJ varieties, have been utilized in sugarcane improvement programmes. A list of foreign clones that have entered into the pedigree

Table 2. Foreign germplasm introgressed into Indian varieties

No	Country (source)	List of varieties/clones
1	Indonesia	EK 28, POJ 100, POJ 181, POJ 213, POJ 385, POJ 1410, POJ 1499, POJ 2364, POJ 2725, POJ 2878, POJ 3247, Kassoer, <i>S. spontaneum</i> (Java).
2	USA	CP 670, CP 1165, CP 34120, CP 29-116, CP 34-120
3	Mauritius	M 2, M 4000
4	Australia	Q 63, Q 116
5	West Indies	B 3412, B 3747

Table 3. Recently introduced Sugarcane germplasm

	Year	Country	EC nos.	No of clones
1	1999	Thailand	432420-432570	150
2	2000	China	453250-453252	3
3	2000	USA	453405-453417	13
4	2003	Mauritius	516236-516240	5

of Indian commercial varieties is given in Table 2. POJ 2878 is the only introduced variety from Indonesia that has ever been successful in this country as a cultivated commercial variety.

Recently, sugarcane germplasm, both wild and cultivated, have been imported from the following countries (Table 3).

Efforts are being made to introduce *Erianthus kanashiroi* from Japan, China; *E. hostii* from Iran, Iraq; *E. rufipilus* & *E. sikkimensis* from Bhutan and *E. longisetosus*, *E. hookerii*, *E. filifolius*, *E. giganteus*, *E. brevibarbis*, *E. strictus*, *E. alopecuroides*, *E. coarctatus*, *E. contortus*, *E. maximus* from USA.

Utilization of Gene Pool in Genetic Improvement in Forage Oats – Achievements and Future Prospects

AK Roy and RN Choubey

Indian Grassland and Fodder Research Institute, Jhansi-284003, Uttar Pradesh

Plant genetic resources are vital inputs for sustaining genetic improvement programme. For an efficient breeding programme, a large collection of cultivars, landraces and wild relatives of the species need to be assembled has to be made, both from exotic and indigenous sources.

Oat (*Avena sativa* L.) is an important cultivated cereal for both fodder and feed purpose. It ranks sixth in world cereal production following wheat, maize, rice,

barley and sorghum. It is an important winter forage crop. It has wide adaptability in northern and north western regions of the country because of its excellent growth habit, quick regrowth and highly nutritive value for both milch as well as draft animals.

The species which make up the genus *Avena* are from a polyploid series with a basic chromosome number of $n = 7$. Three naturally occurring ploidy levels are

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known within the genus, diploids ($2n=2x=14$), tetraploids ($2n=4x=28$) and hexaploids ($2n=6x=42$).

Keeping in view the ever-increasing pressure on land resources, IGFR, Jhansi has tailored its oat genetic improvement programme to develop cultivars, which can fit into existing cropping systems. The programme is being followed with the objective of developing non-lodging, erect, multicut, dual purpose, late flowering types.

Utilization of Exotic Germplasm in Cultivar Development

Oat breeding research in India is of recent origin. Kent, Algerian, Brunker-10, FOS 1/29 varieties were introduced long back and produced good fodder and grain yields. Among these the Kent notified in 1975 has been one of the most successful introduced varieties and it is still under cultivation with wide adaptation.

At IGFR, Jhansi, wide range of germplasm has been introduced from various external agencies such as USDA, National Gene Bank, Sweden; Maryland University; IGER (UK); Brazil, Japan etc. The evaluation and utilization of these germplasm has resulted in development of many promising cultivars, which have high potential for biomass and quality. Many parental stocks such as Cuahtemaoc, Veli, Pennline, Diadem, Akiyutaka have shown high combining ability. Some of the promising strains procured from exotic sources are: Black Mesdag, Saturn, Diadem, Veli, Hankinjan Valco, Rodney, Orbit, Benson, Montezuma, PI 497888, PI 497819, CI 9313, CI 9370. etc. Many such lines have been identified as donors for desirable agronomic traits and have been utilized in crossing programme so as to develop suitable lines for different agro-ecological situations in the country.

Selection from Japanese oat "Hiugo Karyokuro" has resulted in development of a superior variety JHO -851 which has been released for cultivation in entire India. It is multicut variety with high protein and regeneration ability. Similarly cultivars like JHO 822, JHO 810, JHO 829 have been developed utilizing the exotic germplasm as one of the parent.

Utilization of Secondary Gene Pool

The gene transfer from wild relatives is of great importance for improvement of oat, because the cultivated germplasm pools of this crop are quite restricted and the cultivated types have remained isolated from their wild relatives for several thousand years.

In the improvement programme, other species from secondary gene pool of oats have also been exploited involving back crossing and colchicoid techniques to develop superior strains with many desirable traits from both the parents. The hybridization of *A. sativa* ($2n=6x=42$)

with *A. maroccana* ($2n=4x=28$) has resulted in development of F1 sterile hybrid with chromosomal constitution of $2n=5x=35$. The subsequent colchicoidization of the F1 hybrid has resulted in fertile amphidecaploid lines ($2n=10x=70$). The gradual stabilization of these lines through generations has resulted in polysomic lines ($2n=42, 44, 46, 50, 52, 58, 66, 70$). These lines combine the traits of both the parents in various combinations.

This has resulted into creation of an array of genetic material to be exploited for development of superior forage oats with respect to yield and quality. Many improved lines combining desirable traits of wild types are being tested under All India Coordinated trial. Vast potential exists to introduce novel genes into cultivated *A. sativa* background. The desirable progenies from these lines have been identified and are in advanced stages of multilocal trials under the aegis of AICRP (FC).

Utilization of Wild Relatives from Primary Gene pool

Among the wild gene pools *A. sterilis* (hexaploid) contain a number of valuable genes for growth rate, higher biomass, tillering ability, protein content and resistance to pests. Such genes may be introgressed in cultivated *A. sativa* background through interspecific hybridization. At IGFR, Jhansi interspecific hybridization with *A. sterilis* and subsequent backcrossing with *A. sativa* have given rise to many progenies combining the traits of both the parents and many desirable lines have been selected for high biomass under both single cut and multicut system.

Utilization of Exotic Germplasm for Breeding of Dual Purpose Varieties

Oat is the most ideal cereal crop both for fodder and animal feed. Keeping this in view breeding efforts must be made to tailor dual-purpose genotypes (forage-cum-seed). Enough scope exists for identification of genetic stocks from world oat germplasm combining forage productivity in first cut followed by grain productivity. Efforts in this direction have been initiated at IGFR, Jhansi. Several genotypes have been identified as dual purpose and are being tested in trials for their performance.

Future Prospects

- Developing dual purpose oat varieties.
- Breeding oat for diverse cropping systems.
- Exploiting tertiary gene pool for introducing desirable traits.
- Developing multicut types for sustained fodder availability for longer duration.
- High tillering and high protein.

Utilization of Introduced Cotton Germplasm in Varietal Development in India

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Key Words: Cotton, Exotic Collection, Utilization, Varietal Development

Cotton, jute and allied fibers are the important commercial crops of India. Among these cotton is the major fiber crop of global significance and is cultivated in tropical and sub-tropical regions of more than 80 countries of the world. There is a rich germplasm wealth of wild species and related genera of cotton. These include four cultivated species, 50 wild species, and large number of weedy races, hybrids, polyploids and their derivatives. The major collection of cotton germplasm in the world is in United States of America (14,500) and Greece (5000). Further, Sudan, Egypt, Uzbekistan, Krashodar and some East Asian and American countries also hold sizable collection of cotton germplasm (Singh et al.2004). The varietal improvement work in India started as early as 1904 with the establishment of State Agricultural Departments. The cotton varietal improvement work in India is being carried out at Punjab, Haryana, Rajasthan, Maharashtra,

Gujarat, Madhya Pradesh, Andhra Pradesh, Karnataka and Tamil Nadu.

There has been a liberal exchange of cotton germplasm during the last 20 years. Cotton improvement programme in India has made an efficient use of introduced genetic resources in development of cultivars including hybrids. Interspecific hybridization among the cultivated varieties and wild species followed by backcrossing has been extensively used to introgress genes controlling the expression of the desirable traits. The very first world's intraspecific hybrid Hybrid-4 and interspecific hybrid Varalaxmi were developed using American Nectariless and SB289E respectively. American Nectariless, Acala Glandless, Super Okra, 45 Red AK and their morphological variants are the introductions most frequently used in development of commercial cultivars. Some of the important introduced genetic resources utilized in the development of varieties and hybrids are given in Table 1.

Table 1. Important Introduced germplasm of Cotton utilized in development of commercial cultivars in India

S.No.	Name of the species/ Germplasm Utilised	Country of Origin	Variety developed
Wild Species			
1.	<i>G.thurberi</i>	USA	Rajat
2	<i>G.tomentosum</i>	USA	G.COT-12, Badnawar-1, Khandwal
3	<i>G. mexicanum</i>	USA	Surabhi (Vrs-7)
4	<i>G.anomalum</i>	Australia	AKA-8401, Arogya (NISD-2), PKV018
Cultivated species			
<i>Gossypium hirsutum</i>			
5	11969 (SA 309)	USA	Amaravati
6	45 Red AK		HS-974
7	American Nectariless	USA	Hybrid-4/Shankar-4 9H-4, LH-372, Maru Vikas (RAJ-HH-16)
8	C1998	Russia	Supriya (CP-1998F)
9	Deltapine 66-69)-7	USA	RS-875
10	EC 34859		LH -886
11	Egyptian Hirsutum	Egypt	MCU-11
12	Empire 61 WE	USA	F-286
13	M4/58 SIND	Pakistan	Pramukh
14	ACALA44-2	USA	Khandwa-3
15	Kampala	Uganda	MCU-4
16	Acala1	USA	LH357,MCU-4
17	Pope	USA	NA-247
18	Reba B 50 X Acala 44	Africa/USA	L-603
19	Reba B-50	Africa	Jawahar Kapas-4, JK-HY-1, LRA-5166, JK-HY-2, Sumangala (CWROK)-165, Anjali (LRK-516), Nira, JLH 168
20	Tomcot 37H	USA	ADT-1
<i>Gossypium barbadense</i>			
21	Karnak	Egypt	Sujatha
22	Giza 7	Egypt	TNB-1
23	SB 2829 E	Russia	Varalaxmi, Savitri
24	SIV 135	West Indies	Suvin

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ABSTRACT

Promising Desi Cotton (*G. arboreum*) Germplasm for Fibre Quality Traits and Locule Retentivity

RA Meena, D Monga, VV Singh, P Singh and Rajiv Kumar

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Cotton is being grown in fifteen-lakh hectare in north zone out of which desi cotton (*G. arboreum*) constitutes around 25 percent area. The desi cottons are having very high yield potential along with resistance to biotic and abiotic stresses. The yield potential of some desi cotton varieties is noticed up to 40 qtl/ ha, which is even higher than *G. hirsutum* in certain cases. However, inferior fibre properties and poor locule retentivity are the major drawbacks in desi cotton. Due to inferior fibre properties i.e. its coarse nature (micronnair around 7-8), short fibre length (around 16-18 mm) and low strength (16-18 g/tex) the demand of desi fibre in textile industry is very less. Similarly, the seed cotton immediately after opening of boll falls down on the ground and as a result several types of impurities combine with lint, which deteriorate the lint quality.

To identify the source for improvement in these traits from the gene pool of *G. arboreum* cotton maintained at CICR, Regional Station, Sirsa, five hundred forty geographically and phenotypically diverse, exotic and indigenous lines were evaluated for fibre quality traits and locule retentivity for three years from 2001-2002 to 2003-2004 and a wide range of variability for both the parameters was observed. Twenty-eight superior lines for fibre property trait were selected. Out of these twenty eight lines, five superior genotypes for 2.5 percent span length (above 25.6 mm) were CISA 12 (27.5), DLSA 8 (26.8), PA 255 (26.5), 1789 (26.4) and AK 580 (25.6); for fibre fineness (below 5) CISA 12 (5.0), 1789 (4.9) AK 60-2 (4.8), AKH 607 (4.6), AK 580 (4.6) and 6629 (4.5); for fibre strength (above 22) AC 3370-1 (24.8), KWAN 3 (24.5), CISA 245 (24.1), 6629 (23.2) and PA 255 (22.7); for ginning outturn (above 34) AKH 592 (37.3), DLSA 8 (35.5), AK 580 (35.0), 6571 (35.0)

and KWAN 3 (34.5); for lint index (above 4) AK 580 (4.8), AKH 592 (4.3), 6612 (4.2), 6619 (4.1) and 7038 (4.0); for yield potential (above 97 g per plant) AC 1374 (128.8), DLSA 8 (103.4), KWAN 3 (99.9), 7173 WL NLL (98.6) and 6586 (97.5) identified.

The fibre strength-length ratio > 0.8 is considered as good by the textile industry for modern spinning mills. Out of twenty-eight genotypes, the five superior genotypes for fibre strength-length ratio were CISA 245 (1.05), KWAN 3 (1.02), 6629 (0.92), 6644 (0.91) and CISA 329 (0.90). In addition to high fibre strength-length ratio, some genotype also showed superiority for other fibre property traits and yield such as 6629 (0.92) also showed superiority in fineness (4.5), strength (23.2) and GOT (31.3); KWAN 3 (1.02) for fibre strength (24.5 g/tex) and GOT (34.5) with higher yield level (99.9 g/plant) and CISA 245 (1.05) for fibre strength (24.1g/tex) and GOT (32.1). These genotypes can be successfully used for replacement of existing *G. arboreum* cultivars as well as their utilization in the crop improvement programme.

Similarly, sixty-nine genotypes with more than 80 percent boll retention capacity were identified in the field. Out of which eight lines PA 255, CISA 196, CISA 290, CISA 334, CISA 338, CISA 342, 6637 and AC 3088 were observed completely resistant to shattering. In addition to good locule retention capacity, the cultivar CISA 290 also showed higher boll number (45.5) and good yield potential (113.8 gm/ plant) followed by cultivar CISA 196 (boll number 39.5, yield 90.9 gm/ plant) and CISA 342 (boll number 35.5, yield 85.6gm). These can be utilized as such or for incorporating for locule retentivity character through breeding program in desi cotton cultivars.

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SHORT COMMUNICATIONS

Oil Palm Genetic Resources—Introduction, Utilization and Future Needs

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Key Words: Oil Palm, *Elaeis guineensis*, *Elaeis oleifera*, Genetic Resources

Oil palm is native of West Africa and exists in wild, semi-wild and cultivated forms mainly in equatorial tropics like Africa, South East Asia and South and Central America. The cultivated species of oil palm is *Elaeis guineensis* Jacq. which is also found in wild palm groves in West African (Ghana, Nigeria, Ivory Coast, Benin, Togo, Sierra Leone) and Central African (Congo region, Gabon, Zaire, Uganda) countries where its wild relatives are found. *Elaeis oleifera*, native of South and Central America, is another species found scattered in wild palm groves in South and Central American countries like Brazil, Ecuador, El-Salvador, Amazonian belt etc. This species is under-utilized and considered to have tolerance to biotic and abiotic stresses, high oil quality, compact canopy and dwarfness.

Present Status of Oil Palm Genetic Resources in India

The success of any crop improvement programme necessitates the sound footing (assemblage)/presence of wider spectrum of genetic variability (germplasm) in the species. This is all more important especially

in respect to crops like oil palm, where narrow genetic base has been felt as major constraint in research and development of oil palm (Anonymous, 1997). In India, oil palm was first introduced as an ornamental palm at the National Botanical Garden, Howrah in the later part of 19th century (Rethinam, 1998). With a view to ameliorating this situation, efforts were made in India right from 1981 to amass the genetic variability available in the genus for their exploitation. Accordingly, materials from different sources were collected. Most of the collections made were secondary in nature and were not from the natural habitat. They were tenera having limited potential use in oil palm improvement programmes.

Systematic research work on oil palm started in 1960 when the Kerala State Department of Agriculture had undertaken a 40 ha plantation at Thodupuzha (Nampoothiri and Pillai, 1998) using Deli dura materials introduced from Malaysia and Tenera x Tenera population from Nigeria. Later, some more introductions of dura genotypes received from Nigeria, Malaysia, Cote de Ivoire, Papua New Guinea and Zaire were planted at Little Andaman in 1976 and 1983. The germplasm collection available in India has been tabulated and presented in Table 1 and 2.

Since oil palm is being grown on a wide variety of soil and climatic conditions. In India the crop is being grown under non-traditional climatic conditions like high temperature and low humidity, which necessitates need for introducing some stress tolerant materials

Table 1. Oil palm germplasm collection at Palode and Pedavegi

S. No.	Source	Number of accessions
1	NIFOR Nigeria	1
2	Ivory Coast	1
3	Republic of Zaire	1
4	Indonesia	2
5	Cameroon	18
6	Malaysia	3
7	Costa Rica	9
8	Surinam	1
9	Tanzania	11
10	Zambia	9
11	Guinea Bissau	24
12	Palode	5
13	Sampaje	1
14	Tadepalligudem	1
15	Andaman	4
16	Pune	2
17	Kodungallore	1
18	<i>Elaeis oleifera</i>	
	a) Malaysia	1
	b) Costa Rica	1
	Total	96

Table 2. Distribution of cold and drought tolerant oil palm germplasm

S.No.	Place	Cameroon	Tanzania	Zambia	Guinea Bissau
1	Palode (Kerala)	1	4	3	6
2	PCKL (Kerala)	8	9	5	23
3	Pedavegi (A.P.)	15	7	7	13
4	Adilabad (A.P.)	13	2	3	4
5	Nellore (A.P.)	0	4	4	6
6	Mulde (Maharashtra)	0	8	7	3
7	Mohitnagar (W.B.)	10	0	0	0
		47	34	29	55

having high water use efficiency/ tolerant to drought and cold. Accordingly during 1994-95 a large number of such accessions were collected from Cameroon, Tanzania, Zambia and Guinea Bissau. These materials are presently being evaluated under different agro-climatic locations of Andhra Pradesh, Maharashtra, Kerala and West Bengal.

Two accessions of *Elaeis oleifera* were also introduced from Malaysia and Costa Rica. The performance of all these accessions are being evaluated, to suitably introgress desired breeding traits on yield, dwarfness and better oil quality. Further, in evaluation of collections made in 1981 from NIFOR, Nigeria, Ivory Coast, Palode and Zaire, 20 best performing tenera hybrids have so far been identified and have been planned to be selfed for future use in crop improvement programmes.

Apart from this, three oil palm seed gardens have been developed in India at Taraka (Karnataka), Rajahmundry and Lakshmipuram (both in Andhra Pradesh) where the material pertaining to second selection cycle of selected dura genotypes (*inter se* crossed/ selfed) and tenera x tenera progenies have been planted.

Limitations of Indian Oil Palm Breeding Programme

The major bottleneck oil palm breeders are facing in genetic improvement is its very narrow genetic base as a whole on one hand and availability of a few oil

palm germplasm in India on the other. Looking at the importance of oil palm in terms of nutritional food security (as palm oil is rich in vitamin A and E), the main concern of the hour is production of high yielding varieties with better oil quality, tolerance to stresses and dwarfness.

Though efforts had been made in recent past for collecting germplasm from different sources, most of the collections made were not from the natural habitat and were teneras having limited potential direct use in breeding programmes. The existing collections in India are very narrow and require substantial enrichment. It is therefore necessary to continue collection from primary collections of *Elaeis guineensis* from Africa and *Elaeis oleifera* from Central and South America to utilize them for introgression and inter-specific hybridization and subsequent improvement of oil palm.

Requirement of Oil Palm Genetic Resources

The present day oil palm breeding programmes are mainly aimed at identification of high yielding Dura palms (thick shelled type) and suitable pisifera (shell-less type) so that high yielding tenera hybrids (thin shelled type) could be produced. The specific requirement of oil palm germplasm for Indian breeding programmes along with donor country is listed in Table 3.

Table 3. Requirements for oil palm germplasm and their donor countries

Desired traits	Name of species	Name of country
Drought tolerance, Dwarf with compact canopy, High oil extraction ratio, superior oil quality, Big kernel, long bunch stalk	<i>Elaeis guineensis</i> , <i>Elaeis oleifera</i>	SEAsia—Malaysia, Indonesia, Papua New Guinea, Thailand
High yield, drought tolerance, short stature, High oil extraction ratio	<i>Elaeis guineensis</i>	West Africa—Ghana, Nigeria, Ivory Coast, Benin, Togo, Sierra Leone Central Africa—Congo region, Gabon, Zaire, Uganda; South Africa—Angola, Mozambique
Dwarfness, compact canopy, superior oil quality, long bunch stalk	<i>Elaeis oleifera</i>	South America—Brazil, Ecuador, Peru, Colombia, Surinam, Panama, Amazonian belt Central America—Costa Rica, Nicaragua and Honduras

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Yield Performance of Exotic Accessions of Arecanut (*Areca catechu* L.)

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Key Words: Arecanut, Kernel Yield, Nut Traits, Consistency

Introduction

Arecanut (*Areca catechu* L.) is considered as one of the important cash crops of India cultivated in an area of 3.72 h with the production of about 4.15mt of chali yield. It is mainly used as masticatory and is an essential requisite for several religious and social ceremonies. Crop improvement work in arecanut combined with improved input technologies has contributed to achieve the self-sufficiency within the last 50 years (Nair, 1999). Genetic manipulation for high yield and quality through varietal evaluation and selection is one of the known methods of crop improvement. The evaluation of arecanut accessions resulted in identification of five high yielding varieties and same were released for different agro-climatic conditions of the country. The present study was undertaken to evaluate the accessions for different yield component traits and also to study the genetical parameters and nature and magnitude of relationships among the different traits collected from different areca growing countries especially from South East Asian region.

Materials and Methods

The trial was laid out during 1978 with the seventeen exotic accessions introduced from the South East Asian Countries of the world along with the check South Kanara Local in order to evaluate for yield and component traits. The yield parameters viz., dry kernel (chali) yield per palm per year (kgs) was recorded for seven consecutive years from 1986-1993. Ten fruit component traits were also studied by sampling randomly twenty nuts per accessions. Data on chali yield (dry kernel weight) and nut components traits were subjected to statistical analysis and suitably interpreted. Correlation coefficients were computed to establish the relationships between yield and nut components. Also, genetic parameters such as genetic advance (GA-% of mean), heritability (Broad Sense), and genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were estimated for chali yield and nut characters.

Results and Discussion

The mean performance of seventeen exotic accessions introduced from South Asian countries along with the

check South Kanara Local in respect of chali (dry kernel) per palm (kg) for seven consecutive years are presented in the Table 1. The chali yield per palm revealed the significant differences among the accessions. The variation for chali yield ranged from 2.46 to 4.26 kg/palm with a mean of 3.11 kg/palm. The maximum chali yield of 4.26 kg/palm was noticed in the accession VTL-28III (introduced from Saigon) followed by the accession VTL-18I (British Solomon Islands) which recorded 3.90kg/ palm and VTL-11 (Indonesia). The accessions VTL-17 (Singapore), VTL-28I (Saigon) and VTL-12 (Saigon) have also showed their superiority with the yield potential of 3.67, 3.63 and 3.41 kgs of chali/palm, respectively. About 54.91, 41.09, 33.45 32.0 and 82.0 per cent increase in yield were observed in VTL-28III, VTL-18I, VTL-11, VTL-17 and VTL-28I accessions, respectively. The present observation confirms the earlier findings in high yielding varieties (Ananda, 1999), some accessions in respect of chali yield per palm (Ananda and Rajesh, 2004) and in Mangala (Rekha *et al.*, 1991). The lowest chali yield was observed in the accession VTL-18II. The consistency in the performance of chali yield over the seven years period was noticed in accessions VTL-28III and VTL-18I. The accession VTL-12 showed linear trend with moderate chali yielding ability. Similar results were obtained in indigenous germplasm (Ananda, 2001), Mangala *inter se* combinations (Ananda *et al.*, 2004) and in different arecanut accessions (Bavappa, 1980).

The estimates of range and mean performance for 10 fruit components are presented in the Table 2. The range of variation for fruit length was from 4.66 to 6.31cm. The lowest was recorded in VTL-1 and highest in VTL-28III with an overall mean of 5.49. The maximum fruit breadth was recorded in VTL-15(4.64cm) while minimum in VTL-1(3.06cm). An average of dry kernel weight was 8.11g and it ranged from 5.11g (VTL-5) to 10.40g (VTL-12). The recovery of dry kernel from fresh fruit varied from 18.61 percent in VTL-18II to 27.30% in VTL-11 with an average of 23.42 percent. In earlier study similar trend has been reported for fruit component traits in dwarf hybrids of arecanut and its

Table 1. Mean chali (dry kernel) yield/ palm (kg) in exotic accessions of arecanut

Accessions/year	1	2	3	4	5	6	7	Mean	% increase/ decrease over check SK Local
VTL-1	2.14	2.76	2.65	3.05	3.11	2.86	3.36	2.85	3.64
VTL-3	2.21	3.43	2.75	2.60	3.85	3.00	4.65	3.21	16.73
VTL-5	1.53	2.85	3.00	4.12	2.97	2.30	3.64	2.92	6.18
VTL-9	1.85	2.90	2.25	1.99	3.18	2.42	3.95	2.65	-3.64
VTL-11	2.91	4.02	3.63	3.95	4.21	3.28	5.13	3.88	41.09
VTL-12	2.20	3.18	3.18	4.18	3.68	3.20	4.15	3.41	24.00
VTL-13	1.67	2.78	2.19	2.12	3.35	2.81	3.89	2.69	-2.18
VTL-14	1.32	2.49	2.38	3.33	3.05	2.44	3.66	2.67	-2.90
VTL-15	1.98	2.61	2.61	3.25	3.09	2.95	3.23	2.82	2.55
VTL-17	2.56	3.61	3.49	4.30	3.92	3.18	4.65	3.67	33.45
VTL-18I	2.31	3.51	3.66	5.17	4.08	3.82	4.74	3.90	41.82
VTL-18II	1.60	2.37	2.31	2.95	2.67	2.20	3.14	2.46	-10.55
VTL-18III	1.31	2.14	2.73	4.73	1.59	2.21	2.97	2.53	-8.00
VTL-26	2.02	3.41	3.07	3.77	3.74	2.65	4.83	3.36	22.18
VTL-28I	2.45	3.15	3.70	5.50	3.53	3.20	3.85	3.63	32.00
VTL-28II	1.96	2.07	2.21	2.60	2.61	2.22	2.79	2.35	-14.55
VTL-28III	2.52	3.86	4.09	5.91	4.49	3.69	5.25	4.26	54.91
S.K.Local (C)	1.87	2.68	2.58	3.20	2.98	2.49	3.48	2.75	-
Mean	2.02	2.99	2.92	3.71	3.34	2.83	3.96	3.11	-
CD(+/-0.05)	0.31	0.26	0.43	0.69	0.58	0.47	0.62	-	-

Table 2. Genetical parameters and correlation between nut traits and chali yield per palm in exotic accessions of arecanut

Characters	Corr. (r) with chali yield	Mean	Range	GA	Heritability (BS) %	PCV %	GCV %
Fresh fruit length (cm)	0.009	5.49	4.66-6.31	1.289	51.45	9.22	7.01
Fresh fruit breadth (cm)	0.233 *	3.91	3.06-4.64	1.180	66.70	8.50	7.40
Fresh fruit weight (gm)	0.483 **	35.51	23.47-41.19	13.08	97.80	19.80	18.75
Husk thickness (cm)	- 0.124	0.64	0.37-0.95	0.826	46.80	64.00	45.80
Dry kernel length (cm)	0.537 **	2.35	1.80-2.90	1.513	64.10	14.15	11.85
Kernel breadth (cm)	0.486 **	2.49	1.89-3.22	1.384	80.30	12.65	11.16
Dry fruit weight (gm)	0.683 **	13.9	8.99-19.4	4.910	51.60	21.76	15.05
Dry kernel weight (gm)	0.795 **	8.11	5.11-10.4	5.08	84.85	22.90	20.80
Dry husk weight (gm)	0.538 **	5.88	3.49-9.00	3.10	73.90	26.15	22.90
Recovery %	0.737 **	23.42	18.61-27.30	2.28	50.76	07.10	5.25

** - Significant at 1% level, * - Significant at 5% level

parents (Ananda, 2002). The maximum recovery of dry kernel/ chali from the fresh fruit may be due to low content of husk in the accession VTL-11. Hence the accessions with low content of husk are preferred and such palms could be used as potential source for improvement of arecanut crop.

The estimates of genotypic and phenotypic coefficients of variation, heritability (broad sense) and genetic advance (% of mean) for various nut component traits are given in the Table 2. High estimates of GCV and PCV were observed for husk thickness followed by dry husk weight; moderate for dry fruit weight, dry kernel weight and fresh fruit weight and low estimates for recovery percentage, fresh fruit length and fresh fruit breadth. Fruit traits viz., fresh fruit weight, dry kernel weight, kernel breadth and dry husk weight showed high estimates of heritability whereas estimates for genetic advance were high for fresh fruit weight,

dry kernel weight and dry fruit weight. The characters showing high estimates of both heritability and genetic gain are desirable and can thus be improved through simple selection. Ananda *et al.* (2000) also reported moderate GCV and PCV for fresh fruit weight and dry kernel weight and moderate to high heritability with high genetic advance for these traits in high yielding arecanut varieties.

The correlation coefficients between eleven characters are presented in Table 2. The dry kernel weight, recovery percentage, dry fruit weight, kernel length and breadth were found to be positively and significantly correlated with chali yield while the husk thickness had negative association with chali yield. Bavappa and Ramachandra (1967) reported similar results while studying the correlation of different characters associations such as number of branches produced, number of nuts/ bunch and percent nutset with dry kernel yield. The characters

such as dry kernel weight, recovery percentage, dry fruit weight, kernel length and breadth showed considerable increase in the magnitudes of correlation with chali yield, thus highlighting the favourable impact on yield performance of the accessions and making indirect selection to yield through these components.

Among the accessions VTL-28III and VTL-18I were found to be superior for chali yield performance and also showed consistency in yielding behaviour over the years compared to other accessions evaluated in the present study. The high heritability and genetic gains estimated in fresh fruit weight, dry kernel weight and dry fruit weight, which can be improved through simple selection method. Characters such as dry kernel weight, chali yield, dry fruit weight, kernel length and breadth showed high magnitude of correlation with dry kernel yield. The high yielding promising accessions identified in this study can be utilized either to develop varieties/hybrids through suitable breeding programme or recommended for commercial cultivation.

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Evaluation and Utilization of Introduced Coconut Germplasm

V Niral, K Samsudeen, B Augustine Jerard and PM Kumaran

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Coconut, *Cocos nucifera* L., is an important crop of the hot and humid tropics. In India, it is grown in an area of 18.4 lakh hectares with an annual production of 12,597 million nuts. The national productivity is about 6,846 nuts/ ha and 39 nuts/ palm/ year, indicating the vast potential available for increasing the productivity in this crop. However, the improvement of plantation crops, in general, and coconut in particular is tedious and difficult because of the long gestation period, the heterozygosity, large area required for experimentation and the perennial nature of the crop. In spite of these limitations, the Central Plantation Crops Research Institute (CPCRI), Kasaragod (Kerala), has been involved in the

improvement of coconut and has released three hybrids and three varieties for cultivation in the coconut growing regions of the country.

Coconut, though belonging to a monotypic species, exhibits a lot of variability. Coconut varieties are broadly grouped into tall and dwarfs. Talls referred to as var. *typica* and are the most commonly cultivated for commercial production in all coconut growing regions of the world. Tall palms grow to a height of 20-30m and commence flowering 6-10 years after planting. The talls are sturdy and may attain an age of 80-100 years. These palms are normally cross-pollinated and hence highly heterozygous. The dwarfs referred to as var. *nana*

such as dry kernel weight, recovery percentage, dry fruit weight, kernel length and breadth showed considerable increase in the magnitudes of correlation with chali yield, thus highlighting the favourable impact on yield performance of the accessions and making indirect selection to yield through these components.

Among the accessions VTL-28III and VTL-18I were found to be superior for chali yield performance and also showed consistency in yielding behaviour over the years compared to other accessions evaluated in the present study. The high heritability and genetic gains estimated in fresh fruit weight, dry kernel weight and dry fruit weight, which can be improved through simple selection method. Characters such as dry kernel weight, chali yield, dry fruit weight, kernel length and breadth showed high magnitude of correlation with dry kernel yield. The high yielding promising accessions identified in this study can be utilized either to develop varieties/hybrids through suitable breeding programme or recommended for commercial cultivation.

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are never grown on a commercial scale. They are of shorter stature, 8-10m high when 20 years old and start bearing three to four years after planting and have a short productive life of 30-35 years. The dwarf palms are more homozygous than tall, due to a high degree of self pollination.

Research on coconut breeding in India is one of the oldest in the world dating back to 1916. Germplasm collection initiated in 1924 with the introduction of cultivars from Fiji, Indonesia, Malaysia, Philippines, Sri Lanka and Vietnam (Cochin China) at the Central Coconut Research Station, Pilicode. Subsequently selfed and open pollinated progenies were planted at CPCRI (then CCRS), Kasaragod, in 1940s. The germplasm collection was further intensified in 1952 and in 1958 the first indigenous germplasm survey and collection was conducted. In 1981, survey and collection was made from six pacific ocean countries under an FAO/ IBPGR (now IPGRI) funded expedition, which added 24 exotic collections. During 1997-2001, Asian Development Bank (ADB) funded germplasm collection expeditions were undertaken by CPCRI, Kasaragod. Fifteen accessions (including three dwarfs) were collected (in the form of embryos) from the three Indian ocean islands of Mauritius, Madagascar and Seychelles during 1997. Eight accessions each from Maldives and Comoros and Reunion were collected during 1999. In the year 2001, four accessions from Sri Lanka and 11 accessions from Bangladesh were introduced. Indigenous germplasm collecting was strengthened under the National Agricultural Technology Project on Sustainable Management of Plant Diversity (1999-2004).

At present, CPCRI has the world's largest germplasm collection in coconut with 351 accessions including 219 indigenous collections (Table 1) and 132 exotic collections from 25 countries of South and South East Asia,

Table 1. Indigenous coconut germplasm at CPCRI, Kasaragod

Place of collection	Tall	Dwarf	Total
Kerala	28	2	30
Tamil Nadu	13	5	18
Karnataka	6	5	11
Andhra Pradesh	4	1	5
Goa	8	0	8
Gujarat	1	1	2
Orissa	14	0	14
West Bengal	11	1	12
Andaman and Nicobar Islands	67	2	69
Lakshadweep Islands	31	5	36
Maharashtra	6	0	6
Assam	8	0	8
Total	197	22	219

Caribbean Islands, Indian ocean islands, pacific ocean islands and African countries (Table 2). In addition, the institute also hosts the International Coconut Genebank for South Asia (ICG-SA) under the umbrella of Coconut Genetic Resources Network (COGENT) of the International Plant Genetic Resources Institute (IPGRI).

The introduced coconut germplasm is being characterized and evaluated for yield. An exotic germplasm introduced from Philippines, was tested under three different agro-climatic regions and found superior with respect to the nut yield and copra yield over the local cultivar, West Coast Tall (WCT). The annual nut and copra yield was 110 nuts/ palm/ year and 20.8 kg copra/ palm/ year, respectively, an increase of 37.5 percent and 50.7 percent over WCT. The increase in nut yield and copra yield over the released variety 'Chandrakalpa' was 12.2 percent and 20.9 percent, respectively. It was released in 1995 as a variety under the name Kera Chandra, for cultivation in all coconut growing regions of the country (Table 3).

Among the germplasm introductions, some other accessions like Fiji Tall, Philippines Laguna, San Ramon and Strait Settlement Green appear to be promising and give high copra yield of more than 20 kg/palm per year (Table 4). The nut yield of Fiji Tall, Philippines Laguna and Strait Settlement Green is also much higher than that of the control WCT. The exotic accession 'San Ramon' produces very large nuts, the largest in coconut genebank, but yields only 64 nuts/ palm/ year. However it gives a very high copra yield as the mean copra content in the accession, San Ramon (350g/ nut) which is double the copra content in the local control WCT (176g/ nut).

In addition to direct evaluation of exotic collections for introduction in the coconut growing regions of the country, these accessions are also being evaluated for their combining ability for utilization in the hybridization programmes. So far, Fiji Tall, Philippines Ordinary, San Ramon, Java Tall, Jamaica Tall, New Guinea Tall and

Table 2. Exotic coconut germplasm at CPCRI, Kasaragod

Place of collection	Tall	Semi-tall	Dwarf	Total
South East Asia	16	1	3	20
Central & South America,	6	—	1	7
Atlantic Region				
African Regions	4	1	2	7
Pacific Ocean Islands	39	—	6	45
Indian Ocean Islands	30	—	8	38
South Asia	14		1	15
Total	109	2	21	132

Table 3. Yield performance of Philippines Ordinary

Cultivar	Mean Nut yield/ palm/ year	Mean Copra yield		Oil content (%)	Agency responsible for release
		Per nut (g)	Per palm/ year (kg)		
Philippines Ordinary (Kera Chandra)	110	189	20.8	66	CPCRI

Table 4. Comparative performance of promising exotic accessions at CPCRI, Kasaragod

Cultivar	Oil content	Mean yield nuts/ palm/ year	Annual copra yield	
			g/ nut	kg/ palm
Fiji Tall	65.2	106	199	21.1
Strait Settlement Green	67.0	108	186	20.0
Philippines Laguna	66.5	88	259	22.7
San Ramon	68.0	64	350	22.4
WCT (Control)	68.0	80	176	14.1

Strait Settlement Green have been evaluated for their combining ability and this work is in progress. The exotic germplasm has helped enhance the genetic diversity in the germplasm collection for utilization in the coconut improvement programmes in the country. It has also contributed to improving coconut productivity, through direct introductions and also through use in hybridization programmes.

Variations in Chlorophyll and Polyphenols in Exotic Arecanut (*Areca catechu* L.) Accessions

B Rajesh and KS Ananda

Central Plantation Crops Research Institute, Regional Station, Vittal Dhaula Kuan-574 243, Karnataka

Introduction

About 76 species are known to exist in the genus *Areca* (Murthy and Pillai, 1982; Ananda, 2004). Among these, *Areca catechu* is the only cultivated species, the nuts of which are chewed as mild stimulant and only the major use of the crop. Arecanut considered as one of the major cash crops of South and North Eastern parts of India. Crop improvement work in arecanut has been mainly through introduction of exotic and indigenous accessions and refinements of selection procedure in mother palms, seed nuts and seedlings. Presently the efforts were underway to study the variations among the accessions with respect to biochemical traits viz., chlorophyll and total phenol content. Among the chemical constituents of arecanut, polyphenols constitute about twenty per cent of the dried kernel (Jayalakshmi and Mathew, 1982). The plant phenolics play a major role against the biotic stresses. Also arecanut polyphenols may be utilized as the natural colouring agent and pharmaceuticals (Amudhan and Bhat, 2002). It has been reported that the plant polyphenols have been associated with their antioxidant, antimicrobial, anti-inflammatory and antiallergenic properties (Billot *et al.*, 1990). Leaf polyphenols were taken as a population parameter to

describe the genetic variability observed in coconut cultivars based on earlier work in coconut (Jay *et al.*, 1989) and other seasonal crops (Jambunathan and Martz, 1973; Eggum, 1977). Therefore, it is not only important to study the variations for biochemical but also their association for different traits among the accessions. Hence, an attempt was made to study the variability for polyphenolic content in dried kernel and fresh leaf and also estimation of total chlorophyll (seedling stage) in seventeen exotic accessions along with the nature of association for various traits.

Materials and Methods

The study was undertaken at CPCRI, Regional Station, Vittal (Karnataka), during 2001-03 with seventeen exotic collections of *Areca catechu* L. maintained in the main field gene bank with two replications (8 palms/replication). Sampling of 250 ripe nuts from each accession with two replications were collected and dried under sunlight and made into fine powder. 0.05g of dry kernel powder and 0.5g (twenty-five seedlings/accessions) of leaf samples were utilized for the estimation of polyphenol following modified Folin-Ciocalteu method (Bray *et al.*, 1954). Similarly 1.0 g of fresh leaf samples were used for estimation of chlorophylls and same was

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extracted in 80 percent acetone and read the absorbance at 663nm and 645nm in UV spectrophotometer and calculated using absorption coefficients (Thimmaiah, 2004). To establish the relationship between the different traits correlation coefficients were worked out.

Results and Discussions

Significant variations were observed for the total phenolic contents and chlorophyll among the exotic accessions. The maximum total phenolic contents observed in dried kernel of accession VTL-26 (19.60%) followed by VTL-28III (17.54%), VTL-11 (16.85%) and VTL-1 (16.04%) while accession VTL-18I (13.6%) showed lowest polyphenols (Table 1). However, among the accessions polyphenol content ranged from 99.72 to 213.97mg/g in ripe nuts. Similar results were observed in arecanut varieties and cultivars by Amudhan and Bhat (2002) and Jayalakshmi and Mathew (1982). It is also reported that the wild relatives/ species of arecanut had higher phenolic contents in ripe nuts as compared to *Areca catechu* cultivars (Rajesh and Ananda, 2004). Decreasing trend in polyphenol content with maturity have been reported and during the maturation of the fruit the rapid formation of polysaccharides, fat and fibre, increases the bulk of the nut diluting the total polyphenolic content in *Areca catechu* (Mathew *et al.*, 1964). The total phenolics showed significant differences in respect of fresh leaves, which ranged from 1.10 to 2.12 mg/g. Among the exotic accessions, maximum polyphenols

(2.01mg/g) was recorded in VTL-26 followed by VTL-5 (1.90), VTL-1 (1.81) and VTL-12 (1.66) while seedlings of accession VTL-13 showed lowest of 1.18mg/g polyphenol content. The higher leaf polyphenol content in a cultivar of coconut Chowghat Green Dwarf (CGD) can be correlated to its relatively better tolerance to root (wilt) diseases (Champakam and Ratnambal, 1993).

Among the accessions VTL-18III, VTL-3, VTL-14 and VTL-28II showed maximum 2.88, 2.82, 2.80 and 2.65mg /g of total chlorophyll content in fresh leaves of the seedlings, respectively and VTL-18I measured lowest content of chlorophyll (1.81mg/g). Photosynthetic efficiency (chlorophyll a: chlorophyll b) also calculated (Table 1) and accession VTL18III showed maximum of 2.57 and minimum of 2.11 observed in accession VTL-9.

In order to establish the relationship between characters *viz.*, chlorophyll a, chlorophyll b, total chlorophyll and chlorophyll a: chlorophyll b, polyphenol content of fresh leaves (seedlings) and dried kernel, total palm and stem height, the correlation coefficients were worked out in seventeen accessions of arecanut (Table 2). Chlorophyll a positively significant correlated with chlorophyll b (0.936), total chlorophyll (0.995) and chlorophyll a: chlorophyll b (0.995) and negatively correlated with dry kernel polyphenol (-0.017), palm height (-0.491) and stem height (-0.466) which were not significant. Total chlorophyll, photosynthetic

Table1. Estimation of chlorophylls and total phenolics in arecanut accessions

Accessions	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total chlorophyll (mg/g)	Chl a/ Chl b	Total phenolic contents in leaf (mg/g)	Total phenolic contents in dried kernel (mg/g)	Total phenolic contents in dried kernel (%)
VTL-1	1.72	0.70	2.42	2.46	1.81	160.41	16.04
VTL-3	2.01	0.81	2.82	2.48	1.53	151.84	15.18
VTL-5	1.54	0.66	2.20	2.33	1.90	146.07	14.61
VTL-9	1.54	0.73	2.27	2.11	1.34	155.46	15.55
VTL-11	1.39	0.64	2.03	2.17	1.35	168.49	16.85
VTL-12	1.29	0.56	1.85	2.30	1.66	145.39	14.54
VTL-13	1.54	0.66	2.20	2.33	1.18	139.75	13.98
VTL-14	1.95	0.85	2.80	2.29	1.47	165.41	16.54
VTL-15	1.85	0.75	2.60	2.47	1.62	147.16	14.72
VTL-17	1.61	0.69	2.30	2.33	1.42	130.47	13.05
VTL-18I	1.27	0.54	1.81	2.35	1.63	130.66	13.07
VTL-18II	1.44	0.56	2.00	2.57	1.20	139.66	13.97
VTL-18III	2.05	0.83	2.88	2.47	1.51	133.36	13.34
VTL-26	1.71	0.75	2.46	2.28	2.01	196.04	19.60
VTL-28I	1.90	0.75	2.65	2.53	1.58	136.78	13.68
VTL-28II	1.90	0.75	2.65	2.53	1.46	131.59	13.16
VTL-28III	1.38	0.57	1.95	2.42	1.32	175.42	17.54
GM	1.65	0.69	2.35	2.38	1.53*	150.23*	15.23
CV%	6.36	4.50	5.30	—	12.89	11.55	—
CD+/- 0.05	NS	NS	NS	—	0.37	3.12	—

Table 2. Correlations among the different biochemical parameters

Correlation	Chloro a	Chloro b	Total chlorophyll	Chloro a/ Chloro b	Leaf Polyphenol	Dry kernel phenol	Palm height	Stem height
Chloro a		0.936**	0.995**	0.995**	0.426	-0.017	-0.491*	-0.466
Chloro b			0.966**	0.966**	0.083	0.154	-0.417	-0.383
Total chlorophyll				1.00	0.336	0.030	-0.476	-0.242
Chloro a / Chlorob					0.336	0.030	-0.476*	-0.449
Leaf Polyphenol						-0.421	-0.315	-0.326
Dry kernel phenol							-0.123	-0.014
Palm height								0.832**
Stem height								

* Significant at 5% level ** Significant at 1% level

efficiency, leaf polyphenol and kernel polyphenol positively associated with chl b but not significant while negatively correlated with palm height (-0.417) and stem height (-0.383). Rai *et al.* (1999) reported that chl b is positively correlated with leaf polyphenol, which corroborated with the present findings. Total chlorophyll is positively correlated with leaf polyphenol (0.336), kernel total phenol (0.030) and negatively correlated with palm height (-0.476) and stem height (-0.449). Leaf polyphenol negatively correlated with dry kernels polyphenol (-0.421), palm height (-0.315) and stem height (-0.326).

The exotic accessions have exhibited greater variability for polyphenol content in dry kernel and leaves and also observed the variability for pigment contents in leaves. Accession VTL-26 found to be superior for polyphenols in leaves as well as matured fruits and accessions VTL-18III and VTL-3 had higher chlorophyll contents. The accession with desirable higher content of polyphenols can be exploited in quality breeding and further screened for pharmaceutical uses.

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ABSTRACTS

Performance of Exotic Sources of Oil Palm Hybrids in Coastal Andhra Pradesh, India**P Murugesan, P Rethinam, TT Krishnamurthy and M Ravikumar***National Research Centre for Oil Palm, Pedavegi-534 450, West Godavari District, Andhra Pradesh*

Under irrigated condition oil palm is found to perform well in varied soil and climatic conditions of India, if we give enough fertilizer, water and other inputs. As a part of oil palm improvement, the performance of Palode (Indian bred cross combinations), ASD Costa Rica, Papua New Guinea and IRHO oil palm hybrid 'teneras' was evaluated in a trial at Navabharath plantation, West Godavari district of Andhra Pradesh. Number of bunches, fresh fruit bunches yield, and bunch components were studied. Among the different sources, the mean

highest FFB yield (180.08), number of bunches (13.42) bunch weight (18.8), fruit weight (14.7) kernel/bunches, (7%) were recorded in Palode source. Other exotic hybrids mostly showed close results for bunch weight, fruit weight. There were significant difference observed among all the bunch components except fruit weight and kernel/ palm. The PNG was observed superior with regard to fruit/ bunch, mesocarp/ fruit, oil/ bunch and oil/ palm.

Collection and Evaluation of Oil Palm (*Elaeis guineensis*, Jacq) Germplasm in India**RSN Pillai, P Murugesan, RK Mathur and TVRS Sharma***National Research Centre for Oil Palm, Pedavegi-534 450, West Godavari District, (Andhra Pradesh)*

Oil palm is being tested on substantial scale at different agro climatic conditions like high altitude, semi drought and under irrigation to meet the growing demand of vegetable oil and other byproducts in different countries. In India, it is cultivated predominantly in the states of Andhra Pradesh, Karnataka, Tamil Nadu, Kerala and other identified states as an irrigated crop. Being a newly introduced crop, collection of germplasm was initiated by assembling commercial material introduced to the country or from secondary sources during 1970s. The inadequacy of genetic variability in these materials was felt which necessitated the introduction of more materials having different characteristics for enriching the existing breeding programme which was started by the then Central Plantation Crops Research Institute, Regional Station, Palode (Kerala). Accordingly, germplasm collections were assembled with an aim to ameliorate narrow genetic base and produce superior hybrid seeds suitable to different agro-climatic conditions of identified areas. In 1981, 73 exotic accessions were collected from ASD Costa Rica, Papua New Guinea and Cameroon. To extend the growing areas of oil palm in the areas with distinct dry or high altitude conditions, cold and drought tolerant materials from African countries

(Guinea Bissau, Cameroon, Tanzania and Zambia) were collected and they were planted for evaluation in different target areas. In 1981-82 Tenera accessions were introduced from NIFOR-Nigeria, Ivory Coast and Zaire. Also, two accessions of American oil palm (*Elaeis oleifera*) were introduced from Malaysia and Costa Rica and they were planted at Palode (Kerala). During the year 2000, two advanced generation *Dura* accessions from ASD, Costa Rica were imported under UNDP programme "Breeding for oil palm seed production" and planted as seed garden at National Research Centre for Oil palm, Pedavegi (Andhra Pradesh). Apart from these, 24 tenera accessions received from Costa Rica were being evaluated at different locations viz., Pedavegi (Andhra Pradesh), Palode (Kerala), Bheemanakoli (Karnataka) and Mulde (Maharashtra). During the year 2000, *dura* accessions were collected from indigenous sources namely, Tadepalligudem (Pune) and Andaman and Nicobar Islands and they are under preliminary evaluation. All the germplasm accessions collected are being evaluated for different traits of interest and their results are also discussed in this paper. National Research Centre for Oil palm is committed for the cause of expanding genetic resource of oil palm either through exchange or other means.

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SHORT COMMUNICATIONS

In vitro* Conservation of Exotic Mint Germplasm*Neelam Sharma, S Vimala Devi and Richa Satsangi***Tissue Culture and Cryopreservation Unit, National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110 012***Key Words:** Mint, Volatile Oil, *In vitro* Conservation

Mentha L. (Lamiaceae), commonly known as mint, is a taxonomically complicated genus that includes around 25 species of aromatic perennial and annual herbs apart from hybrids such as spearmint (*M. spicata*), peppermint (*M. piperita*) and threatened species of global conservation interest (*M. gattefossei* and *M. requienii*). The plant is a native of temperate and subtemperate regions of the world.

All *Mentha* species contain varying amount of volatile oils including menthol, and other isolates like menthone, piperitone, iso-menthone, methyl acetate, carvone, linalyl acetate and linalol. The mint oil has a fine odour and also it is an excellent carminative, antiseptic preservative and gastrostimulant. Hence, it has a diverse utilization commercially in herbal products as well as in flavouring of foods, beverages, tobacco, mouthwashes, dental creams and medicinal products. This wider range of utilization has led to extensive cultivation of *Mentha* in many parts of world. It is now widely cultivated in USA, Europe, South and South-east Asia and Latin American countries. The whole plant including the freshly sprouted flowering buds have been used for commercial extraction of volatile oils.

The USDA-ARS National Clonal Germplasm Repository, Corvallis maintains world's largest germplasm repository on *Mentha*. It consists of about 580 mentha accessions representing 40 taxa and 130 interspecific hybrids. The germplasm is being maintained as clonal-field grown, clonal-*in vitro* maintained or potted plants (Chambers and Hummer, 1992).

Mint germplasm including many cultivars, even the two commercial types-peppermints and spearmints are sterile. These are conventionally propagated vegetatively by running stolons and offshoots. Plant tissue culture is a unique technique for multiplication of true to type plants and maintains the integrity of the genotype. Mints have been amenable to *in vitro* technique, making *in vitro* propagation and conservation of germplasm, a

viable alternative to clonal field maintenance (Reed 1999, Tariqul Islam *et al.*, 2003). Tissue culture provides an easy and inexpensive way for international exchange of disease-free material.

One such international germplasm exchange, *Mentha* germplasm from USDA, Corvallis were received through germplasm exchange division, National Bureau of Plant Genetic Resources (NBPGR) in the form of *in vitro* collections and as live materials. From the live material, single nodal segments were surface sterilized (0.1% mercuric chloride for 7-10 minutes) and used for *in vitro* culture establishment. The material received as *in vitro* material was subcultured on Murashige and Skoog's 1962 (MS) medium supplemented with 0.5 mg/l of 6-benzyladenine (BA) and 0.1 mg/l of indole-3-butyric (IBA) for contamination free establishment. This was further subcultured using single nodes for initiation and maintained for 3 wks for establishment and to detect and eliminate contamination, if any. The cultures were maintained at 25 ±2°C under 16 h photoperiod (30 mmol/ m²/ s⁻¹) provided by cool white fluorescent lamps (Philips, Mumbai). As a part of long-term study, the healthy proliferating cultures after 3 wks were transferred to low temperature modules (4°C) for conservation. Periodic monitoring for survival of cultures was carried out.

A total of 22 accessions comprising EC 388948, EC 388950, EC 388951, EC 388953, EC 388955 to EC 388961, EC 388963, EC 388964, EC 388966 to EC 388969, EC 388971, EC 388972, EC 388974, EC 388978 and EC 388980 were established *in vitro*.

Twenty-two accessions of above mentioned exotic germplasm material were maintained in culture room by periodic subculture at 4-16 months interval. In the present study, low temperature incubation at 4°C without light has been found to be beneficial for mint conservation by prolonging subculture interval, as new sprouts were observed after 8-12 months. This study using slow growth technique by low temperature incubation has helped in conserving

twenty-two accessions of mint germplasm for eight years so far. In an earlier study, the beneficial effect of low temperature and diffused light on conservation of four mint species was reported (Reed 1999). The reduction of light intensity or total darkness in conjunction with low incubation temperature has been reported to effectively slow down the growth rate and enhance conservation period in many medicinal species (Chandel *et al.*, 1996, Sharma 2001). However, cold tolerant level may vary from species to species and accession to accession.

Plant tissue culture technique, besides its advantage in propagation and conservation, also has potential, if needed, to introduce genetic variability in mentha genotypes through somaclonal variations, wide hybridization (embryo rescue), somatic hybrids or transgenic plants. It is very important to conserve exotic germplasm with or without currently identified economically important traits. In India exotic mint germplasm has been utilized for crop improvement programme (Gupta, 1995). In this context, the conserved exotic germplasm of *Mentha* may serve as a nuclear material for utilization for genetic manipulation and crop improvement programme.

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Evaluating Germplasm Introductions of Underutilized Plants

RS Rath, HL Raiger, BS Phogat and RP Dua

National Bureau of Plant Genetic Resources, New Delhi-110 012

Key Words: Underutilized, Promising, Evaluation

Germplasm introduction is the key to diversifying the crop composition and broadening the genetic base of existing crops in any area. Germplasm introduction and evaluation has led to introduction of several new crops and improvement of the existing crops in India. 3361 accessions of different underutilized plants have been introduced during the last fifty years (RC Agrawal, Personal Communication). Maximum introductions were made in faba bean (1016), followed by those in amaranth (645), su-babool (488), chenopods (216) and jojoba, in the descending order. Most of the accessions came from USA (1205), Syria (360), Australia (252), UK (180), Bulgaria (188) and Germany (154).

Evaluation of the introductions of underutilized plants under the aegis of All India Coordinated Research Project on Underutilized Crops led to identification of 395 promising lines (Anon. 2004), mainly in adzuki bean (92), winged bean (68), amaranth (72) and rice bean (53). Four of the promising lines were released for cultivation. Two new plants, namely, jojoba and paradise tree were adopted for cultivation. Project on cultivation and oil extraction has been taken up by Government of Rajasthan while paradise tree has been adopted by NOVOD Board and the Departments of Forest of Tamil Nadu, Karnataka, Orissa and Maharashtra for large scale cultivation. Seeds of jojoba contain 45 per cent oil suitable

twenty-two accessions of mint germplasm for eight years so far. In an earlier study, the beneficial effect of low temperature and diffused light on conservation of four mint species was reported (Reed 1999). The reduction of light intensity or total darkness in conjunction with low incubation temperature has been reported to effectively slow down the growth rate and enhance conservation period in many medicinal species (Chandel *et al.*, 1996, Sharma 2001). However, cold tolerant level may vary from species to species and accession to accession.

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Table 1. Introductions of underutilized plants and promising lines identified

S.No.	Botanical Name	Total No. of accessions	Sources	Promising lines
1	Amaranth (<i>Amaranthus</i> spp.)	645	Kenya (35), Nigeria (48), Russia (41), USA (342)	72, Suvarna*
2	Buckwheat (<i>Fagopyrum</i> spp.)	134	Hungary (23), Japan (30), Nepal (29), USA (17), USSR (17)	30
3	Chenopods (<i>Chenopodium</i> spp.)	216	Germany (24), Nepal (15), UK (28), USA (89)	17
4	Job's tear (<i>Coix lachryma</i>)	17	Brazil (2), Japan (5), USA (3)	
5	Winged bean (<i>Psophocarpus tetragonolobus</i>)	183	New Papua Guinea (26), Philippines (21), Thailand (59), USA (17)	88
6	Adzuki bean (<i>Vigna angularis</i>)	101	Belgium (7), Colombia (5), Nigeria (11), USA (73)	92
7	Rice bean (<i>Vigna umbellata</i>)	79	Belgium (6), Brazil (5), Colombia (5), Indonesia (8), USA (53)	53
8	Broad bean (<i>Vicia faba</i>)	1016	Bulgaria (155), Germany (130), Italy (120), Syria (360), USA (98)	36
9	Paradise tree (<i>Simarouba glauca</i>)	5	El Salvador (2), Italy (1), UK (1), USA (1)	1
10	Perilla (<i>Perilla frutescence</i>)	2	Japan (1), Hungary (1)	1
11	Bitter apple (<i>Citrullus colocynthis</i>)	12	USA (9)	
12	Water melon (<i>Citrullus lunatus</i>)	138	Denmark (3), Taiwan (13), USA (117)	
13	Salt bush (<i>Atriplex</i> spp.)	36	Australia (5), France (4), Israel (4), USA (15)	3
14	Bamboo (<i>Bambusa</i> spp.)	2	Japan (2)	
15	Horse tail tree (<i>Casuarina equisetifolia</i>)	25	Australia (8), USA (11)	
16	Su-babool (<i>Leucena leucocephala</i>)	488	Australia (139), UK (132), USA (172)	
17	Cuphea (<i>Cuphea wrightii</i>)	32	USA (32)	
18	Euphorbia (<i>Euphorbia</i> spp.)	30	Mexico (3), Spain (8), USA (15)	
19	Jatropha (<i>Jatropha curcas</i>)	2	Ghana (1), Nigeria (1)	
20	Guayule (<i>Parthenium argentatum</i>)	28	USA (28)	1, Arizona-2*
21	Jojoba (<i>Simmondsia chinensis</i>)	170	Australia (1), Israel (2), UK (1), USA (166)	1, EC 33198*
Total		3361		395

* Released for cultivation

for use as a lubricant in high pressure machinery and is a substitute for sperm whale oil. On the other hand, kernels of paradise tree contain 55 to 60 per cent edible oil, quality of which is comparable to that of groundnut.

A summary of germplasm introductions and

promising lines identified for cultivation is presented in the Table 1.

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Quality Evaluation of Some Exotic Lines of *Ocimum* Germplasm

Poonam Suneja, Jitendra Mohan, Ashok Kumar, DS Pillania and SK Pareek

National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110 012

Key Words: Basil, Volatile Oil, Hydro-distillation, Evaluation

Ocimum belongs to family *Lamiaceae* and is commonly known as basil. It is distributed in the tropical and warm temperate regions of the world. Ten exotic lines of *Ocimum basilicum* have been introduced from various countries.

Ocimum oils are classified on the basis of their chemical composition rather than by their botanical origin. Sweet basil aromatic in nature yields a volatile oil which is used as flavouring agent and also as a perfumery material. The fragrant leaves are used for flavouring sauces, salads and soups.

The above ten accessions have been studied for

their qualitative and quantitative parameters (essential oil content, physico-chemical properties and aroma constituents by GC.). These germplasm were grown in 2003-2004 at Issapur experimental station of NBPGR, New Delhi.

Fresh material of all these accessions was subjected to hydro-distillation using Clevenger's apparatus, at NBPGR, New Delhi. The essential oils so obtained were dried over anhydrous Na_2SO_4 . The oil percentage of ten accessions varied from 0.09 to 0.16 percent on dry weight basis.

These dried oils were studied for their physico-chemical properties and further analysed for their aroma

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constituents over Gas Liquid Chromatograph (GLC) model Perkin Elmer Auto System equipped with capillary column Carbowax 20M of 50 m length, Flame ionization detector, Okidata 320 M recorder, Digital computer DEC station fed with Total Chrome Navigator software and nitrogen as carrier gas in the chemical laboratory of NBPGR, New Delhi. Volatile aroma constituents were identified on the chromatogram by comparing their retention time with authentic compounds. Based on the chemical composition several chemotypes were identified (Pareek *et al* 1982 and Sobti and Pushpangadan, 1982) Physico- chemical constants were also studied. These were found to be in the prescribed range.

On the basis of major aroma constituents, the germplasm were grouped into different chemotypes (AICRP, 1998). On the same basis, basil oils have been grouped together into three chemotypes *i.e.* European type (rich in methyl chavicol), linalool rich and methyl chavicol and linalool rich. GC profile of ten accessions showed the presence of above-mentioned chemotypes as given below.

Linalool Rich

EC-174527 (methyl chavicol-0.38 %, linalool-67.13%), EC-388772 (methyl chavicol-16.37%, linalool-60.72%), EC-338782 (methyl chavicol-14.23%, linalool-32.48%), EC-387838 (methyl chavicol-4.53%, linalool-73.63%)

and EC-338794 (methyl chavicol-4.57%, linalool-74.87%).

Methyl Chavicol Rich

EC-338785 (methyl chavicol-89.32%, linalool-1.14%) and EC-388890 (methyl chavicol-67.28 %, Linalool-26.99%)

Methyl Chavicol and Linalool Rich

EC388893 (methyl chavicol (42.16%, linalool-47.12%), EC-388788 (methyl chavicol-47.88%, linalool-38.65%) and EC-388891 (methyl chavicol-48.1%, linalool-37.59%).

The above study reveals that these accessions find use in perfumery and flavour industry. The accessions rich in methyl chavicol may find use in flavour and confectionery industry where as linalool rich germplasm can be useful in perfumery industry

References

- Pareek SK, R Gupta and ML Maheshwari (1982). A Eugenol Rich Sacred Basil (*Ocimum sanctum* L.) its Domestication and Industrial Utilization. *Pajai journal* 13-17.
- Sobti SN and P Pushpangadan (1982) Studies on the genus *Ocimum*, Cytogenetics, Breeding and Production of New Economic Importance: In: CK Atal and BM Kapoor (Ed.) *Cultivation and Utilization Aromatic Plants*, R.R.L. 47-48.
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Augmentation and Evaluation of *Sesbania* Germplasm

S Sardana, Vandana Joshi, Vimal Prakash, and RV Singh

National Bureau of Plant Genetic Resources, New Delhi-110 012

The role of green manuring in improving soil fertility and crop productivity is well recognized. *Sesbania* is one of most important green manuring crop and is biodegradable, eco-friendly and organic rich bio-fertilizer. It belongs to family Fabaceae tribe Robineae. It is a versatile leguminous crop, distributed in tropical and subtropical areas of Indian sub-continent and also distributed in tropical areas of Africa, Southeast Asia, China and West Indies.

In the present study, 159 accessions belonging to 32 species of *Sesbania* were introduced from Australia; Brazil; CIAT, Columbia; Ethiopia; and IRRI, Philippines, have enriched genetic resources of *Sesbania*. Species of *Sesbania* augmented were *S. aculeata*, *S. afraspera*,

S. bispinosa, *S. campylocarpa*, *S. cannabina*, *S. cinerascens*, *S. coerulescens*, *S. emerus*, *S. erubescens*, *S. exaltata*, *S. exasperata*, *S. formosa*, *S. goetzei*, *S. grandiflora*, *S. greenwayi*, *S. herbacea*, *S. hiristyla*, *S. keniensis*, *S. leptocarpa*, *S. macrantha*, *S. microphylla*, *S. nilotica*, *S. pachycarpa*, *S. punctata*, *S. quadrata*, *S. rostrata*, *S. sericea*, *S. sesban*, *S. simpliaiuscula*, *S. speciosa*, *S. tetraptera*, *S. virgata*. Some of the lines introduced from Ethiopia are with high nitrogen (*S. cannabina*, EC 507726 and *S. rostrata*, EC507727) and with profuse nodulation (*S. afraspera*, EC507728 and *S. nilotica*, EC 507729). Some of the species (*S. virgata*, *S. sesban* var. *sesban*, *S. sesban* var. *bicolour*) introduced from Brazil are perennial in nature.

constituents over Gas Liquid Chromatograph (GLC) model Perkin Elmer Auto System equipped with capillary column Carbowax 20M of 50 m length, Flame ionization detector, Okidata 320 M recorder, Digital computer DEC station fed with Total Chrome Navigator software and nitrogen as carrier gas in the chemical laboratory of NBPGR, New Delhi. Volatile aroma constituents were identified on the chromatogram by comparing their retention time with authentic compounds. Based on the chemical composition several chemotypes were identified (Pareek *et al* 1982 and Sobti and Pushpangadan, 1982) Physico- chemical constants were also studied. These were found to be in the prescribed range.

On the basis of major aroma constituents, the germplasm were grouped into different chemotypes (AICRP, 1998). On the same basis, basil oils have been grouped together into three chemotypes *i.e.* European type (rich in methyl chavicol), linalool rich and methyl chavicol and linalool rich. GC profile of ten accessions showed the presence of above-mentioned chemotypes as given below.

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Wide range of variability was observed for plant vigour, plant height, leaf size, pod length, seed colour, seed size and seed shape. A high variability was also observed for green manuring traits such as green biomass (0.43-1.27 kg/ m), dry biomass (0.068-0.35 kg/ m), plant height (39.79-112.29 cm), number of root nodules per plant (28.51-71.69) and fresh weight of nodules per plant (0.43-1.86 g) at 45 days after sowing (DAS). Similarly wide variability was observed at 60 DAS for green biomass (0.83-4.48 kg/m), dry biomass (0.24-0.72 kg/m), plant height (109.62-189.23 cm), number

of root nodules per plant (37.08-97.75) and fresh weight of nodules per plant (0.57-2.67 g). Promising accessions identified were EC435745 (*S. punctata*), EC435741 and EC435738 (*S. cannabina*) for high green biomass, dry biomass, high plant height with high vigour, and moderate number of stem nodules and fresh weight of root nodules per plant. Some of accessions namely, EC466704 (*Sesbania* sp.), EC466898 (*S. cannabina*) and EC509444 (*S. virgata*) possessed high number of root nodules per plant and fresh weight of nodules per plant at 45 as well as 60 DAS.

Current Status and Future Opportunities of Introduced Cymbidium Hybrids in India

Syamali Chakrabarti

National Research Centre for Orchids, Pakyong-737 106, Sikkim

Key Words: Cymbidium Hybrids, Introduction, Plant Quarantine

Introduction Cymbidium hybrids are prized for their sprays of long lasting large attractive flowers and play an important role in the orchids trade as cut flowers. It occupies the seventh position out of top ten cut flowers of international trade. More than 1,25,000 hybrids have been registered with an average of 10,000 or more every year). In pre-independence era, a good number of cymbidium hybrids were introduced in India from England and America by the tea planters, hobby growers and foreign tourists in some part of West Bengal (Darjeeling district), Sikkim, Meghalaya and other north eastern region where the climatic condition is congenial for growing cymbidiums. There are three types of cymbidium hybrids for trade-standard, miniature and novelty (which are sometimes called intermediate.)

Standard hybrids grow into large plants and available in almost every colour except blue. Miniature hybrids have been bred from dwarf species of cymbidiums and colour range is limited to green, yellow or brown. All cymbidium hybrids are wonderful performers. In general standard and novelties bloom from January to the middle of May whereas miniature bloom from November to March.

Current Status

Though India has introduced a good number of hybrids, and has favourable climate, low cost of labour and progressive technology cymbidium orchid industry is not even in the infant stage both in terms of micropropagation and large-scale commercial cultivation. Many of the hybrids introduced in 1930's-80's are now old and obsolete and grown as hobby by the growers.

Recently in Arunachal Pradesh near about 25 cymbidium hybrids were introduced by state forest research institute (SFRI) with collaboration of WWF India under the leadership of Dr. SN Hegde for large scale propagation in tissue culture laboratory and cultivation in different parts of the state like Ziro Hapoli, Bomdilla, Tawang, Dirang etc where climate is suitable for cymbidiums and registered for trade for cut flowers and orchids plants involving the tribal people of these areas. Some promising hybrids growing in these areas are Cascade, Golden Fleece, Mieke Nederhorst, Molly, No. 60, etc.

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The state tissue culture laboratory, Department of Horticulture, Govt of Sikkim is also propagating seven introduced hybrids in large-scale distribution to growers under technology mission. State Horticulture Department is also introducing two promising hybrids for propagation in its tissue culture laboratory.

Other introduced hybrids are under cultivation by some hobby growers and progressive nursery people in Sikkim, Darjeeling, Kalimpong, Shillong and adjacent areas for hobby growing and selling as plant materials.

Bottlenecks in India

Although there is a great potential for cultivation of cymbidium hybrids in the northeastern region and there exist a lucrative market both within the country and abroad the enthusiasm of further introduction of newly developed hybrids is lacking due to the complex quarantine procedures for introduction of planting materials, high import duties on floriculture planting materials, non availability of suitable introduced cymbidium hybrids with requisite characters for trade, lack of technology for commercial multiplication, lack of post harvest handling technology for cut flower export and lack of incentives, appropriate policies for exporters and commercial approach in cultivation.

Conclusion

Cymbidium hybrids by virtue of their unique position in cupflower trade are expected to be in limelight with its demand growing more than that of other cut flower.

Although the major aim for the development of cymbidium orchid industry in India should be export oriented, the domestic market should not be neglected as the demand for cut flower is likely to increase in the coming days. Further action needs to be taken in the following lines:

- i) Introduction of suitable modern hybrids considering the market demand.
- ii Instead of depending totally on the foreign hybrids it is better to take planned breeding programme by the Govt. and private research institutes, universities, and NGOs for developing quality hybrids.
- iii) The procedure for the introduction of hybrids should be simplified and the import of hybrids can be done easily with a through study.

Considering the above facts well planned programme may be taken by the Organization like national research centre for orchids (NRCO), National Horticultural Board (NHB), State Department of Horticulture of North Eastern States, NGOs and other private organization to popularize the large scale cultivation by introducing quality hybrids.

Introduction, Evaluation and Economical Potential of *Pogostemon cablin* Benth. in J&K (India)

Kanti Rekha, MK Bhan, AK Dhar and SS Balyan

Plant Breeding and Crop Husbandry Division, Regional Research Laboratory, Canal Road, Jammu Tawi-180 001 (Jammu & Kashmir)

Key Words: *Pogostemon cablin*, Patchouli oil, Introduction, Jammu

Pogostemon cablin Benth. (Lamiaceae) is an important aromatic plant and its dried herb on steam distillation yields light yellow coloured essential oil known in trade as Patchouli oil. It ranks high among essential oils and is used extensively in perfumery and cosmetics. Currently, Indonesia is the largest producer in the world with a production exceeding 1500 tonnes of oil. India is producing a very meager quantity of patchouli oil and

is importing about 50 tons of pure patchouli oil besides 100 tonnes of formulated oil. In order to promote indigenous production of patchouli oil, efforts have been made to introduce and evaluate patchouli under sub-tropical climate of Jammu (J&K) region. Its first introduction and domestication attempts were taken up at RRL, Jammu in 2000. Five years data revealed that patchouli could be cultivated in Jammu as a perennial

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crop under partial shade, in well-drained fertile soils and with assured irrigation during pre- and post-monsoon periods. It thrives well in different agro-ecological situations of Jammu with a temperature ranging from 5° to 35°C and annual rainfall ranging between 100-110 cm. It shows luxuriant growth with the advent of monsoon coupled with high temperature and high humidity. Maximum yields are obtained when the temperature during growth is around 28-30°C and an average humidity of 75 percent. Results show that it can grow successfully and produces quality leaves for at least three years. Best time for raising rooted cuttings is August-September with about 90-95 percent success. Shade is essential for raising nursery. Stem cuttings selected from healthy nematode free bushes 10-12 cm length, with terminal bud and a crown of 2-3 leaves

are suitable. These become ready for transplantation in about 8-10 weeks. The first harvest of the crop is obtained after about 5 months of transplanting and subsequent harvests are done after every 2 months depending upon the crop maturation. The yield of the oil from shade-dried leaves varies from 2.5-3.0 percent. The crop yields about 2t/annum of dry leaves and about 50-60kg/ ha of oil. For encouraging commercial production, efforts are underway to develop high oil yielding varieties, low cost agro-technologies, harvest management, distillation technology for better recovery of oil, accessible market facilities to farmers and oil purification to meet the market standard. Its commercial cultivation will create employment avenues to rural communities, also providing scope for increasing oil production and hence reducing the imports.

Recent Trends in Spice and Herbal Industry

Veena Gupta

Senior Scientist, National Bureau of Plant Genetic Resources, New Delhi-110 012

Key Words: Spices, Herbs, Introduction

Indian spices and herbs are the prime sources of the fabulous wealth and prosperity. There are more than 100 plant species grown in India which accounts for approximately 8% of the global trade in these commodities. History of usage of spices and herbs goes back to 3000 BC when most of these plants were used for embalming, perfumery, poison antidotes, cosmetics and medicines. Great voyages of Vasco-de- Gama and Columbus resulted in the introduction of many spices and herbs including chillies, vanilla, cinnamon and many aromatic plants. Black pepper was the first to enter into international trade. As a result, spices and herbs of all kind are now available worldwide for sale in global market. India occupies the leading position in international trade as exporter while Japan, USA and European Union are the leading spice and herb importers.

Five species viz., black pepper, capsicum, cinnamon, ginger, turmeric and their derivatives accounts for the major international market share but there are many more in the list. China and Vietnam are the major producers and exporters of the star anise. Indian cardamoms are still considered to be of the superior

quality in global market. India and Guatemala are the world's largest producers of cardamom. Cinnamon has been introduced in many tropical countries but commercial cultivations are confined to India, Indonesia, Srilanka and Malaysia. Cumin is another herb where India leads the market.

Realizing the importance of these plants, National Bureau of Plant Genetic Resources, New Delhi has made efforts in introduction of promising germplasm from source countries. These introductions have contributed more genetic variability in terms of yield potential and disease resistance. A Bulgarian cinnamon cultivar S-33, for high oil content and coriander-2 for more secondary branches, large umbel, bold and yellow green seed was introduced. In Cumin cv VC-19 for yield and cv Cumin-1 with bold seeds, resistant to wilt and *alternaria* blight was introduced. Ginger free from nematode infestation from Indonesia are few other examples.

Similarly in *Mentha piperata* (EC41911) procured from Russia with high herbage yield, 0.5% essential oil and 60 percent menthol content has been released

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for cultivation. EC291748 in saffron from Italy and EC217012 in *Matricharia chammomila* from Romania for green herbage and high essential oil and *Thymus vulgaris* (EC207655) from USA as a good source of oil thyme and thymol. A large number of basil genotypes for different traits have been introduced from France. These include linalool genotypes EC176934, methyl-chavicol genotypes EC338781-338775 and 338778, methyl-cinnamate genotypes EC312264 and eugenol genotypes EC-282721. *Satureja hortensis* (EC328517)

from Iran and *Pimpinella anisum* anethol rich lines (EC-22091) from France are among new introductions. Many of these are successfully adopted in the Indian agricultural system. National Bureau of Plant Genetic Resources, New Delhi has also entrusted with the responsibility of conserving this biological wealth. It has established a National Gene Bank which has a seed gene bank, a tissue culture repository and a cryo-bank. All the available germplasm of potential crops is being stored at national gene bank.

ABSTRACT

Potential Genetic Resources of *Salicornia*

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Salicornia bigelovii an annual C3, leafless halophyte is a potential sea resource irrigated edible oil crop. Due to its highly salt tolerant nature, it is grown in coastal desert areas with direct seawater irrigation. *Salicornia* seed contained high level of oil (26-32 percent) and more or less similar to safflower and sunflower in edible qualities. Seed meal had 35 to 40% protein with 0.05 percent saponins and could replace soybean meal used in poultry industry. Straw of *Salicornia* is rich in lignin and salt. It can be used in making fire logs, particle boards and paper. Straw is also used as animal fodder on blending with other fodder(s). At vegetative growth stage growing parts of plants are harvested and used as green vegetable and salad.

Based on decades of intensive research work done in Mexico, United States of America, Eritrea and other parts of the world, new varieties have been developed with seed yield potential of 2.5 to 2.8 tonnes per hectare. The performance of salicornia may further be increased with the development of hybrid varieties by exploiting male sterility system.

Looking into challenges from population growth, fast depletion of underground fresh water and shortage of edible oil, salicornia appears to be potentially valuable new oilseed crop for subtropical coastal desert areas of the world. Thus the possibilities of inbreeding and evolving these elite materials have to be explored.

for cultivation. EC291748 in saffron from Italy and EC217012 in *Matricharia chammomila* from Romania for green herbage and high essential oil and *Thymus vulgaris* (EC207655) from USA as a good source of oil thyme and thymol. A large number of basil genotypes for different traits have been introduced from France. These include linalool genotypes EC176934, methyl-chavicol genotypes EC338781-338775 and 338778, methyl-cinnamate genotypes EC312264 and eugenol genotypes EC-282721. *Satureja hortensis* (EC328517)

from Iran and *Pimpinella anisum* anethol rich lines (EC-22091) from France are among new introductions. Many of these are successfully adopted in the Indian agricultural system. National Bureau of Plant Genetic Resources, New Delhi has also entrusted with the responsibility of conserving this biological wealth. It has established a National Gene Bank which has a seed gene bank, a tissue culture repository and a cryo-bank. All the available germplasm of potential crops is being stored at national gene bank.

ABSTRACT

Potential Genetic Resources of *Salicornia*

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Salicornia bigelovii an annual C3, leafless halophyte is a potential sea resource irrigated edible oil crop. Due to its highly salt tolerant nature, it is grown in coastal desert areas with direct seawater irrigation. *Salicornia* seed contained high level of oil (26-32 percent) and more or less similar to safflower and sunflower in edible qualities. Seed meal had 35 to 40% protein with 0.05 percent saponins and could replace soybean meal used in poultry industry. Straw of *Salicornia* is rich in lignin and salt. It can be used in making fire logs, particle boards and paper. Straw is also used as animal fodder on blending with other fodder(s). At vegetative growth stage growing parts of plants are harvested and used as green vegetable and salad.

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SHORT COMMUNICATIONS

Plant Quarantine Measures to Prevent Nematode Spread among South Asian Countries

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Key Words: Nematodes, Risk Analysis, Pest Free Areas, Regionalization

On an average 60 to 70 thousand samples of various agri-horticultural crops in the form of true (orthodox) seeds, vegetative propagules (rooted cuttings, underground plant parts like rhizomes, tubers, bulbs, suckers and tissue cultured materials) are imported, into India for research purposes. Each sample is processed for detection of nematodes using general as well as specialized nematological techniques.

Information on the interception of nematodes along with germplasm under exchange, plant parasitic nematodes of quarantine significance, in the region, was compiled and analyzed for risk involved in the exchange of seed and planting material for the countries (Bangladesh, Bhutan, India, Maldives, Nepal and Sri Lanka) of the South Asian Region. Among the 116 highly pathogenic plant parasitic nematodes known around the world, so far only 55 are recorded from the region. Out of nematode data recorded, 53 species are reported from India, 22 from Sri Lanka, 15 from Bangladesh, 7 from Nepal and one species each from Bhutan and Maldives. Several species that are reported from India are either not known to occur in other countries of the region or might be present but not surveyed and studied yet. Under the prevailing circumstances and similar climatic conditions, quarantine measures to prevent the spread within the region, of nematode pests like *Anguina tritici*, *Aphelenchoides fragariae*, *A. ritzemabosi*, *Ditylenchus angustus*, *Globodera pallida*, *G. rostochiensis*, *Radopholus similis* and *Tylenchulus semipenetrans* are suggested.

The nematode species not known to occur in the region viz., *Aphelenchoides arachidis*, *Belonolaimus longicaudatus*, *Bursaphelenchus xylophilus*, *Ditylenchus dipsaci*, *Globodera tabacum*, *Heterodera glycines*, *H. schachtii*, *Hoplolaimus pararobustus*, *Meloidogyne coffeicola*, *Nacobbus aberrans*, *Pratylenchus neglectus*, *Punctodera punctata*, *Radopholus citri*, *Rhadinaphelenchus cocophilus*, *Rotylenchus robustus*,

Trichodorus similes and *Xiphinema diversicaudatum* are of greater quarantine interest and need to be handled with highest caution. The listed nematodes require joint regulations and measures to maintain the status quo. To prevent crop losses and nematode pest multiplication, demarcation of clean areas and further all exchanges of seeds/ planting material from clean areas are emphasized.

The quarantine significance of vegetative propagules is highlighted by the fact that almost all underground plant parts exchanged (if not treated suitably with nematicide at the port of export) have been observed to carry several species of nematodes (Rajan and Arjun Lal, 2004). The nematodes tend to survive under the moist and cool packing conditions of air transport. The observations have been more so where some soil has also been transported along with the material (Mathur *et al.*, 1981). The true seed borne, white tip nematode (*Aphelenchoides besseyi*) has been intercepted repeatedly from *Oryza sativa* as it has spread world wide along with the seeds (Mathur and Lal, 1989).

The association of nematodes with the true seeds and foliage is poorly investigated as routine studies in most Nematology are confined to extraction of nematodes from soil or from roots. Two hosts (*Fraxinus americana* and *Stylosanthes hamata*) have been recorded as new hosts, that too from the true seeds (Gokte *et al.*, 1989; 1990). Seeds of graminaceous crops and their wild relatives; foliage of imported plants should be given due attention as their examinations revealed presence of nematodes (Lal and Mathur, 1988 b).

In certain instances, previously unrecorded nematode species from the country of export (origin) was found to be associated with imported germplasm. For example, *Heterodera zae* was intercepted from rooted plants of *Vetiveria zizanioides* imported from the Republic of Tanzania (Lal and Mathur, 1988 a; Lal *et al.*, 1990). Similarly *Tylenchorhynchus neoclavicaudatus* was

intercepted from washings of potato tubers imported from USA (Mathur *et al.*, 1978) and *Polenchus minutus* from palm plants imported from UK (Lal and Mathur, 1995). Interception of nematodes even from small quantities (a few grams of seed or a few days old rooted plants/bulbs etc) suggest that import of seeds/planting material in bulk for propagation need to be reviewed and suitably amended to prevent the introduction and spread of exotic nematodes.

All the interceptions listed are from the plant material accompanied with phytosanitary certificates from the quarantine authorities of countries of their export. Therefore there is an imperative need to strengthen quarantine facilities, rules and regulations to meet the growing challenge.

It is concluded that due to cumbersome nature of the nematodes and detection techniques involved, imports of plants and seeds of hosts from countries where the nematodes of quarantine importance occur, should be restricted to areas registered as the 'particular nematode free areas'. Stem cuttings should be preferred (for exchange) as compared to rooted cuttings or vegetative propagules. The exchange of tissue cultured planting materials is not always safe as the nematode contamination could also proliferate on cultured plant parts and may get exchanged.

Interception of plant parasitic nematodes and specially the one having wide host range and several races, in the imported consignments, emphasize the need to conduct a thorough and critical examination of all material under exchange. Adequate provisions are required for dealing with nematodes in plant quarantine regulations of each country of the region. Regulatory nematology

laboratories need to be established for detection, identification and generating data on nematode distribution. Need of facilities required for treatment of infested material should be taken with urgency.

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***Fusarium solani* (Mart.) Sacc. Intercepted in Introduced Germplasm during Last Twenty-five Years**

PC Agarwal, Baleshwar Singh, Usha Dev, Indra Rani, KD Joshi and RK Khetarpal

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Key Words: *Fusarium solani*, Interception, Quarantine

The international collaboration and free exchange of germplasm for utilization in crop improvement has played a key role in achieving self-sufficiency in the

food production. However, this exchange has been responsible for spread of many seed-borne pathogens to newer areas. In order to prevent the entry of new

intercepted from washings of potato tubers imported from USA (Mathur *et al.*, 1978) and *Polenchus minutus* from palm plants imported from UK (Lal and Mathur, 1995). Interception of nematodes even from small quantities (a few grams of seed or a few days old rooted plants/bulbs etc) suggest that import of seeds/planting material in bulk for propagation need to be reviewed and suitably amended to prevent the introduction and spread of exotic nematodes.

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Interception of plant parasitic nematodes and specially the one having wide host range and several races, in the imported consignments, emphasize the need to conduct a thorough and critical examination of all material under exchange. Adequate provisions are required for dealing with nematodes in plant quarantine regulations of each country of the region. Regulatory nematology

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***Fusarium solani* (Mart.) Sacc. Intercepted in Introduced Germplasm during Last Twenty-five Years**

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The international collaboration and free exchange of germplasm for utilization in crop improvement has played a key role in achieving self-sufficiency in the

food production. However, this exchange has been responsible for spread of many seed-borne pathogens to newer areas. In order to prevent the entry of new

racers or virulent isolates along with seeds and vegetative propagules, a systematic examination of the introduced material constitutes an essential component of plant quarantine.

The National Bureau of Plant Genetic Resources, New Delhi received about 60,000 samples in the form of true seeds, vegetative propagules or tissue culture plants of various crops each year for quarantine clearance. All the samples were first subjected to visual examination and then to blotter test for the detection of seed-borne fungi. As a result of critical examination, a large number of pathogenic species belonging to *Puccinia*, *Tilletia*, *Fusarium*, *Colletotrichum*, *Drechslera* etc. were intercepted (Khetarpal *et al.*, 2001).

The genus *Fusarium*, commonly known as wilt fungi causes severe crop losses in cereals, pulses, vegetables, ornamentals, plantation crops, etc. Various species of *Fusarium* viz., *F. nivale*, *F. oxysporum*, *F. solani*, *F. culmorum*, *F. moniliforme* and *F. avenaceum* were intercepted on various crops (Agarwal *et al.*, 2001).

Fusarium solani (Mart.) Sacc., the causal organism of damping-off, foot rot and stem canker has a very wide host range, affecting crops belonging to 65 families. The fungus can be carried within the seed, root, stem, tubers, corms, rhizomes and bark. Richardson

(1990) has reported the fungus to be seed-borne in 45 crops.

F. solani was intercepted on 93 crops from 43 countries as listed in Table 1. It was detected as seed-borne on 65 new crops for the first time. Among the South Asian countries, the fungus was intercepted on seeds of *Corchorus* spp., *Cucurbita* spp., *Hibiscus cannabinus* and *Solanum melongena* from Bangladesh; *Quinoa* sp. and *Solanum* spp. from Nepal and *Annona* spp. cuttings and *S. melongena* from Sri Lanka.

F. solani causes substantial economic losses in various crops worldwide. Foot-rot syndrome in legumes has been reported as a major limiting factor to crop production causing substantial yield losses in pea and bean crops in Europe and North America. Sudden death syndrome (SDS) of soybean, an important disease in the southern USA is now becoming more prevalent and severe in northern states also (Scherer and Yang, 1996). Lima and Lopes (1998) reported different levels of aggressiveness between isolates of *F. solani* that attack potato in Brazil. Recent molecular studies also have revealed high levels of diversity within the fungus (CABI, 2003).

Interception of *F. solani* in 93 crop species from various parts of the world is very significant from quarantine view point as even a low incidence of seed-

Table 1. *Fusarium solani* intercepted in introduced germplasm during last twenty-five years

Crop	Source	Crop	Source
<i>Abutilon</i> sp.*	USA	<i>Cuphea</i> sp.*	USA
<i>Acacia</i> spp.*	Australia	<i>Datura alba</i> *	Hungary
<i>Aegilops</i> sp.*	Germany, USA	<i>Daucus carota</i> *	USA
<i>Aeschynomene</i> sp.*	Australia	<i>Digitalis viridiflora</i> *	Italy
<i>Agaves</i> spp.*	USA	<i>Digitaria</i> sp.*	USA
<i>Allium</i> sp.	Egypt, Germany	<i>Echallium elaterium</i> *	Japan
<i>Aloe</i> sp.*	Australia	<i>Elaeis guineensis</i> *	Zambia
<i>Amaranthus</i> sp.*	Taiwan	<i>Eleusine</i> spp.*	UK, Zambia, Zimbabwe
<i>Annona</i> spp.*	Australia, Sri Lanka	<i>Enterolobium cyclocarpum</i> *	USA
<i>Berberis vulgaris</i> *	France	<i>Eucalyptus</i> sp.*	Australia
<i>Beta vulgaris</i>	Canada, Denmark, Germany, Hungary, Iran, Poland, Sweden, USA	<i>Flemingia congesta</i> *	Nigeria
<i>Brassica</i> spp.*	Canada, China, Denmark, France, Sweden, Taiwan, UK	<i>Gliricidia</i> sp.*	UK
<i>Calliandra</i> sp.*	Nigeria	<i>Glycine max</i>	Poland, Taiwan, USA, USSR
<i>Capsicum</i> spp.	Costa Rica, Czechoslovakia, France, Israel, Italy, Hungary, Nigeria, Romania, Taiwan, UK, USA, USSR	<i>Gossypium</i> spp.	Australia, USSR
<i>Carica papaya</i> *	Australia, Venezuela	<i>Grossularia</i> sp.*	USSR
<i>Carthamus tinctorius</i> *	Germany, Singapore, Turkey, USA	<i>Guizotia abyssinica</i> *	Australia
<i>Casuarina</i> spp.*	Australia	<i>Helianthus annuus</i> *	Australia, Bulgaria, Canada, Germany, Italy, USA
<i>Centrosema</i> spp.*	Australia	<i>Hibiscus cannabinus</i>	Bangladesh, Brazil, UK, USSR
<i>Cicer arietinum</i>	USA	<i>Hordeum</i> spp.	Italy
<i>Corchorus</i> spp.*	Bangladesh	<i>Ipomoea batatas</i> *	Taiwan, USA
<i>Crescentia</i> sp.*	UK	<i>Jasminum</i> sp.*	UK
<i>Crotalaria juncea</i>	USA	<i>Lathyrus</i> sp.*	Syria
<i>Cucumis melo</i>	USA	<i>Lavandula vega</i> *	Bulgaria
<i>Cucurbita</i> spp.	Bangladesh, Mauritius, USA	<i>Lagenaria</i> sp.*	UK
		<i>Lens culinaris</i>	Syria, UK
		<i>Lesquerella</i> sp.*	USA
		<i>Leucaena leucocephala</i> *	UK (Table 1 Contd.)
		Crop	Source

Table 1. (Contd.)

<i>Limnanthes alba</i> *	USA	<i>Pyrus</i> spp.*	USA
<i>Lotus tenuis</i> *	USA	<i>Psophocarpus tetragonolobus</i> *	Canada
<i>Luffia acutangula</i> *	UK	<i>Quinoa</i> sp.*	Nepal
<i>Lycopersicon esculentum</i>	Taiwan, USA	<i>Rosa</i> spp. *	Netherlands
<i>Macrotyloma uniflorum</i> *	Ethiopia	<i>Rumex acetosa</i> *	France
<i>Manihot</i> sp.*	Brazil	<i>Sesamum</i> spp.	Israel, Thailand
<i>Manisuris sellona</i> *	USA	<i>Setaria</i> sp.*	USSR
<i>Medicago</i> spp.*	Australia, Hungary, USA	<i>Spinacea oleracea</i> *	USSR
<i>Medicus</i> sp.*	USA	<i>Solanum melongena</i>	Bangladesh, Japan, Sri Lanka, USA
<i>Melilotus alba</i>	Taiwan, USSR	<i>S. tuberosum</i>	Peru
<i>Mentha arvensis</i> *	France, Vietnam	<i>Solanum</i> spp.	Nepal
<i>Ocimum</i> spp. *	Germany	<i>Sorghum</i> spp.	USA
<i>Oryza sativa</i> *	Philippines	<i>Stylosanthes</i> spp.*	Brazil, Australia, USA
<i>Panicum</i> spp.*	USSR	<i>Trifolium</i> spp.	Australia, USA
<i>Paspalum veginatum</i> *	Australia	<i>Triticum</i> spp.	Italy, Sweden, USA
<i>Pennisetum typhoides</i>	Zimbabwe	<i>Vigna</i> spp.	Taiwan, Thailand
<i>Phaseolus aconitifolius</i>	Taiwan, USA	<i>V. unguiculata</i>	Australia, Brazil, Italy, Nigeria, Taiwan, USA
<i>Piper nigrum</i> *	Indonesia	<i>Vitis</i> spp.*	South Africa
<i>Pistacia</i> sp. *	Holland	<i>Zea mays</i>	South Africa, USA
<i>Pisum sativum</i>	France, Netherlands, Sweden, USA	<i>Zucchini</i> sp.*	Israel
<i>Plantago maritime</i> *	USSR		
<i>Prunus</i> spp. *	Italy, Turkey		
Crop	Source		

* Not reported earlier as seed-borne (Richardson, 1990)

transmission of a soil-borne pathogen can be a potential threat to agriculture if infected seed is sown in uninfected area.

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Insect-Pests Intercepted in Introduced Planting Material during Quarantine Processing from 2000-04

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Key Words: Insect-Pests, Quarantine, Interception, Germplasm

The import of exotic planting material, either in bulk or as small samples meant for research in various crop improvement programmes is a potential and inadvertent source of introducing exotic pests into new areas which may severely damage the crop production and economy of a nation. There are glaring examples of various

pests and diseases introduced along with imports, which have resulted in enormous crop losses (Khetarpal *et al.*, 2001).

National Bureau of Plant Genetic Resources is the nodal agency to undertake the quarantine processing of germplasm and transgenic material introduced into

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Insect-Pests Intercepted in Introduced Planting Material during Quarantine Processing from 2000-04

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Key Words: Insect-Pests, Quarantine, Interception, Germplasm

The import of exotic planting material, either in bulk or as small samples meant for research in various crop improvement programmes is a potential and inadvertent source of introducing exotic pests into new areas which may severely damage the crop production and economy of a nation. There are glaring examples of various

pests and diseases introduced along with imports, which have resulted in enormous crop losses (Khetarpal *et al.*, 2001).

National Bureau of Plant Genetic Resources is the nodal agency to undertake the quarantine processing of germplasm and transgenic material introduced into

the country for research purposes. Several insect pests of great economic significance have been intercepted over the years of which many are not reported from India.

During the five-year period from 2000- 2004, a total of 5,20,596 samples of exotic planting material of various crops were processed for quarantine clearance. All the planting material (both true seed and vegetative propagules) were inspected by naked eye or with the help of magnifiers for the detection of external symptoms of damage i.e. holes, rotting, swelling, deformity, etc. or presence of dead or alive insects/ mites, eggs/ egg shells, immature stages, exuviae or excreta thereof.

Seed samples (12,561) of plant genera were exposed to soft X-rays, at 22 Kv, 3 mA for 15 seconds at a distance of 30 cm to detect hidden infestation (Bhalla *et al.*, 2002). Samples of small seeds (772) difficult to detect through X-ray radiography were subjected to transparency test by heating in lactophenol-acid fuchsin. The infested samples were salvaged using several techniques viz., mechanical cleaning (1685), fumigation (1692), X-ray (974) and pesticidal dip and spray treatment (1028). One thousand six hundred and ninety two infested seed samples were fumigated with ethylene dichloride-carbon tetrachloride (EDCT) mixture @ 320 mg/ l for 48 or 640 mg/ l for 24 hrs. at 30°C in an airtight container at normal air pressure and 1,028 infested samples of vegetative material were given dip/ spray treatment with an acaricide, Kelthane @ 0.035% and insecticide, Malathion @ 0.05% or a combination of both.

The insects were retrieved from the seeds and vegetative propagules either by detention or soaking and were identified on the basis of identification keys and reference collection at NBPGR. The various pests intercepted are listed in Table 1.

Visual examination revealed insect infestation in 1,685 samples. The important interceptions include *Araecerus* sp.; *Cryptolestes* sp.; *Lasioderma serricorne*; *Rhizopertha dominica*; *Sitophilus granarius*; *S. oryzae*; *S. zeamais*; *Sitotroga cerealella*; *Systole coriandri* and *Tribolium castaneum* in the crops and countries as listed. Apart from these, unidentified aphids, immature insect stages, mealy bugs, mites, scale insects and staphylinid beetles were also detected in several crop species.

Araecerus sp. intercepted in *Zea mays* is a cosmopolitan stored grain pest with a wide host range and reported from several tropical and subtropical countries including India. *Cryptolestes* sp., intercepted from

Pennisetum typhoides has only one of its species *C. pusillus* reported from India. The difficulty in identifying *Cryptolestes* at the species level accounts for it not being reported from many countries. *L. serricorne* is cosmopolitan but is most abundant in the tropics. *Sitophilus granarius* is distributed throughout the temperate region and is rare in the tropics limited only to cool upland areas and is reported from India. *S. oryzae* and *S. zeamais* are found in all warm and tropical countries and have a high ability to establish anywhere with favourable moisture and temperature. *Sitotroga cerealella* has a wide host range and is widespread in India. The seed damage caused by *S. cerealella* is similar to that caused by the rice weevil *Sitophilus oryzae* but can be distinguished by the adult emergence holes on the infested seeds and adult feeding damage in case of *S. oryzae*.

X-ray radiography revealed infestation in 974 samples. The major interceptions were *Acanthoscelides obtectus*, *Bruchidius atrolineatus*, *Bruchophagus gibbus*, *Bruchus dentipes*, *B. lentis*, *B. pisorum*, *Callosobruchus analis*, *C. chinensis* and *C. maculatus* in plant species and countries as in Table 1. *A. obtectus* originated in tropical South America, but has spread to other warm regions, including one unconfirmed report from India. *Bruchidius* sp. has been reported on a wide range of hosts from all over the world. *B. atrolineatus* intercepted in *V. unguiculata* from Nigeria has yet not been reported from India and is a serious pest of *Vigna* spp. and *Lens* spp. from several African countries.

Bruchophagus gibbus, a chalcidoid reported on lucerne and purple clover from Australia, China, Germany and USA has yet not been reported from India. *B. rodhi* has been reported only on *Medicago sativa* with unconfirmed reports of being present in northern India. It has been reported to cause a damage of 5- 53 % to seeds of leucerne and red clover. *B. mellipes*, has been reported only on *Sesbania* spp. with unconfirmed reports of being present in India.

Bruchus dentipes is a pest specific to *Vicia faba* causing upto 76% damage is reported from countries like Greece, Syria, Turkey and Australia, and is yet not reported from India. *B. ervi* intercepted from Syria and several other countries has unconfirmed records of being present in Central Asia and Australia. *B. pisorum* intercepted from *P. sativum*, reported to have a wide host range, has a limited distribution in India confined only to the pea growing northern India. *B. lentis* has

Table 1. Insect Pests Intercepted in introduced material during 2000- 04

Pest	Host	Source
* <i>Acanthoscelides obtectus</i>	<i>Phaseolus vulgaris</i>	Colombia, Mexico, Peru, USA
<i>Araecerus</i> sp.	<i>Zea mays</i>	USA
* <i>Boottanomyia</i> sp.	<i>Eucalyptus</i> sp.	Australia
* <i>Bruchidius</i> sp.	<i>Trifolium alexandrinum</i>	Egypt
	<i>Trifolium</i> spp.	Egypt, Ethiopia, UK
* <i>Bruchidius atrolineatus</i>	<i>Vigna unguiculata</i>	Nigeria
* <i>Bruchophagus gibbus</i>	<i>Medicago sativa</i>	USA
* <i>B.mellipes</i>	<i>Sesbania rostrata</i>	Philippines
	<i>Sesbania</i> sp.	Brazil, Ethiopia
* <i>Bruchophagus rodii</i>	<i>M. sativa</i>	USA
* <i>Bruchophagus</i> sp.	<i>Sesbania</i> sp.	Brazil, Ethiopia
* <i>Bruchus dentipes</i>	<i>Vicia faba</i>	ICARDA (Syria)
* <i>B. ervi</i>	<i>Lens</i> spp.	ICARDA (Syria)
	<i>L. culinaris</i>	Syria, Chile, Germany, Greece, Iran, Italy, Lebanon, Morocco, Turkey, Russian Federation
* <i>B. emarginatus</i>	<i>Pisum</i> spp.	Russia
* <i>B. pisorum</i>	<i>P. sativum</i>	Bulgaria, Eritrea, Russia
* <i>B. lentis</i>	<i>L. culinaris</i>	Afghanistan, Azerbaijan, ICARDA (Syria), Spain
	<i>V. faba</i>	Afghanistan, Canada, Ethiopia, Pakistan, Ukraine, Yemen
* <i>B. nubilis</i>	<i>V. faba</i>	Ukraine
* <i>Callosobruchus analis</i>	<i>Vigna unguiculata</i>	Nigeria, USA
* <i>C. chinensis</i>	<i>L. culinaris</i>	ICARDA (Syria)
	<i>Vicia faba</i>	Eritrea
	<i>Vigna unguiculata</i>	Nigeria, USA
* <i>C. maculatus</i>	<i>V. unguiculata</i>	Nigeria, USA
<i>Cryptolestes</i> sp.	<i>Sesamum indicum</i>	Uganda
	<i>Pennisetum typhoides</i>	Nigeria
<i>Lasioderma serricorne</i>	<i>Hordeum vulgare</i>	ICARDA (Syria)
* <i>Quadrastichodella eucalyptii</i>	<i>Eucalyptus camendulensis</i>	Australia
<i>Rhizopertha dominica</i>	<i>H. vulgare</i>	ICARDA (Syria), Mexico
	<i>Oryza sativa</i>	Malaysia
	<i>Triticum aestivum</i>	Australia, Azerbaijan, ICARDA (Syria), Mexico
	<i>Triticale</i>	Mexico
* <i>Sitophilus granarius</i>	<i>T. aestivum</i>	USA
<i>S. oryzae</i>	<i>O. sativa</i>	Malaysia, Philippines, Thailand, USA
	<i>Sorghum bicolor</i>	Brazil, Philippines, USA
	<i>T. aestivum</i>	Nepal
	<i>Z. mays</i>	CIMMYT (Mexico), Thailand
<i>S. zeamais</i>	<i>Z. mays</i>	CIMMYT (Mexico), Indonesia, Philippines, Thailand, USA
<i>Sitotroga cerealella</i>	<i>O. sativa</i>	Nepal
	<i>Z. mays</i>	Bolivia
<i>Systole coriandri</i>	<i>Coriandrum sativum</i>	Russia
<i>Tribolium castaneum</i>	<i>Gypsophylla</i> spp.	Israel
	<i>P. typhoides</i> , <i>T. aestivum</i>	Nepal
	<i>Sesamum</i> spp.	USA
	<i>Sorghum bicolor</i>	Canada
	<i>Z. mays</i>	Thailand, USA

* Pests not yet reported from India; * Pests detected through X-ray radiography

been recorded as a serious pest in Algeria, Iran, Lebanon and Turkey with infestation level reaching 80% with complete loss of germination. It is a univoltine species and overwinters in seeds posing higher quarantine risk.

Quadrastichodella eucalyptii in *Eucalyptus* sp., a pest not yet reported from India, has been reported as a seed-destroying pest of *Eucalyptus* from Australia, Japan, Malaysia and New Zealand. *Systole coriandri*, a chalcidoid reported on *Angelica* and coriander from Chile, Hungary and Russia has been reported from India only from endemic pockets (CAB International, 2003).

Pests like *Callosobruchus analis*, *C. chinensis*, *C. maculatus*, *R. dominica* and *Sitophilus oryzae* although reported from India pose a quarantine risk during import due to their high economic significance and possibility of presence of new biotypes/strains having greater physiological adaptability (Wadhi, 1980). Both the species *C. maculatus* and *C. chinensis*, known to occur widely in tropical/subtropical conditions, possess biological strains. The introduction of a mutant strain in a new climatically suitable environment could lead to population explosion.

The importance of effective implementation of plant quarantine is clearly indicated by the interception of several economically important pests not yet reported from India. Quarantine risk is much higher due to the hidden nature of infestation and their being repeatedly intercepted.

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Pathogenic Fungi and Bacteria in Phytosanitary Issues-Current Trends and Future Directions

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Key Words: Quarantine, Phytosanitary, Fungi, Bacteria, Pest Risk Analysis

The latest Global Agreement on "Sanitary and Phytosanitary Measures" (SPS Agreement) deals with phytosanitary issues among the member countries of World Trade Organisation (WTO). SPS has the major implication on food safety, animal and plant health in relation to trade. As the main purpose of WTO is trade flow with equal treatment, there is an increase in the dissemination of dangerous fungi, bacteria, viruses, nematodes and insects. To combat such threat, Government of India enforced plant Quarantine (Regulation of Import into India) Order, 2003 to regulate exchange of plant/plant material for sowing, planting, propagation with general and specific conditions for import. Regulation of import to prevent introduction of destructive fungi and bacteria is highlighted in three schedules in the order. Importation of banana, rubber, and date palm is prohibited due to *Ralstonia solanacearum*, *Microcyclus ulei* and *Fusarium oxysporum* f. sp. *albedinis*, respectively (Schedule IV). Several plant species like cassava, citrus, cocoa, cotton, groundnut, rice and tobacco can be imported with additional declarations (Schedule V). Specific post-entry quarantine measures and treatments are imposed to prevent exotic fungi and bacteria in *Allium* spp., barley, beans, carrot, chickpea, grape, maize, peas, sorghum and soybean. (Schedule VI).

NBPGR Regional station, Hyderabad is discharging quarantine requirements of ICAR institutes, State

Agricultural Universities, Private Companies and International institute (ICRISAT) located in South India. Suitable detection techniques are used to detect plant pathogens like fungi and bacteria on exotic germplasm. Few of the quarantine significant pathogens intercepted at this Regional Station were *Peronospora manshurica* on soybean from USA; *Ralstonia solanacearum* on groundnut from Australia, Brazil, Cyprus, Malawi, Niger, Sudan, USA and Zimbabwe; *Xanthomonas campestris* pv. *holcicola* and *Ralstonia andropogoni* on sorghum from PDR Yemen.

Soybean downy mildew caused by *P. manshurica* is not known to occur in India. This pathogen was intercepted on soybean from USA. Oospores of the pathogen were detected by visual examination and sedimentation test. However, at NBPGR, New Delhi, the pathogen was intercepted in 1535 samples from 15 countries (Agarwal and Singh, 1998). Thirty physiological races were reported from USA alone (Dunleavy, 1997). The oospore can retain viability upto eight years (Pathak *et al.*, 1978). Bacterial leaf streak (*X. campestris* pv. *holcicola*) and leaf stripe (*R. andropogoni*) were identified during the rainy season of 1987 on sorghum. Dot-immunobinding assay was used to identify both these bacteria (Prasada Rao *et al.*, 1990). There is no authentic evidence on the detection of these two pathogens in India, hence they are categorised

The importance of effective implementation of plant quarantine is clearly indicated by the interception of several economically important pests not yet reported from India. Quarantine risk is much higher due to the hidden nature of infestation and their being repeatedly intercepted.

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as quarantine pests (Anonymous, 2003). Bacterial wilt (*R. solanacearum*) was intercepted in groundnut accessions from eight countries. The disease expression took place only at higher temperatures (30°C and above). A diagnostic schedule involving grow-out of imported groundnut seeds for four weeks and plating the leaf bits and twig pieces on Tetrazolium Chloride Agar medium was found effective for the detection of infection (Anitha *et al.*, 2004).

Several serological tests are available for detection and identification of plant viruses for the past four decades. Relatively, little work is done on serological detection of fungi and bacteria prior to development of Enzyme linked immunosorbent assay (ELISA) and monoclonal antibody techniques. At present there are many examples where fungal and bacterial pathogens can be detected routinely by ELISA. With the advent of molecular biology and the ability to compare regions of genomic DNA representing conserved sequences, the development of diagnostic techniques increased at an amazing rate. The major condition associated with pathogen detection techniques applied for the enforcement of plant quarantine regulations and policies includes cost, duration of testing, sensitivity, reproducibility and suitability to screen a large number of samples. Although molecular diagnostic techniques satisfy most of the needs, few barriers prevent their wider adaptability.

Pest risk analysis (PRA) has gained importance due to liberalization of world trade. Moreover, it has become obligatory to member countries of WTO to base their phytosanitary measures on scientific evidence of pest risk. Capacity for pest risk analysis is an area of concern, which needs immediate attention. PRA needs to be worked out for important crops having fungal and bacterial disease problems. For example, sunflower

germplasm is mostly available in European countries. Hence PRA on sunflower with special reference to quarantine significant pathogen like downy mildew (*Plasmopara halstedii*) is essential for the exchange of germplasm. Identification of pest free areas based on surveys and surveillance is important. Pathogens like *Fusarium poae* in wheat, downy mildews of sorghum (*Peronosclerospora sorghi*) and pearl millet (*Sclerospora graminicola*), where many races and biotypes are reported all over the world, should be included in different schedules of Plant Quarantine Order, 2003. Establishment of National Referral laboratories, electronic linking of all quarantine laboratories, development of National database, identifying research on detection techniques and treatment schedules for fungi and bacteria of quarantine importance are the steps suggested in the context of phytosanitary measures.

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Colletotrichum spp. Intercepted in Exotic Germplasm during 1976-2004

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Key Words: *Colletotrichum* spp., Interception, Quarantine, Germplasm

The international exchange of the Plant Genetic Resources (PGR) has contributed towards increase in crop productivity in India. Since several pathogens have been reported as seed-borne, there is always a risk of inadvertent

introduction of seed-borne pathogens along with such imports. Therefore, a thorough and critical examination of introduced material for associated pests is essential for plant quarantine clearance. National Bureau of Plant

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***Colletotrichum* spp. Intercepted in Exotic Germplasm during 1976-2004**

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introduction of seed-borne pathogens along with such imports. Therefore, a thorough and critical examination of introduced material for associated pests is essential for plant quarantine clearance. National Bureau of Plant

Genetic Resources, New Delhi receives about 60,000 samples of germplasm and trial material each year for quarantine clearance. All the samples are first subjected to visual examination and then blotter test for detection of the associated pathogens. As a result of critical examination, a large number of seed-borne fungi including the destructive *Colletotrichum* spp. have been detected (Agarwal *et al.*, 2004; Khetarpal *et al.*, 2001). Information on these species on various crops introduced from several countries during 1976-2004 and their economic significance is discussed.

The genus *Colletotrichum* is having a number of pathogenic species causing considerable economic losses in a wide range of crops. Species of *Colletotrichum* produce different types of symptoms such as dieback, seedling blight, leaf blight, leaf spot, anthracnose, red rot and fruit rot etc. Richardson (1990) reported a large number of species as seed-borne in various crops. Species of *Colletotrichum* intercepted in exotic germplasm introduced during 1976-2004 is presented in Table 1.

Colletotrichum acutatum Simmonds ex Simmonds,

which causes black spot and leaf curl, was intercepted on *Capsicum* spp. from Taiwan, *Lycopersicon esculentum* and *Medicago* spp. from USA, *Panicum maximum* from Australia and *Solanum melongena* from Bangladesh. Wright and Heaton (1991) reported 25-50% losses in celery crop in Australia.

Colletotrichum dematium (Pers.) Grove causing dieback, leaf blight, leaf spot and anthracnose was intercepted on a large number of hosts from many countries. Awashthi and Bhargava (2000) reported significant reduction in yield of chickpea in India due to *C. dematium*.

Colletotrichum falcatum Went [*Glomerella tucumanensis* (Speg.) Arx & E. Müll.] the causal agent of red rot of sugarcane was intercepted on *Saccharum* spp. from USA. Viswanathan and Samiyappan (1999) reported up to 100% yield losses to cane production by *C. falcatum* in many states in India under severe epiphytotic conditions.

Colletotrichum gloeosporioides (Penz.) Sacc. [*Glomerella cingulata* (Stonem.) Spauld. & Schrenk]

Table 1. Species of *Colletotrichum* intercepted in exotic germplasm during the years 1976-2004

Fungi	Host	Country/Source
<i>Colletotrichum acutatum</i> Simmonds ex Simmonds	<i>Abelmoschus esculentus</i>	Bangladesh
	<i>Capsicum</i> spp.	Taiwan
	<i>Coriandrum sativum</i>	USA
	<i>Lycopersicon esculentum</i>	USA
	<i>Medicago</i> spp.	Australia
	<i>Panicum maximum</i>	Australia
	<i>Solanum melongena</i>	Bangladesh
<i>Colletotrichum dematium</i> (Pers.) Grove	<i>Abelmoschus esculentus</i>	Bangladesh, Nepal
	<i>Beta vulgaris</i>	Belgium, Romania, USA, Former USSR
	<i>Capsicum</i> spp.	Bangladesh, Nigeria, Taiwan, USA
	<i>Carica papaya</i>	Bangladesh
	<i>Cyamopsis tetragonoloba</i>	USA
	<i>Corchorus</i> spp.	Bangladesh
	<i>Desmenthus</i> sp.	Ethiopia
	<i>Glycine max</i>	Nigeria, Poland, Taiwan, Thailand, USA
	<i>Hibiscus</i> spp.	Bangladesh, Nigeria, UK
	<i>Indigofera</i> sp.	USA
	<i>Linum</i> sp.	Hungary, Poland
	<i>Lagenaria siceraria</i>	USA
	<i>Lycopersicon esculentus</i>	Taiwan
	<i>Lotus</i> sp.	USA
	<i>Macrotyloma uniflorum</i>	Ethiopia, USA
	<i>Medicago</i> sp.	USA
	<i>Melilotus alba</i>	Taiwan, USA
	<i>Ocimum</i> sp.	Nigeria
	<i>Ornithogalum setifolium</i>	UK
	<i>Phaseolus aureus</i>	Taiwan
	<i>Piper nigrum</i>	Malaysia
	<i>Solanum melongena</i>	Bangladesh, USA
	<i>Stylosanthes</i> sp.	USA
	<i>Triticum</i> sp.	Italy
<i>Colletotrichum falcatum</i> Went	<i>Vigna unguiculata</i>	Indonesia, Italy, Nigeria, Philippines
	<i>Saccharum</i> spp.	USA
<i>Glomerella tucumanensis</i> (Speg.) Arx & E. Müll.		

Contd.

Table 1. Contd.

Fungi	Host	Country/Source
<i>Colletotrichum gloeosporioides</i> (Penz.) Sacc.	<i>Alnus rubra</i>	USA
[<i>Glomerella cingulata</i> (Stonem.) Spauld. & Schrenk]	<i>Brachiaria</i> sp.	USA
	<i>Capsicum</i> spp.	Brazil, Italy
	<i>Cnidoscolus</i> sp.	Mexico
	<i>Corchorus</i> spp.	Bangladesh
	<i>Cucumis</i> sp.	USA
	<i>Cucurbita</i> sp.	Japan, USA
	<i>Glycine max</i>	UK, USA
	<i>Leucaena</i> sp.	UK
	<i>Linum</i> sp.	USA
	<i>Mangifera indica</i>	Brazil, USA
	<i>Medicago</i> sp.	USA
	<i>Piper nigrum</i>	Indonesia, Malaysia
	<i>Pyrus</i> sp.	Malawi
	<i>Sesamum</i> sp.	Italy
	<i>Sesbania rostrata</i>	Philippines
	<i>Setaria</i> sp.	Mexico
	<i>Solanum melongena</i>	Bangladesh
	<i>Stylosanthes</i> sp.	USA
	<i>Vigna unguiculata</i>	USA
	<i>Vitis</i> sp.	Former Czechoslovakia
<i>Colletotrichum graminicola</i> (Ces.) Wilson [<i>Glomerella graminicola</i> Politis]	<i>Crotolaria</i> sp.	Indonesia, USA
	<i>Corchorus</i> spp.	Bangladesh
	<i>Glycine max</i>	Taiwan
	<i>Solanum melongena</i>	Bangladesh
	<i>Sorghum</i> spp.	Nigeria, South Korea, Sudan
	<i>Vigna unguiculata</i>	USA
	<i>Zea mays</i>	USA
<i>Colletotrichum lagenarium</i> (Pass.) Ellis & Halst.	<i>Z. diploperennis</i>	USA
	<i>Cucumis melo</i>	USA

the dieback, anthracnose, fruit rot and stem canker fungus was intercepted on a large number of hosts from several countries. Seeds from infected pods failed to germinate in case of *Stylosanthes hamata* (Davis, 1987).

Colletotrichum graminicola (Ces.) Wilson [Glomerella graminicola Politis] anthracnose, leaf blight, seedling blight and stalk rot fungus was intercepted on many crops from several countries. More than 50% losses were reported in grain yield from severe infection by *C. graminicola* in USA (Harris *et al.*, 1964). In India, Sharma (1980) estimated cultivar-dependent losses of 41 to 60% by comparing the yields of chemically protected and unprotected plots.

Colletotrichum lagenarium (Pass.) Ellis & Halst. [Colletotrichum orbiculare (Berk. & Mont.) Arx] which causes anthracnose was intercepted on *Cucumis melo* from USA. Amin and Ullasa (1981) reported yield losses up to 63% in watermelon under artificial inoculation.

Interceptions of *Colletotrichum* spp. from South Asian countries include-*C. dematium* on *Beta vulgaris*, *Corchorus* spp., *Hibiscus* spp., *Solanum melongena*; *C. gloeosporioides* on *Corchorus* spp.; *C. graminicola* on *Corchorus* spp., *S. melongena* from Bangladesh. *C.*

dematium was also intercepted on *Abelmoschus esculentus* from Nepal.

Keeping in view the quarantine significance and yield losses caused by different species of *Colletotrichum*, it is essential to carry out a thorough examination of exotic germplasm for associated pests.

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Implementation of Cartagena Protocol on Biosafety for Safe Transfer, Handling and Use of LMOs in India

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Key Words: Cartagena Protocol, Biosafety, Living Modified Organisms

A national biosafety system to regulate production and release of living modified organisms (LMOs) is presently considered essential in any country with a biotechnology programme. A globally harmonized regime for biodiversity was negotiated under the Convention on Biological Diversity (CBD) and "Cartagena Protocol on Biodiversity to the Convention on Biological Diversity" was finally adopted by Conference of the Parties on January 29, 2000. India has ratified the Cartagena Protocol on Biosafety on January 17, 2003 and it has come into force on September 11, 2003, becoming legally binding in the international legal system.

The objective of Cartagena Protocol is primarily to contribute for ensuring adequate level of protection in respect of safe transfer, handling and use of LMOs resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity taking also into account the possible risks to human health and specifically focussing on transboundary movements.

The Protocol enables the signatory countries an opportunity to obtain information before new biotech organisms are imported. It acknowledges each country's right to regulate bio-engineered organisms, subject to existing international obligations. It also creates a framework to help improve the capacity of developing countries to protect biodiversity. To become a party to the protocol, a country or a regional economic

integrated organization must first be a party to the CBD. The Inter-governmental Committee on the Cartagena Protocol on Biosafety (ICCP) was created to prepare for the Protocol's entry into force. The ICCP has highlighted capacity building as a key requirement for the early entry into force and for the effective implementation of the Protocol. To this end the Global Environmental Facility (GEF) has initiated a project through United Nations Environmental Programme (UNEP) to assist the signatories to the Cartagena Protocol in establishing national biosafety frameworks as well as country based demonstration projects, through any of the GEF implementing agencies.

India already has in place a biosafety framework in the form of rules for manufacture, use, import, export and storage of hazardous microorganisms/ genetically engineered organisms or cells, 1989 notified under the Environmental Protection Act, 1986. Therefore, it has accessed for funds for country based demonstration project from GEF through World Bank for the project on "Capacity Building for the Implementation of Cartagena Protocol on Biosafety". Ministry of environment and Forests is the nodal point to implement and coordinate the project in four research organisations viz. National Bureau of Plant Genetic Resources, New Delhi; GB Pant University of Agriculture and Technology, Pantnagar; Indian Agricultural Research institute, New Delhi and Central Food Technology Research Institute, Mysore. The capacity building project is expected to enhance

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India's national capacity in order to implement the Protocol. It will also address the capacity building needs of the country for implementing the national biosafety framework related to transboundary movement of LMOs. This includes the assessment, management and long term monitoring and documentation of the risks to the sustainable use of biodiversity and to human health potentially posed by the introduction of LMOs.

It is envisaged that at the end of the three-year capacity building project there will be sufficient capacity in the country including in terms of effective co-ordination between the responsible agencies to assess and manage risks associated with transboundary movement of LMOs through strengthening of the legal and regulatory frameworks, enhanced institutional capacity and effective communication strategies. Knowledge and methodologies on biosafety will be shared and transferred to the State agencies across the country through sustained training programmes.

Key Provisions of Cartagena Protocol

- The Protocol provides for establishing an internet-based "Biosafety Clearing-House" to help countries in sharing and exchange of scientific, technical, environmental and legal information about living modified organisms (LMOs) and their products.
- It creates an advance informed agreement (AIA)

procedure that in effect requires exporters to seek consent from an importing country before the first shipment of an LMO meant to be introduced into the environment.

- The Protocol establishes a process for considering more detailed identification and documentation of LMO commodities in international trade.
- The protocol contains reference to a precautionary approach and reaffirms what has been stated in Principle 15 of the Rio Declaration on Environment and Development, that is, governments may use the precautionary principle to bar import of a transgenic product even in the absence of conclusive evidence that the product is not safe.
- The Protocol calls on Parties to cooperate with developing countries in building their capacity for managing modern biotechnology.
- The Protocol does not address food safety issues and consumer product labeling. It does not cover non-living products derived from LMOs, such as cooking oil from genetically modified (GM) corn or ketchup from GM tomatoes.

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Evaluation of Imported Transgenic Planting Material: Emerging National Scenario

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Key Words: Transgenic Crops, Terminator Technology, Import Permit

Advances in technologies enabling transfer of foreign gene in plants have overcome several barriers to crop improvement. These technologies offer immense benefits in terms of increased yield, better quality and resistance to biotic and abiotic factors. The transgenic crops can minimize crop damage through disease and pest-resistant varieties, reduce the use of chemicals and enhance stress tolerance in crops, thereby permitting economically productive farming on hitherto unproductive lands. Over the last two decades, transgenic plants were widely used

in basics and applied studies. The first genetically engineered crop released in 1994 for commercial production was the *FlavrSavr* tomato in United States. Thereafter adoption of GM crops has been at very fast pace. The global area under transgenic crops has continued to grow over the last eight years, reaching 81 million hectares (m ha) in 2004, which represents a 47-fold increase from 1.7 m ha in 1996. Thus potential of this technology for enhancing crop productivity has been accepted worldwide.

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Because of the revolutionary nature of this new technology, there are also concerns about the risks and uncertainty associated with it, which too needs to be managed effectively. For example, the "terminator technology" (Oliver, 1998) was the most controversial news in commercial transgenic research in the last decade. The technology offered "Technology Protection System" (TPS) by genetically engineering a suicide mechanism into seeds, disabling farmers from saving seeds and using it in the next generation. In India, out of more than 100 million farmers, 80 percent are dependent on farm-saved seed. The potential threat to small farmers caused widespread outrage and protests during 1998, forcing the authorities to ban the technology in India. India has developed an efficient regulatory mechanism to monitor experiments in plant biotechnology as well as for biosafety assessment of transgenic plants. India is among the few developing countries, which have instituted biosafety regulations and incorporated them in national laws as far back as in 1989 (GOI 1989). The biosafety guidelines to monitor all experiments involving genetically improved plants, both within the laboratory/ greenhouse and outside were first prescribed in 1990 by DBT and were further revised and evolved in 1994 and 1998.

NBPGR is the nodal agency for issuing import permit for transgenic planting material for research purposes, on technical clearance of Review Committee on Genetic Manipulation (RCGM), DBT, Govt. of India. Since 1997, transgenic lines are being imported on regular basis through NBPGR. Eight transgenic crops for different traits were imported through NBPGR (Mangal *et al.*, 2003). Till date 32 imports of different crops namely *Brassica oleracea*, *B. juncea*, *B. napus*, *Oryza sativa*, *Gossypium* sp., *Zea mays*, *Cicer arietinum*, *Glycine max*, *Nicotiana tabacum* and *Triticum aestivum* have been imported in the country for research purposes from countries like Belgium, Philippines, USA, Australia, UK, Scotland, Switzerland, China, Canada and South Africa.

Among the transgenes introduced, transgenic *Brassica* lines have been imported with *Cry9C*, *osmads*, *bar*, *barnase* and *barstar* genes, which impart resistance against lepidopteran insects, photoperiod insensitivity, resistance to gluphosinate ammonium herbicide, male sterility and restoration of male fertility, respectively. The transgenes imported in rice include *Ama1* gene from *Amaranthus* for improved nutrition, *Cry1Ac* and *Cry19C* genes for imparting resistance against lepidopteran insects, *Cry1A(b)* for resistance to stem borer, *Xa21* for resistance to bacterial leaf blight, *PR* genes for resistance to sheath borer, *bar* gene, herbicide

Basta-resistant gene and the genes for phytoene synthase, phytoene desaturase, and lycopene cyclase involved in the synthesis of β -carotene in the endosperm of Golden rice. Recently, fungal pathogen resistance genes ScFv fragments from various sources incorporated in rice and wheat were also imported from Germany. In addition, *Cp4EPSPS* gene (for tolerance to glyphosate herbicide) and *aad* gene (coding for 3'-(9)-oaminoglycoside adenylyl transferase and conveying resistance to streptomycin and spectinomycin) in soybean and cotton, *CryX* and *Cry1A* genes (for resistance to lepidopteran insects) and *vip3* gene (for resistance to bollworm) in cotton; *Cry1Ab*, *CP4EPSPS* and *pat* genes (synthetic *bar* gene coding for phosphinothricin acetyl transferase and isolated from *Streptomyces viridochromogenes*) in maize, *Bean alpha A1* gene for imparting resistance against *Collasobruchus chinensis*, a serious pest of stored grains in chickpea and *Aox* gene for alternate oxidase in tobacco have also been imported.

In 2000, under DBT project National containment Facility along with transgene testing laboratory for evaluation of imported transgenic planting material was established at NBPGR. Under this project all the imported transgenic planting material is regularly being tested for terminator technology. The terminator cassette consists of three sets of genes namely, *repressor*, *cre-recombinase* and toxic genes. The primers have been designed from the sequence available from the *cre-recombinase* gene and are being used for PCR based detection to check the presence of this cassette in the received transgenic material. Besides this, primers were also designed and successfully employed for detection of transgenes like *Cry1Ab*, *Cry1Ac*, *CryX*, *Xa21*, *Vip-3*, *AOX*, *CP4EPSPS*, *barnase*, *barstar*, antifungal peptide genes, *phytoene synthase*, *Phytoene desaturase* and *Lycopene cyclase* etc. In addition, primers have also been designed for scorable/selectable markers such as *hptI*, *hptII* and *bar* or promoter fragments such as CaMv 35S and *nos* terminator and employed for detection of their presence in transgenic materials.

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Polymerase Chain Reaction for Evaluation/ Detection of Transgenic Planting Material

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Key Words: Transgenic Crops, Exogenous Gene and Polymerase Chain Reaction

Transgenic crops developed using recombinant DNA technology can make a significant contribution to global food, feed and fibre security, and alleviation of poverty, particularly in the Third World (Dunwell, 1999). Global area under cultivation of transgenic crops has increased from 1.7 million hectares in 1996 to 81 million hectares in 2004 (James, 2004). The commonly used regulatory sequences to transform most of GM plants are Cauliflower Mosaic Virus promoter (*CaMV* 35S) and the *Agrobacterium tumefaciens* nopaline synthase terminator. Consequently, methods detecting one of these regulatory sequences are popular for screening purposes.

With the fast introduction of new transgenic crops the demand to detect exogenous genes is increasing. To differentiate between transgenic and non-transgenic crops, a series of analytical tools is a prerequisite. The majority of the methods hitherto developed, mainly focused on detection of DNA. Polymerase Chain Reaction (PCR) has high sensitivity and specificity where a primer is designed based on the regulatory sequence or part of exogenous structural gene for evaluation/detection of transgenic crops. In the present study, the primers were designed and tested for screening to study the feasibility of the PCR for evaluation/detection of transgenic planting material.

Most of the new analytical methods used for detection and quantification of exogenous genes in GM crops are very expensive and time consuming. In India till 2003, 28 imports of GM planting material of eight crops for different traits have been made (Mangal *et al.*, 2003). The present study is carried out under the DBT project, "Development of PCR based methods for testing of transgenic planting material", and methods developed to analyse these transgenic crops are being validated by interlaboratory tests and standardization of upgraded techniques is under progress. The relatively inexpensive,

qualitative and sensitive method used in the present study, would be suitable for meeting regulatory obligations of country.

Crushed seeds of transgenic soybean, maize, mustard, and cotton were used for the study. Nucleotide sequences of exogenous genes were obtained from NCBI and primers were designed and synthesized. PCR protocols were standardized for amplification of exogenous gene sequences in transgenic crops.

Results showed that the PCR product with 195bp from *CaMV* 35S promoter was amplified in the GM soybean, maize, mustard, and cotton. While no PCR product was detected from the conventional/non-GM soybean, maize, mustard, and cotton. The PCR analysis with these primers could detect 10-20ng quantity of DNA of plant material. The designed primer pairs were used for detection of exogenous genes in respective GM crops. Respective primer pair amplified the PCR product of 320bp from *CP4EPSPS* gene in soybean and maize, 340bp and 290bp from *barnase* and *barstar* in GM mustard and 447bp from *CryIAC* gene in cotton. Hence, the PCR technology has been effectively employed for testing of transgenic planting material.

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Antifungal Essential Oils: An Eco-friendly Approach for Salvaging Germplasm

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Key Words: Antifungal, Essential Oils

About one third of crop losses worldwide is attributed to plant pathogenic micro-organisms including fungi, bacteria and viruses. A number of economically important diseases are seed-borne and seed-transmitted. Seed-borne fungi also play an interfering role in the exchange of plant genetic resources (PGR) as there is always an inadvertent risk of introducing new or exotic pathogens through international movement of seeds and planting material.

During quarantine processing of introduced germplasm, a large number of pathogenic fungi belonging to species of *Fusarium*, *Drechslera*, *Colletotrichum*, *Phoma*, *Curvularia* etc. were intercepted from time to time (Khetarpal *et al.*, 2001). Use of chemical fungicides in the control of fungal diseases though effective, is accompanied by plethora of problems such as environmental pollution, health hazards and development of resistance by the target pathogens. The increasing toll on environment and human health thus calls for a "back to nature" approach in crop protection. Hence efforts are being made to explore safe and eco-friendly alternatives for salvaging infected exotic germplasm.

Five fungal pathogens having wide host range viz., *Drechslera sorokiniana* (Sacc.) Subram. & Jain (isolated from wheat cultivar Arnig), *Colletotrichum graminicola* Ces. (from sorghum cultivar MSSR001047), *Macrophomina phaseolina* (Tassi) Goid. (from local cultivar of sesame) and *Fusarium solani* (Mart.) Sacc., (from soybean cultivar FT 50211) and *Phomopsis sojae* Leh. (from soybean cultivar FT 50211) which cause heavy crop losses were detected in the seeds through blotter test. Pure cultures were isolated and maintained on potato dextrose agar (PDA) for inhibition studies.

In vitro screening of fifteen essential oils viz., *Anethum sowa* (dill oil), *Artemisia vulgaris* (mugwort), *Cymbopogon flexuosus* (lemongrass), *C. martinii* var. *motia* (palmarosa), *C. winterianus* (citronella), *Eucalyptus globulus* (eucalyptus), Jam rosa (hybrid between *Cymbopogon nardus* x *C. jwarancusa*), *Mentha arvensis* (Japanese mint), *M. piperita* (peppermint), *M. spicata*

(spearmint), *Ocimum basilicum* (basil), *Pimpinella anisum* (anise), oils of citrus peel (*Citrus limon*) and orange peel (*Citrus reticulata*) and dementholated oil of *Mentha* (DMO) was undertaken for all the five fungal cultures using poisoned food technique (Nene and Thapliyal, 1979).

Oils were subjected to gas chromatographic analysis using Hewlett- Packard GC Model 58308 fitted with stainless steel column (6' X 1/4") packed with carbowax (10%), FID and recorder.

Minimum inhibitory concentration (MIC) i.e. the minimum dose required to cause cent percent inhibition of mycelial growth was computed for each oil using regression equation and FORECAST tool available with Microsoft Excel. ANOVA was carried out to derive least square difference at 5 and 1% probability levels and Duncan's multiple range test of means (Gomez and Gomez, 1984). MIC values in ppm were rounded to first decimal which ranged from 439.8-2200.

Oil of palmarosa was found to be the most effective followed by oils of lemongrass, jamrosa and citronella against these test fungi. A careful perusal of the chemical compositions of the oils reveals that the differences in antifungal activity may be due to the geraneol and citral contents. The oil of palmarosa (0.1% by wt) as seed treatment of wheat artificially inoculated with *D. sorokiniana* gave complete control of the seed-infection.

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Methodologies for Safe Movement of Highly Perishable Plant Germplasm during International Exchange

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Occurrence of outstandingly rich diversity of wild relatives, landraces and primitive cultivars of cultivated plants in their centers of origin has led to global interdependence of countries for germplasm to sustain the present day crop improvement programs. This has led to transport of diverse plant materials, primarily primitive forms and released varieties or cultivars across international borders. This introduction and exchange of plant germplasm on a worldwide basis has led to development of well-defined procedures for import and export because unregulated germplasm exchange activity may result in introduction of weeds, insects, nematodes and pathogens exotic to the country and harmful to its agriculture.

Seeds, vegetative propagules and whole plants have been transported across international borders since times immemorial. However, maintenance of viability of material, especially highly perishable non-orthodox seeds and vegetative propagules has been a formidable task as considerable time is taken during transit and also during quarantine inspection and clearance. Use of *in vitro* techniques has improved the phytosanitary aspects of plant introductions as it has a built-in capacity for early detection of pests and pathogens. This feature is the biggest advantage of this procedure for supply compared to field propagated material.

Several economically important tree species produce non-orthodox seeds, which are large in size and perishable due to high moisture contents. In addition, they are short-lived; longevity in some cases is as short as 7-10 days. Short distance transport of such seeds can be accomplished by mixing the seeds with saw dust, charcoal powder or sand and sending the consignment through air mail or courier but these additives are not permitted across international borders. In addition, international exchange of such seeds pose problems due to big seed size, incidence of pathogen contamination, precocious germination and loss of viability during transit, which can take few days to few weeks to reach the destination through proper channel. Valuable genetic stocks of such species can be safely transported using *in vitro* cultures of seeds, embryos and embryonic axes

as has been shown in cassava (*Manihot esculenta*) seedlings for transport from Columbia to Nigeria (Guevara *et al.*, 1998) and coconut for transport of germplasm collected during explorations from Mauritius, Madagascar and Seychelles to India (Kumaran *et al.*, 1998). In coconut, there are problems and constraints for exchange of germplasm because of occurrence of diseases in coconut growing areas. In some cases viz. lethal yellowing disease, the symptoms need one year to express. Hence, embryo culture in sterile conditions needs to be maintained for one year before releasing or exporting the material to a country free of this disease (Assy Bah and Engelmann, 1993). *In vitro* method thus ensures minimum phytosanitary risks, high rate of seedling establishment and avoidance of seed borne diseases.

Propagules of vegetatively propagated crops such as cuttings, bulbs, suckers and tubers are again highly perishable, bulky and are difficult to transport over long distances. Moreover, transport of such bulky material is limited due to space requirement. Regeneration capacity of such propagules may be adversely affected during transit over long distances. Axillary and apical meristems, dormant buds (in case of temperate crops) cultured *in vitro* and proliferating shoot cultures can be considered for transport of such crops maintaining high survival rates and minimum space requirement. In addition, the germplasm can be supplied irrespective of the season and without waiting for availability of regenerative propagules thus facilitating quick and easy distribution of germplasm. *In vitro* regenerated storage organs like tubers, bulbs and rhizomes can also be used for international distribution of germplasm (Agarwal, 2003). Alginate encapsulated somatic embryos (synseeds), buds, bulbs or meristems which can develop into plantlets can also be used for exchange of tissue cultured plants (Rao *et al.*, 2000). *In vitro* cultured nodal cuttings of yams are frequently used for its transport worldwide (Maurie *et al.*, 1998).

Pollen grains form another alternative for international exchange of germplasm since they are generally free from pathogens (Hoekstra, 1995). No fungal or bacterial diseases have been reported to be transmitted through

pollen exchanges (Shivanna, and Rangaswamy, 1992) hence they are subjected to less stringent quarantine restrictions. The binucleate pollen which has considerably longer life span compared to trinucleate pollen, can be transported to long distances without loss of viability. Their viability has been extended to as long as 10-14 years (Shivanna, and Rangaswamy, 1992). Large amount of pollen can be transported packed in small vials and directly used for breeding at different locations.

Hence germplasm can be transported across international borders in the form of *in vitro* cultures of seeds, embryos, embryonic axes, apical and axillary meristems, dormant buds, proliferating shoot cultures or encapsulated propagules as well as in the form of pollen grains maintaining minimum phytosanitary risks, space economy and high regeneration values.

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The Exotic Shrubs and Trees in Indian Arid Regions

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Key Words: Exotic Perennials, Shrub, Trees, Fodder

The Indian deserts comprising mostly of arid regions are characterized by sandy plains more or less devoid of vegetation except in the rainy season where multitudes of ephemerals come up and transform the barren lands into green carpet. The perennial components of these habitats comprising of scrubby, xerophytic vegetation characterized chiefly by *Salvadora oleoides*, *Prosopis cineraria*, *Capparis decidua* and *Zizyphus* spp. occur in open clumps. The exotic *Acacia tortilis* and *Prosopis juliflora* introduced long ago have been naturalized and they now occupy a significant place in the ecology and economy of these deserts and its inhabitants respectively.

Efforts to systematically introduce useful genetic material of exotic perennials by the Station date back

to almost four decades now (the Station was a part of the Plant Introduction Division, IARI, New Delhi). Since then a large number of accessions have been introduced (Bhandari *et al.*, 2000). Some of these successful introductions are bound to have significant role if introduced on a large scale.

The seed material after being received through the Germplasm Exchange Division, NBPGR, New Delhi is subjected to required/recommended pre-treatment and is sown in pots for raising saplings. The data on germination percentage and early vigor is recorded and the 3-4 month old sapling is transplanted in pits in the field at specified distance. Periodic data on morphological characters of plant habit, reproductive

pollen exchanges (Shivanna, and Rangaswamy, 1992) hence they are subjected to less stringent quarantine restrictions. The binucleate pollen which has considerably longer life span compared to trinucleate pollen, can be transported to long distances without loss of viability. Their viability has been extended to as long as 10-14 years (Shivanna, and Rangaswamy, 1992). Large amount of pollen can be transported packed in small vials and directly used for breeding at different locations.

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phenomenon and post harvest data on fruit and seed characters are recorded. Some of these shrub and tree introductions of significant importance are described here below.

Acacia albida (Del.) A. Chev., (EC 123793 ex. Senegal) is a tall thorny tree found suitable to this region. It is a peculiar tree in that it bears green leaves throughout the dry season but shed them on the onset of wet season thereby providing fodder at the time of scarcity. The accession exhibited a maximum height of 8-10m with a canopy of 3-6m and thick foliage of pinnate leaves. It has been widely accepted for agro-forestry programmes.

Acacia ampliceps B.R. Maslin (EC 170437 ex. Australia) also called salt wattle, jila-jila bush - is a small tree suitable for warm to hot, semi arid to tropical climate. It is useful for fuel, low windbreaks, sand dune rehabilitation and fodder (Turnbull, *et al* 1986; Thomson, 1986). This accession established in the field in 1986 exhibited a maximum height of 3.8 m with a 2-3 m wide canopy and 10 cm thick bole in ten years. It has been reported to have high DMD of 45.6 % and crude protein value of 15.6%. The dried phyllodes are highly preferred by sheep. The species is excellently adapted to arid environmental conditions of west Rajasthan (Harsh *et.al.*, 1993) and can play an important role in rural afforestation programmes.

A. holosericea A. Cunn. ex. G. Don (Wahroon) (EC 170441 and EC 191246 ex. Australia) is a silvery small tree and is one of the most promising *Acacia* species for dry tropical region. Its major positive features are drought resistance, easy initial establishment of saplings, fast growth rate and satisfactory adaptation to most soil types. Two accessions have exhibited profuse growth and attained a height of 3.5-6 m, canopy of 2-6 m and bole diameter of 5-13 cm. The species has exhibited profuse podding. The plant is though not readily grazed by livestock in Australia but reports from Senegal indicate high palatability of dry phyllodes. The species is suitable for windbreaks and amenity plantings.

Acacia maconochieona (EC 170446 ex Australia) is slender umbrella shaped, beautiful ornamental tree with excellent survival and growth rate. Its 10-year old trees attained a height of even more than 6 m with a range of 3.9-6.6m. The canopy was 2.3m x 4.5m wide with a long bole of 1.5-2.5m, bifurcated into 2 at 0.5-1m height from ground with several branches arising at top of plant giving a dome shaped appearance on top supported on a thick stout, forked bole. It has

been reported that this is one of the most salt tolerant Australian *Acacia* species. Plants withstand waterlogging upto 2.5m. The plants are highly suitable for fuel wood, charcoal and stock fodder. They have good coppicing ability.

Cassia sturtii R. Br. (syn. *Cnemophila* var. *coriaceae*) (EC 129010 ex. Australia) is a spheroid bush and is seen to have attained about 2m height and a canopy 1-2m wide in five years. It has a small axis with 20-150 cm height with 6-10 primary branches, which spread all around and give the plant a spherical, symmetrical appearance. Primary, secondary and tertiary branches arise successively from the main axis. Beautiful yellow caesepinoid flowers are borne by the plant. 1-3 kg pods per plant have been harvested from the plants. In their native habitat they are eaten by sheep at the time of extreme fodder shortage (Anon., 1975). Its initial establishment trials have shown that it holds great promise for arid and semi arid regions.

Cassia helmsii is a spheroid bush, almost similar in appearance to *C. sturtii*. An accession EC 191260 introduced from Australia attained a height of 1.5m with a canopy of 1m. The leaves are more expanded and broader than *C. sturtii* and the flowers and pods are also bigger. Profuse flowering and fruiting has been observed.

Simmondsia chinensis (Link.) Schneid) jojoba or hohoba (EC 33198 ex. USA) is a shrub with high potential as this the sole substitute for sperm whale oil (45-58% of liquid wax in its seeds). It is a hardy shrub which can withstand droughts, tolerate salinity and has been reported to adapt to wide range of temperature, rainfall and habitat conditions. It exhibited initial slow growth and then attained a height of 1-2.5 m in 10 years. Several branches arise at 10-15 cm from the ground level and spread out to form a bushy habit. Primary, secondary and tertiary branches arise all around forming a spheroid bush. Pale green, single female and yellow clustered male flowers are borne on leaf axils. Flowering was observed in 3-4 year old plant in winters. Single fruit on each alternate node is the common flowering pattern though multiple fruiting has been reported in few cases. Its oil is used as lubricant and finds many uses as chemical intermediate in industrial processes, in cosmetic and pharmaceutical industries, etc.

Carissa grandiflora (E 37513 ex USA) is a tall evergreen shrub with scarlet red fruits and is a rich source of Vitamin C besides sugar, protein and fats.

The bush has exhibited good initial growth and heavy fruiting pattern indicative of its suitability for semi arid regions and has been recommended for large-scale cultivation.

As evidenced the potential for greater utilization of exotic shrubs and trees is high. A multiple use management policy for desert rangelands should provide an incentive for including selected exotics in seeding mixtures for improvement of livestock forage, wildlife habitat, biomass, fuel wood, oil and reclamation of disturbed areas. The proportion and extent of use of exotics however needs to be ascertained before introductions to ensure economic and ecologic benefit to the existing system.

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Pests Intercepted in Imported Transgenic Planting Material during 2002-2004

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Key Words: Pests, Transgenic, Interception

The National Bureau of Plant Genetic Resources (NBPGR) is the nodal agency to issue import permit and undertake quarantine for imported transgenic planting material meant for research purposes as per the Plant Quarantine (Regulation of Import into India) Order 2003. The import permit is issued only after the import clearance from Review Committee on Genetic Manipulation, Department of Biotechnology is obtained.

Plant quarantine ensures introduction of valuable germplasm meant for use in the crop improvement programmes in a pest-free state (Khetarpal *et al.*, 2001). A containment facility of the level-4 has been built at NBPGR to ensure that during quarantine processing of transgenics, no viable biological material/ pollen/ pathogen may enter or leave the facility keeping in view the biosafety requirements.

During 2002-2004, 6746 samples of transgenic crops comprising *Gossypium* spp. (11), *Nicotiana tabacum* (2), *Oryza sativa* (6721), *Triticum aestivum* (11) and *Zea mays* (1) imported from Belgium, Canada, China, Germany, Philippines, Singapore, South Africa, Vietnam and USA were processed from quarantine point of view. Most of the material was imported by private sector

viz., De Nocol Crop (3), Hybrid Rice International (75), Mahyco (38), Metahelix Life Sciences (6598), Monsanto (1), Nath Seeds (7), Syngenta (1), whereas 23 samples were meant for public sector i.e. Directorate of Rice Research and University of Hyderabad.

Quarantine processing involved detection of pests in imported material and salvaging of infested material by using suitable detection and disinfestation procedures/ techniques. All the samples were processed through visual and/ stereo-binocular microscopic examination to detect and remove abnormal/ infected/ infested seeds, dead insects/ stages thereof, fungal fructifications, nematode galls, plant debris, soil clods, weed seeds etc. These were then subjected to various techniques for detection of specific pests.

Seed samples of all the crops were subjected to incubation and/ or washing test for detection of fungi and bacteria. Seeds of *Gossypium* spp. were screened through X-rays generated at 22kV 3mA for 10 seconds at a distance of 30cm from the source to detect likely presence of hidden infestation caused by insects. Seeds of *O. sativa* were subjected to soaking, washing and staining test to detect seed-borne nematodes. The post-

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entry quarantine inspection of *Gossypium* spp., *O. sativa*, *T. aestivum* and *Z. mays* grown in containment facility (greenhouse) by the indenter was undertaken and leaf samples suspected to be infected were tested in the laboratory.

Two thousand two hundred and fifty samples of various crops imported from different countries were found infected/ infested with pathogens and insect pests. The important pathogens/ pests intercepted in different crops are listed in Table 1.

Interception of large number of insects in 1548 samples of *O. sativa* imported from Singapore indicated the poor health status of the material. Among these, *Cryptolestes ferrugineus* is not known to occur in India (CAB International, 2003).

All the infected/infested samples were salvaged by using various suitable disinfection/disinfestation procedures/techniques and released to the indenters. *O. sativa* samples found infested with insects were salvaged by fumigation with ethylene dichloride-carbon tetrachloride mixture @ of 320 mg/l for 48 hrs at 30°C and normal atmospheric pressure while fumigating the entire consignment (6598 samples) as an additional safeguard. *O. sativa* and *N. tabacum* found infected with fungi were salvaged by giving hot water treatment at 52° C for 30 minutes. Apart from this all the *O. sativa* samples (123) were given mandatory prophylactic hot water treatment against seed-borne fungi, bacteria and the white tip nematode *Aphelenchoides besseyi* before releasing the material to the indenters. Several other pathogens including *Soybean mosaic virus* (SMV), the downy mildew fungus, *Peronospora manshurica* etc. have been intercepted in transgenic material earlier also. *P. manshurica* is of utmost quarantine importance to India as it is yet not known to occur in the country and there are reports of world wide distribution of several physiological races (Lim *et al.*, 1984; Marcinkowska 1991; Singh *et al.*, 2003) and also several

Table 1. Pests Intercepted in Imported Transgenic Planting Material during 2002-2004

Interceptions	Crop	Source of Import
Fungi		
<i>Alternaria longipes</i>	<i>Nicotiana tabacum</i>	Canada
<i>Drechslera oryzae</i>	<i>Oryza sativa</i>	Singapore, Vietnam
<i>Fusarium dimerum</i>	<i>O. sativa</i>	Philippines
<i>F. moniliforme</i>	<i>O. sativa</i>	Singapore
	<i>Zea mays</i>	South Africa
<i>Phoma glumarum</i>	<i>O. sativa</i>	Singapore
<i>Tricochonis padwicii</i>	<i>O. sativa</i>	Phillippines
Insects		
<i>Cryptolestes ferrugineus</i> ,	<i>O. sativa</i>	Singapore
<i>C. pusillus</i> , <i>Rhizopertha dominica</i> , <i>Sitophilus oryzae</i> , <i>Sitotroga cerealella</i> , <i>Tribolium castaneum</i> , Psocids		

strains of SMV are known world wide (CAB International, 2003).

The interception of insect pests/pathogens, thus highlights the importance of plant quarantine in minimizing/eliminating the risk of introducing destructive exotic pests and their strains, along with germplasm of transgenic planting material.

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International and National Regulations for Access to Plant Genetic Resources

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Key Words: Germplasm, Regulations, Access

Developments in the international and national regulations over the past 15 years have changed the scenario of access to plant genetic resources (PGR). The genetic resources users and managers need to understand the legal and policy environment related to access to PGR, to be more effective and work towards sustainable utilization of these resources.

An attempt has been made in this analysis to guide the researchers through relevant international and national agreements, laws and policies relevant to access to PGR. The international legal instruments, their coverage and status have been summarized in Table 1. A summary of national legislation and their scope has been presented in Table 2.

Table 1. International legal instruments and their scope and status

International Legal Instruments (Relevant Indian Legislation)	Scope /Applicability	Status /Jurisdiction
● International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)	● Covers all PGRFA (does not regulate non-food and non-agricultural uses) and addresses diverse topics, including conservation use, international cooperation, technical assistance and farmers' rights ● Establishes multilateral system for selected crops (over 35 food crops/29 forages species) ● Sets rules for access and benefit-sharing for these materials, both <i>ex situ</i> and <i>in situ</i>, while respecting property rights (except for CGIAR holdings of agreements)	● Adopted by FAO Conference in 2001 ● Entry into force after the 40th country ratified in November 2004 ● Legally binding for all countries that ratify and not applicable to those that do not ● Countries that ratify will be required to bring national laws and regulations into conformity with the Treaty ● CGIAR Centres are likely to sign agreements with the Treaty's Governing Body in order to adhere to the Treaty formally
● Convention on Biological Diversity (CBD) (Biological Diversity Act 2002)	● Covers all biodiversity ● Provides general principles for access and benefit-sharing concerning materials collected after the coming of CBD and not covered by the International Treaty on PGRFA	● Legally binding for countries that have ratified (183 as on March 2002) ● Ratifying countries must adopt appropriate legislation/regulations and/or bring existing ones into harmony with the Convention
● International Plant Protection Convention <i>Plant Quarantine (Regulation of Import into India) Order 2003 issued under the Destructive Insects and Pests (DIP) Act 1914</i>	● An instrument and forum for harmonizing phytosanitary measures used in regulating international trade ● Provides international regulatory framework for trade and protection of environment from adverse effects of products of modern biotechnology. (Gautam, 2000)	● Established in 1952 (last revised in 1997) ● Adopted in January 2000
● CBD/ International Protocol on Biosafety (Cartagena Protocol) (Guidelines for safety of Biotechnology by DBT, 2002 under the Environment Protection Act (EPA)1986)	● Members States must comply with minimum standards of protection of IP	
● WTO – TRIPS Agreement (Protection of Plant Varieties and Farmer Rights Act 2001 and Patent (Amendments) Act 2005)	● Must ensure protection of microorganisms, non- biological and microbiological processes and plant varieties that meet protection criteria	● Entered into force in January 1995 after the Marrakesh Ministerial Meeting in April 1994 ● Legally binding on all WTO Members ● Has Possibility for trade sanctions for those found not in compliance
● WTO/Agreement on Application of Sanitary and Phytosanitary Measures (Plant Quarantine (Regulation of Import into India) Order 2003 issued under the DIP Act 1914)	● Covers measures adopted by countries to protect human or animal life from food-borne risks; animal or plant-carried diseases; plant pests and diseases to ensure food safety and prevent the spread of pests among animals and plants (Khetarpal and Gupta, 2002)	● Adopted by 167 WTO members presently

(Contd.)

Table 1. Contd.

International Legal Instruments (Relevant Indian Legislation)	Scope /applicability	Status /Jurisdiction
- UPOV (Plant Breeders' Rights) (India is not a member of UPOV)	UPOV aims to maximize plant breeding efforts by providing a model for securing protection under UPOV for plant breeders' rights for plant varieties.	- Four versions; only 1991 is still open for joining. - Legally binding on 50 Parties to the Treaty.
FAO Global Plan of Action	- Covers all PGRFA - Contains specific "activities" on <i>in situ</i> conservation and development, <i>ex situ</i> conservation, utilization, and institutions and capacity building.	- Adopted in 1996 by the 4th Intl Technical Conference on PGRFA (150 countries) - Legally non-binding - Serves as a framework, guide and catalyst for PGRFA, and thus has a bearing on and a relation to a legally binding agreement.
FAO Code of Conduct for Plant Germplasm Collecting and Transfer	- Deals with the etiquette of collecting and transfer of PGRFA - Has a provision on collector's permits, responsibilities of collectors, sponsors, curators and users, as well as on reporting, monitoring and evaluating observance of the Code.	- Adopted by FAO Conference in 1993 - Not legally binding
- FAO-CGIAR Agreements Placing collections under the auspices of FAO - Associated documents/ instruments include: a) 2 joint FAO-CGIAR statements on the Agreement; b) standard Material Transfer Agreement (MTA)	- Agreements apply to the management, availability and transfer of specifically designated germplasm - Joint statements address concern the practical implementation of the agreement; the agreed MTA (which has the force of a binding contract on recipients) is used in the transfer of designated germplasm.	11 Centres (those having <i>ex situ</i> collections) have signed binding agreements with FAO - Agreements were foreseen as interim, pending the coming into force of the ITPGRFA. Treaty's Governing Body and Centres to develop new agreements in line with Article 15 of the Treaty.

(Adapted from S. Bragdon *et. al.*, 2004)

Table 2: National Legislations with implication on access to plant genetic resources

Acts/Guidelines	Objectives	Scope
- Protection of Plant Varieties and Farmer Rights (PPVFR Act, 2001) - Effective from: January 2005	To provide for an effective system of protection of plant varieties; and rights of farmers and plant breeding; ensure availability of high quality seeds improved varieties to farmers.	a) New varieties to be protected (registered) in the Act, should be novel, distinct, stable and uniform (NDUS), and shall be subjected to tests by the PPVFR Authority b) Application for new varieties should be accompanied with complete passport data of all the genetic resources used in the development of new material c) Proof of lawful acquisition of all materials used in development of new varieties to be furnished. (Brahmi <i>et. al.</i>, 2004 a)
- Biological Diversity Act - Effective from: April 2004	Conservation and sustainable use of biological diversity; regulation of access to biological resources; secure sharing of benefits out of use of Indian biological resources /use of traditional knowledge	a) The access to Indian biological resources by non-Indians shall be subject to the approval of National Biodiversity Authority. These conditions do not apply to transfer of genetic resources under any project approved by the Govt. of India, and also transfer of results under approved projects. (Brahmi <i>et. al.</i>, 2004 b)
- Patent (Amendments) Act 2005 - Effective from : January 2005	New amendment include patenting on newly developed (GM) micro-organisms and micro biological process that conform to the criteria of novelty, inventive step and utility	a) Source of biological resources used in the development of patents is to be acknowledged b) All biological resources used in development of patents to be deposited in the designated repositories before sealing of patents.
Geographical Indications of Goods (Registration and Protection) Act 1999	Applicable to goods such as agricultural goods, natural goods or manufactured goods as originating and manufactured in a territory of a country Where the given quality/ reputation is essentially attributable its geographic region (Land races of crop plants specific to certain agro-climatic regions of the country).	

(contd.)

Table 2 Contd.

Acts/Guidelines	Objectives	Scope
● Plant Quarantine (Regulation of Import into India) Order 2003 under the DIP Act 1914 Effective from : April, 2004	● Rules for Regulating the Import of Plants etc. into India, including import of germplasm/genetically modified organisms (GMOs)/transgenic planting material; live insects/ fungi including bio-control agents, soil, peat, and sphagnum moss, timber and wooden logs.	a) The Order includes prohibition on import of commodities with weed/alien species contamination and restriction on import of packaging material of plant origin unless treated. b) Additional Declarations to be given on phytosanitary certificates have been specified and notified points of entry have been increased.
● Guidelines for Safety of Biotechnology by DBT under the EPA 1986 Effective from: 1990 (last revised in 1998)	● National framework for development of genetically modified plants and their commercial exploitation	a) Gives guidelines for import and shipment of genetically modified plants only and for toxicity and allergenicity evaluation of transgenic seeds, plants and plant parts.

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ABSTRACTS

Interception of Plant Viruses in Exotic Germplasm Imported During 2000-04

VC Chalam, RK Khetarpal, DB Parakh, AK Maurya, A Jain and Shamsheer Singh

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Germplasm of different crops is imported into India every year for crop improvement programmes. As per the Plant Quarantine (Regulation of Import into India) Order, 2003 the imported germplasm material including transgenics are subject to quarantine processing at the National Bureau of Plant Genetic Resources, New Delhi. During 2000-2004, a total of 27,632 samples comprising cereals (23912) and legumes (3720) were imported from different countries. Cereals comprised of *Hordeum vulgare* (5536), *Triticum* spp. (17400) and *Triticale* (976), and legumes include *Asparagus* spp. (1), *Glycine* spp. (1700), *Phaseolus* spp. (1281), *Pisum sativum* (53), *Vigna radiata* (177), *V. unguiculata* (360), *Vicia faba* (136) and *Vicia* spp. (12). They were grown in post-entry quarantine nursery and greenhouses for screening against exotic viruses or strains thereof. The objective was to minimize

the risk of introduction of destructive viruses and their strains into the country and release virus-free harvest to the indenter. Seedlings were observed regularly after emergence till flowering. The accessions showing virus-like symptoms were further subjected to a combination of more than one of the techniques viz., infectivity test, electron microscopy, variants of enzyme-linked immunosorbent assay (ELISA) viz., Double Antibody Sandwich- ELISA and Direct Antigen Coating- ELISA and dot immunobinding assay. All plant residues in greenhouse and plant samples used for testing were incinerated as per quarantine procedure. Twelve viruses viz., *Alfalfa mosaic virus* (AMV), *Bean common mosaic virus* (BCMV), *Bean yellow mosaic virus* (BYMV), *Cherry leaf roll virus* (CLRV), *Cowpea aphid borne mosaic virus* (CABMV), *Cowpea mosaic virus* (CPMV),

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Botanic Gardens: A Gateway of Plant Introduction

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Key Words: Botanic Gardens, Introduction, Acclimatization, Improvement, Exchange

Botanic Garden is an institution holding documented germplasm collections for the purpose of conservation, research, display and education. There are about 2,240 Botanic Gardens throughout the world, spread over 155 countries. About 80,000 plant species have been maintained by the Botanic Gardens worldwide. The germplasm collections of Botanic gardens are unique source at one place and provide enormous scope for study, research and to further utilize these for crop improvement programme. Introduction of plants is an important activity of the Botanic Gardens. There is exchange relation of Plant Genetic Resources (PGRs) amongst the botanic gardens throughout the world by Index Seminum (Seed List) particularly those located in the iso-climatic zones. Therefore, there is a unique scope for introduction of new and novel genotypes from different sources. Once the introduced plant species are acclimatized, these are used for various purposes. The new plant species thus introduced and developed when released in the horticultural trade contribute effectively. However, at present introduction of PGRs through Plant Exchange Programme from abroad is little difficult after enactment of CBD that emphasizes benefit sharing and other legal application.

National Botanical Research Institute Botanic Garden is the third largest and one of the old botanic gardens in India and effectively contributing in plant introduction since its inception. There is exchange relation with about 200 botanic gardens of the world. The emphasis is selection and introduction of new ornamentals for their further exploitation in the horticultural trade. As a result of the sustained efforts many new plant species have been introduced and a repository of genetic base created. Some of the notable introductions are as follows. *Adansonia za*, *Agave salmiana*, *Caesalpinia cacalaco*, *C. mexicana*, *C. gilleisii*, *C. velutina*, *Bougainvillea cvs.*, *Dioon edule*, *Encephalartos gratus*, *Euonymus fortunei* 'Emerald 'n' Gold', *Gladiolus cvs.*, *Houtuynia cordata* 'Chamaleon', *Jacaranda cuspidifolia*, *Nolina stricta*, *N. paryii* etc. The introduced plant materials are first acclimatized, multiplied and their performance assessed in the local agro-climatic conditions. The genotype having desirable characters are further multiplied and utilized in the improvement programme and also given to the other botanic gardens and research Institutes on exchange. Besides, those, which have commercial potentiality, are released for horticultural trade.

Utilization of Introduced Germplasm for Genetic Improvement of Indian Tobacco

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Introduced germplasm has played a significant role in cultivar improvement various types of tobacco cultivated in India. Out of 79 varieties developed and released so far, 13 are direct introductions. Six varieties have been developed using both parents of exotic origin and 11 by using one exotic parent. Forty-nine varieties have been developed by hybridization among indigenous germplasm only. Thus, contribution of introduced

germplasm to tobacco varietal development in India is about 40% as compared to 60% of indigenous germplasm. A judicious use of indigenous germplasm from different sources in complement with specific exotic germplasm is suggested to make further gains in productivity and quality of Indian tobaccos, besides promoting sustainability of the crop. Implications of extensive use of exotic germplasm have also been

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Plant Introductions in Nepal

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Nepal is primarily an agricultural country. The sector contributes nearly 38 per cent to GDP and employs more than 65 per cent. Over 500 crops species are edible and nearly 200 species are under cultivation. Agro-biodiversity plays a vital role in the food security. The valuable genetic resources have been nurtured by farming communities over millennia. Introduction and exchange of germplasm have been carried out since the ancient time. The systematically organized approach of introduction and exchange of germplasm started with the advancement of science, for the betterment of humankind. Nepal has significantly contributed towards exchange of germplasm as visualized by the series of exploration mission carried out by different institution/countries. Similarly the nation has benefited from the plant introduction.

Initially in 1961, two rice varieties CH 45 and BR 34 were introduced for research purposes. Later on CH 45 became the first modern variety in Nepal which is still popular in various rice growing areas. Subsequently

different crops (maize, wheat, millet, potato, oilseeds, vegetables fruit crops etc.) were introduced from various countries/institutes.

Germplasm introduction is important in identifying new adaptive crops and in obtaining new parental material for the development of cultivars of existing crops. Plant introduction has helped increasing genetic and species diversity of plant genetic resources for food and agriculture (PGRFA). The crop improvement work mainly depends on the availability of plant genetic resources which are considered as the basic raw materials to meet the present needs and future aspiration of plant breeders. No country in the world is self-sufficient in genetic resources and their introduction helps to feed the ever increasing population of the world. In Nepal, exotic germplasm are being used to develop crop varieties and limited attention has been given for enhancement of local landraces. The policy process of facilitated exchange of germplasm has been initiated.

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