SPECIAL ISSUE

Indian Journal of Plant Genetic Resources

Vol. 7 1994 No. 2

(continued on back cover page)

Published by

INDIAN SOCIETY OF PLANT GENETIC RESOURCES

NBPGR CAMPUS, NEW DELHI - 110 012, INDIA

Indian J. Pl. Genet. Resources 7(2): 125-131, 1994; Special Issue

BIODIVERSITY IN INDIAN CAMELLIAS - PROBLEMS AND PROSPECTS OF CONSERVATION

I.D. Singh and B. Bera

Tocklai Experimental Station, Tea Research Association
Jorhat 785 008 (Assam)

The availability of genetic diversity in Indian Camellias are discussed with emphasis on need for their conservation. The parts of the gene pool vary according to how they contribute useful variations. The Indian Camellias are endemic to the North-east India which are represented presently by 14 spacies in collections with over 2500 accessions. The majority of the collections are of *Camellia assamica* maintained at three locations. The weaknesses of the present collections are highlighted. The migration of Indian Camellias primarily old seed jats of Assam type presently occupying over 60 per cent of the world tea acreage is focussed. With the alarming rate of loss of genetic diversity due to fast uprooting of old seed-grown plantations in N.E. India, deforestation and difficult accessability of various areas of genetic diversity calls for global concern in conserving tea genetic resources. Future strategies for the conservation of tea germplasm in India are discussed.

Key words: Tea, *Camellia* spp., genetic diversity, conservation

Tea (*Camellia sinensis* (L) O. Kuntze) is the most important beverage crop in the world. Its consumption is fast increasing every year. Among the tea producing countries, India holds number one position as the largest producer, consumer and exporter of tea. It has one of the richest source of *Camellia* genetic wealth specially distributed in the North East. All the three cultivated species of tea namely China type (*Camellia sinensis* (L) O. Kuntze), Assam type (*C. assamica* (Masters) Wight) and Cambod type (*C. assamica* spp. *lasiocalyx* (Planch) Wight) are found in Indian sub-continent. Apart from these species, innumerable intermediate types of tea existing in the region, are the hybrid forms of cultivated species. Besides cultivated species, there are 12 different wild relatives of tea which are also found in the sub continent (Bezbaruah and Singh, 1978).

The conservation of genetic diversity in tea is essential for tailoring new cultivars to meet the ever increasing demand for more and speciality teas. Although a rich genetic diversity of Camellias exist in the North eastern region of India but their systematic survey and collection is lacking. With increasing human activities in the fields of urbanization, industries and modern agriculture

in the region, most of the Camellias genetic wealth are being lost at an alarming rate and hence need to be preserved before they are lost for ever. This paper aims to highlight the availability of biodiversity in Indian Camellias, emphasize the need for their conservation and suggest possible approaches to be adopted for their conservation by concern agencies.

ORIGIN OF INDIAN TEA

The region where tea is considered to be endemic are the hills of Assam, Nagaland, Manipur, Mizoram and Myanmar. In 1823, some indigenous tea plants was presented to Robert Bruce by a Singhpho Chief, a tribal of the region. He reported this indigenous tea plant as a possible source of commercial tea. It took another decade for its popularization as commercial tea due to its yield and quality characteristics. But tea was cultivated first in India (of China type) introduced from China in 1830. After that both China and indigenous Assam type plants grew well. Presently hybrid forms of Assam are very popular in most of the tea growing countries (Singh and Bezbaruah, 1987).

Assam tea and its wild relatives are endemic to the North East region where a rich wealth of genetic diversity exist. Planned surveys in this region for the collection of genetic variants should be taken on priority basis. The alarming rate of deforestation in the region calls for immediate action especially to preserve the endangered forms of Camellias.

GENETIC DIVERSITY AND DISTRIBUTION

Tocklai Experimental Station of the Tea Research Association at Jorhat can claim to have the largest collection of diverse types of tea. The collection is represented by 14 species with 2507 accessions maintained at three main centres (Table 1 and 2). Out of 14 collected species, maximum diversity is shown in *Camellia assamica* followed by *Camellia assamica* ssp. *lasiocalyx.*, mostly collected from the North east region of India. Among the wild relatives maximum diversity is shown in *Camellia drupifera, C. kissi* and *C. caudata* mostly found in the hills of Meghalaya and Assam (Table 1).

Presently tea collection is represented by (i) Primitive seed sources as jats, (ii) natural genetic variants of cultivated species, (iii) wild and related *Camellia* spp., (iv) improved clonal and seed cultivars and (v) natural and bred polyploids. A summary of actual accessiosns maintained at various collection centres of Tea Research Association is presented in Table 2. Although efforts to collect wide genetic diversity of tea started in the beginning of the 20th century, but its representation is far from adequate due to non systematic approach.

Table 1. Particulars of various species of tea established in the field gene bank by Tocklai in North East India

Species	Source of collection	No. of accessions
Camellia assamica	Assam, Manipur Sri Lanka, S. India	2337
C. sinensis	China, Darjeeling Hills	35
C. assamica ssp *lasiocalyx*	Indo China, Myanmar, Assam	60
C. kissi (drupifera)	Meghalaya	50
C. caudata	Assam	
Eurya japonica	N. East India	7
E. acuminata	N. East India	2
Gordonia excelsa	N. East India	2
G. imbricata	Sri Lanka	2
C. japonica	U.S.A., Japan	-
C.sasanqua	U.S.A., Japan	-
C. irrawadiensis	Upper Myanmar	2
C. japonica var. Kyoniski	Japan	1
C. rosiflora	Sri Lanka	1
	Total	2507

Table 2. Collection of genetic diversity of tea in the North East India

	Location	No. of accessions
1.	**Tocklai Experimental Station Jorhat, Assam**	1699
	(i) Primitive seed sources, natural variants	1279
	(ii) Improved seed/clonal cultivars	176
	(iii) Polyploids	174
	(iv) Wild and related *Camellia* spp.	75
2.	**Nagrakata Sub Station, West Bengal**	555
	(i) Natural variants and breeding stocks	490
	(ii) Improved seed/clonal cultivars	65
3.	**Clonal Proving Station, Ging T.E., Darjeeling**	253
	(i) Natural variants and breeding stocks	193
	(ii) Improved seed/clonal cultivars	40
	Total	2507

In addition to field collections, over 1400 herbarium specimens are maintained at Tocklai Experimental Station, Jorhat. These were used extensively for taxonomic studies by Wight to rename cultivated teas into *C. assamica, C. assamica* ssp. *lasiocalyx* and *C. sinensis* (Barua, 1965).

A closer look of genetic diversity in Indian Camellias selected so far has indicated the following :

1. No systematic survey has been taken to collect diverse germplasm representing the gene pool of tea and draw their distribution map
2. Majority of the collections are of *C. assamica* and its hybrid ferms with a bias towards agronomical types.
3. Wild and related *Camellia* species are poorly represented in the collection.
4. Indo-Burma region especially the courses of Irrawaddy river is a rich gene bank for the transgressive segregants of natural hybrid forms of *C. sinensis* and *C. assamica* as *C. assamica* ssp. *lasiocalyx.*
5. The hills of Assam, Meghalaya, Manipur, Nagaland and Mizoram are rich sources of genetic diversity in *Camellia* spp.
6. The genetic diversity collected so far has been poorly evaluated for their various characteristics and
7. Majority of the collections are maintained at one location in field gene banks.

It is therefore, essential that setps should be taken to preserve full spectrum of tea germplasm for current and future use. It is also required because needs of today's plant breeders may be very different from those of 21st century, due to changing food habits and processing methods on the one hand, and projected climatic changes on the other. A systematic collection of genetic diversity in tea should represent the entire gene pool spectrum (Fig. 1) where collections from areas of diversity and cultivation as well as from breeding and research programmes are maintained.

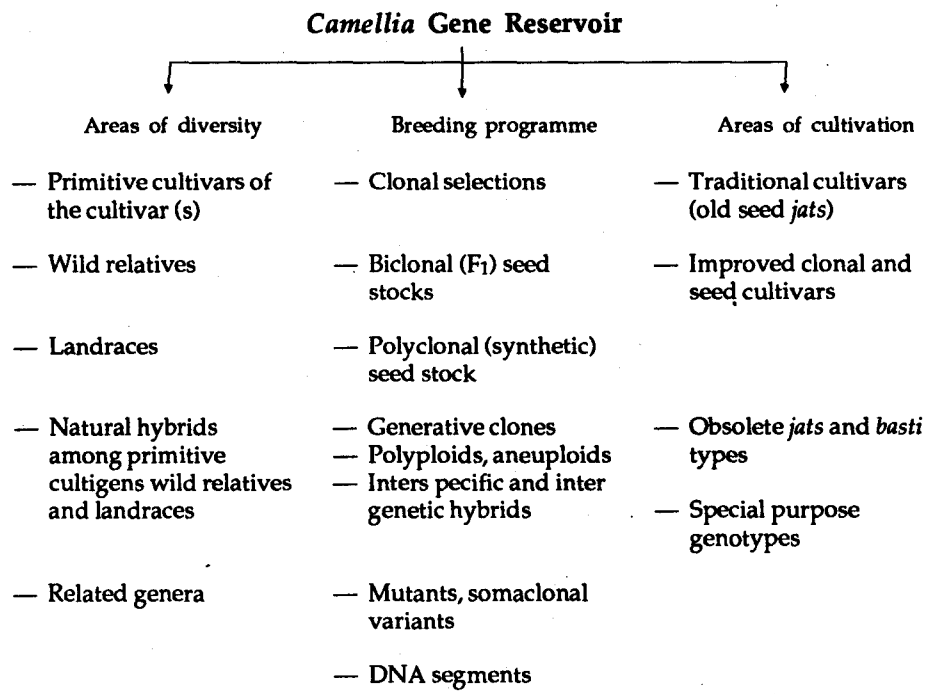


Fig. 1. A *Camellia* gene reservoir full spectrum and its possible sources

MIGRATION OF INDIAN CAMELLIAS FROM NORTH EAST INDIA

The commercial tea plantations in major tea growing areas of India as well as world have received early planting materials primarily from the North east India. Such materials occupy over 60 per cent of the world tea acreage (Singh, 1979). Among the major recipients of early tranditional tea cultivars (seed *jats*) are S. India, Sri Lanka, Mauritius, Bangladesh, East Africa, Central Africa, Iran, Indonesia, and Malaysia. Majority of the seed *jats* which were taken are of *C. assamica* type wherein selection practiced has resulted into the development of many superior clonal cultivars. Among the notable clonal releases are of UPASI series (1 to 30) from the United Planters Association of S. India, TRI 2000 series from the Tea Research Institute of Sri Lanka and many clones released from the Tea Research Foundation of Central Africa, Malawi. The nature of planting materials migrated from the N.E. India to other countries indicate presence of limited genetic diversity regarding the tea gene pool. Hence, the scope of collecting tea germplasm of *C. assamica* and its related species through exotic introductions from abroad is limited. Therefore, attempts should be made to collect the representative gene pool of *C. assamica* from different sources within the country.

CONSERVING TEA GENETIC RESOURCES

Tea is taken as a beverage in most part of the World. Among all the beverages, by far, tea is considered the cheapest. It has medicinal properties also. Tea has been used in pharmaceutical formulations. Demand for more tea of better quality as well as speciality teas is increasing. Tea is cultivated as a perennial crop. All these warrant for collection of diverse tea germplasm to tailor future plants to meet consumers requirements. Rich genetic diversity in tea is found in economically weak geographical regions of China, North East India and Myanmar primarily in the hilly tracts. Accessability to such regions is restricted. It is an alarming problem specially in N.E. India where uprooting of old teas takes place at 2.00 - 2.5 per cent annually besides high rate of deforestation. Therefore, an integrated conservation strategy at the global level ranging from *in situ* conservation of populations to conservation at the molecular level should be developed.

It will be desirable if tea biodiversity reserves are created as an instrument for *in situ* conservation of its genetic diversity. Under this programme, old seed grown sections of tea plantations in N.E. India whose seed sources do not exist, are kept as reserve. Since tea is endemic to N.E. Indian Sub- continent, establishment of tea biodiversity reserves in such areas are important. The cooperation of various national and international agencies engaged in tea cultivation trade and R & D programmes are needed to draw and implement a global plan for the conservation of genetic diversity in tea.

The modernisation of India tea industry for higher productivity of better quality tea through the development schemes like uprooting and replanting is undesirable for conservation of tea genes. The rate of uprooting of old seed grown sections @ 2.5 per cent annually in N.E. India, which are the gold mines of tea genes, is resulting into the loss of valuable genetic diversity almost @ 2.5 per cent annually. If this rate continues within 40- 45 years, all the original sources of tea genes will be lost due to uprooting and would be replaced with few popular clones/seed stocks representing a narrow genetic base. Thus, an integrated action plan is needed to conserve the valuable genes from such seed-grown plantations.

A District Selection Scheme initiated by Tocklai Experimental Station, Jorhat in early seventies with the objective of collecting valuable tea germplasm from old seed grown sections of tea plantations in N.E. India and developing superior clones have paid us rich dividend. Over 7348 ha. of old seed grown sections have been surveyed representing only 3.2 per cent of such acreage and over 115 agronomically superior clonal cultivars developed. Interestingly one clone per ha. has been found. With this rate, another 1500 - 1800 clones could be developed if all the old seed-grown sections are surveyed in the

N.E. India. However, the scheme has not been able to fulfil its desired objectives of collecting germplasm due to biased approach in selecting for agronomical types. The scheme needs to be strengthened for collecting diverse germplasm.

The recalcitrant nature of tea seed, perennial growth habit, slow rate of vegetative propagation/multiplication, widely spaced planting of collections in the field gene bank (100 - 120 cm) × 60 -75 cm apart) requiring considerable land area and lack of proper cryopreservation techniques cause slow progress in conservation.

APPROACHES IN CONSERVATION OF TEA GERMPLASM

While formulating new strategies for collection of genetic diversity, care must be taken to eliminate the weaknesses of earlier collections. Following approaches/points need to be considered while drawing collection strategies:

1. Collection should represent full spectrum of the gene pool.
2. Surveys and collections to be made os as to draw geographical distribution of Indian Camellias which is presently far from adequate.
3. Attempt should be made to collect population (specific) diversity and not plant diversity as specimen plants.
4. Attempts should be made to collect diverse germplasm of wild and related species besides cultivated species from hilly tracts of N.E. India and Myanmar.
5. In addition o ex situ conservation in field gene banks, *in situ* as well as *in vitro* methods of conservation should also be adopted.
6. Bulk of the germplasm collections should be maintained atleast 2- 3 places in the country to safeguard against natural çalamities.
7. The old seed grown sections going under uprooting should be surveyed on priority basis for conserving valuable genetic diversity.

REFERENCES

Barua, P.K. 1965. Classification of the tea plant: species hybrids. *Two & A Bud* **13**: 14-16.

Bezbaruah, H.P. and I.D. Singh: 1978. Current status of tea germplasm in India. Proc. National Symp. Plant & Animal Genetic Resources. I.A.R.I., New Delhi. Dec. 29-30.

Singh, I.D. 1979. Indian tea germplasm and its contribution to the World's tea industry. *Two & A Bud* **26**: 23-26.

Singh, I.D., and H.P. Bexbaruah, 1987. Genetic resources in tea. *In* : Plant Genetic Resources - Indian Perspective. Proc. National Symp. Plant Genetic Resources, R.S. Paroda, R.K. Arora and K.P.S. Chandel (eds) NBPGR, New Delhi, March 3-6. 1987.

Indian J. Pl. Genet. Resources 7(2): 133-145, 1994; Special Issue

SOME OBSERVATIONS ON SYSTEMATICS OF *CROTALARIA* SPECIES

Anjula Pandey and E. Roshini Nayar

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

This paper deals with the systematics of 22 species available in the National Herbarium of Cultivated Plants (NHCP), NBPGR, New Delhi. An effort has been made to work out linkage of *C. juncea* L. with other related species using important vegetative and reproductive key characters. A Himalayan specis *C. tetragona* Roxb. ex Andrews appears to be the closest wild related species of the cultivated *C. juncea*. The section Calycinae to which *C. juncea* belongs, is well represented in India. Another section called Crotalaria shares many characters intermediate to this group is also concentrated mainly in the peninsular region. Besides distribution of different sections such as Grandiflorae, Hedriocarpae, Macrostachyae, etc. has also been discussed. A working key for identification of Indian species was developed based on this study.

Key words : *Crotalaria*, systematics, diversity/distribution

The genus *Crotalaria* Dill. ex L., a large group of annuals or perennial herbs/sub-shrubs, shrubs is distributed in tropics and subtropical regions of the world showing major distribution in tropical Africa followed by centre of variability in the south east Asia and Central America. The genus belongs to tribe Genisteae in subfamily Papilionaceae of Leguminosae. Of about 450 species, over 300 occur only in Africa. About 90 species occur in India, of which over 30 are confined to the peninsular region. Many species are important source of fibre, green manure, fodder, paper pulp, ethnomedicines, etc. Some of the important species such as *C. juncea, C. striata, C. burhia, C. retusa, C.spectabilis, C.verrucosa* are available form variable habitats. *C. juncea* is the most widely cultivated fibre plant in India, Pakistan and Brazil. Baker (1914) has reviewed the taxonomic history and monographical work on the African species as Bentham (1943) has enumerated species from South Asia and Central and South Africa. Senn (1939) has also worked on North and Central American species of *Crotalaria*. There is no comprehensive work on Asian group although Hooker (1879), Gamble (1957) and Cook (1958) have described the Indian species in their floristic works. Since then the efforts by various workers are

lying segregated for researcher's use. Therefore, a completely new treatment of the entire genus though difficult but would be desirable.

The most important species *C. juncea* L., commonly cultivated for bast fibre is a shrubby annual, varying in height from 1.8-3.6 m with bright yellow flowers. Sunhemp of commerce derived from its stem is highly economic fibre with great value in export. Besides this, diverse uses are reported from other species including some wild and cultivated species. *C. juncea*, a source of Indian hemp (also called Madras hemp, Brown hemp), yields a fibre which is more durable than jute, fairly resistant to moisture, mildew and micro-organisms and is much hardy even in salt water (Wlth. India, 1950). It is the oldest fibre cultivated in Indo-Pakistan subcontinent (Watt, 1889). This species has never been reported in wild form nor does its origin known. Tremendous variability has been reported from this region. In the present work, effort has been made to study the species available using certain important vegetative and reproductive characters as key markers to delineate different groups and the species. Based on this, wild species closer to the cultivated *C. juncea* were pinpointed. Effort has been made to establish linkage within these species. A working key has been presented for ready use.

Distribution of Diversity in Cultivated and Wild taxa

Several plant species are native to Asian Tropics. There are about 2,000 plant species that are known to be endemic to the Indian region. About 90 species belonging to the genus *Crotalaria* occur in varied habitats. Amongst these, 35 species are endemic to peninsular region, Assam and temperate Himalayas. India stands second to tropical Africa in its richness of diversity of *Crotalaria* species. Species endemic to peninsular region and confined to Nilgiris and Palni hills are *C. maduraensis* Wight, *C. sandoorensis* Bedd. ex Gamble, *C. grahamiana* W. & A. Species having wider distribution from north western Himalayas to the tropical region are *C.retusa* L., *C. spectabilis* Roth, *C. albida* Heyne ex Roth, *C. mysorensis* Roth, *C. medicaginea* Lamk., *C.striata* DC. The Calycinae and Crotalaria are major sections represented in India with tremendous diversity in each type (Table 1). Other sections such as Hedriocarpae, Incanae, Grandiflorae, Macrostachyae are poorly represented. *Crotalaria* are mainly concentrated in the peninsular region whereas Calycinae occur more widespread in diverse habitats. Several species were found to be widely adaptable to different habitats; some of them are even available up to 3000 m altitude in the Himalayan region. *C. albida* and *C.medicaginea* represent many ecotypes occurring even at high altitudes of sub-temperate regions (1500 - 2000 m), peninsular and Myanmar region. Their absence from north eastern region is indicative of their specific habitat requirement for low humid/low rainfall conditions.

Table 1. Classification and distribution of *Crotalaria*

Sections (after Baker, 1914)	Sections* (after Polhill, 1968)	Main area of distribution	Habitat
Diffuae	Calycinae,	Peninsular region,	Open forest land, grassy slopes, dry
	Crotalaria	N W Himalayas	forest areas
Alatae	Crotalaria	Peninsular region	Dry grass lands
		N W Himalayas	
Calycinae	Calycinae	Peninsular, Diverse	
	Crotalaria	North-west & North-eastern regions	margin of swamps, forest clearings
Glaucae	Crotalaria	Peninsular region	Grassy areas, coastal land
Erectae	Crotalaria	Peninsular; (few Himalayan species)	Swamps, open dawns, hill slopes
Eriocarpae	Crotalaria,	Peninsular region,	Open dawns
	Calycinae	Himalayas	Waste places, dry habitat
Trifoliolatae Dispermae	Dispermae,	Peninsular, NE & N W Himalayas	Low hills & coastal areas
	Diffusae		
Trifoliolatae Polyspermae	Calycinae, Crotalaria, Incanae, Hedriocarpae, Grandiflorae	wide spread	Hill slopes, forest areas, grassy lands
Multifoliolatae	Crotalaria	Peninsular region	Slopes, coastal areas, semi-ever green forests

* Classification based on specimens studied

Crotalaria : generally confined to peninsular region, more bushy types, erect

Calycinae : adaptable to diverse habitat, semi-diffused types

Other groups: scattered all over

Variability was found in *C.ferruginea* for drought resistance, *C.burhia* for dry low rainfall requirements, *C. triquetra* for salt tolerance. Ecotypes in marshy/coastal parts of peninsular region are available. Some of the endemic types such as *C.sandoorensis, C. penduclularis* Grah. ex W. & A., *C. lutescens* Dalz. are now reported to be rare and endangered probably due to habitat disturbance (Nayar and Sastri, 1987).

MATERIAL AND METHOD

Species included in this investigation are listed in table 2. The material was used from the National Herbarium of Cultivated Plants (NHCP), at NBPGR, New Delhi. Seeds of some species were grown in pots and the fresh flowers used for study. Besides, material was also used for comparative studies from other national and international herbaria.

Table 2. Species studied for vegetative and reproductive Characters

Section		Species
Arinariae	Calycinae	*C. burhia* Hamilt.
Diffusae	Calycinae	*C. filipes* Benth.
		C. prostrata Rottle ex Willd.
Alatae	Calycinae	*C. alata** Buch.-Hamilt. & Roxb. ex D. Don
Calycinae	Calycinae	*C. calycina* Schrank
		C. albida Heyne ex Roth
		C. hirta Willd
		C. pusilla Heyne ex Roth
		C. nana Burm.
		C. mysorensis Roth
		C. sessiliflora L.
Glaucae	Crotalaria	*C. lutescens** Dalzell
Erectae	Crotalaria	*C. retusa* L.
		C. sericea Retz. = *spectabilis* Roth
Eriocarpae	Calycinae	*C. juncea* L.
	Crotalaria	*C. verrucosa* L.
		C. triquetra Dalzell
		C. fulva Roxb. = *berteriana* DC.
		*C. tetragona** Roxb. ex Andrews
Trifoliolatae (Dispermae)	Dispermae	*C. medicaginea* Lamk.
	Calycinae	*C. orixensis* Willd.
(Polyspermae)	Incanae	*C. incana* L.
	Macrostachyae	*C. striata* DC.
	Grandiflorae	*C. laburnifolia* L.
Multifoliolatae	Crotalaria	*C. quinquefolia** L.
		C. grahamiana W.&A.

* Material used from other herbaria

For study of herbarium material, customery method (Lawrence, 1964) involving floral dessections was used. This involved removal of dried flowers from herbarium specimens, treating with hot water (40°C) for 40-50 minutes, dessecting well spreading them with help of needle and brush on glass slide. The dried dessections (using blotters) were mounted on glass slide/paper and examined under the dissecting microscope (with 10 X and 20 X magnifications).

Based on study of vegetative and reproductive key characters (Table 3), the species were classified into seven sections (Table 4). A schematic diagram was drawn to illustrate the relatedness of different sections (Fig. 1). Species closely related to *C. juncea* were studied and compared. The line diagrams of different representative species studied, have also been illustrated (Fig. 2).

RESULTS AND DISCUSSION

Species with apparently diverse morphology were classified into different sections/groups by several earlier workers. Based on study of vegetative as well as floral/reproductive characters alongwith anatomy of plant parts, species were classified into different sections. Thus majority of the species were placed in sections Calycinae and Crotalaria which represented 36 per cent and 39 per cent of the total species diversity in this region. Others sections such as Hedriocarpae, Incanae, Grandiflorae, etc. were poorly represented. In general, the sections Crotalaria represented by more bushy, erect types having specific habitat requirement and less adaptability to diverse ecological conditions. Majority of taxa in this sections were confined to peninsular region. On the contrary, Calycinae with diffused to semi-diffused habit, were more adaptable to diverse habitats. They were wide-spread as compared to the previous group. Based on analysis of the distribution pattern, two centres of diversity and variability were pinpointed- the Peninsular region and the Eastern region.

Table 3. Important key characters used for study of different species of *Crotalaria*

Vegetative characters :	*Reproductive characters* :
Habit	Inflorescence
Stem	Flower
Stipule	Calyx
Leaf	Standard
Leaflets	Wing
Indumentum	Keel
	Style
	Stamen
	Pod
	Seeds/pod
	Size of seeds
	Colour of seed
	Texture of seed coat

Table 4. Sectional distribution of certain floral and vegetative characters in genus *Crotalaria* in India

Sections	Stipule	Calyx	Corolla/ Standard (with respect to appendages)	Beak of the keel	Style	No. of species in India/ Introduced species
Gradiflorae	0	equally lobed	Appendages extending on to claw	Untwisted	Curved	1, 2*
Incanae	+	2 lipped	"	Twisted/ Untwisted	Curved & geniculate	1, 1*
Hedriocarpae	+	equally lobed	"	Twisted/ Untwisted	Curved	3, 1*
Macrostarchyae	±	equally lobed	"	Untwisted	Curved	1*
Calycinae	0/+	2 lipped	Appendages on blade only (reduced)	Twisted	Curved & geniculate	36
Crotalaria	+	Calyx tube protracted on the lower side	"	Twisted (sometimes) or untwisted	Curved & geniculate	38, 1*
Dispermae	–	"	"	Twisted	Geniculate	5

* Introduced species

The floral morphology indicated that Calycinae and Crotalaria represented the highly specialised groups with complex floral structure. The former with deeply cleft calyx as long as keel differed from the latter in having calyx protracted downwards. The section Dispermae, closer to Crotalaria appeared to be a specialised one with low seed numbers. The other sections represented comparatively simpler floral morphology.

C. juncea after critical examination of vegetative and reproductive parts was found to be an intermediate species between Crotalaria and Calycinae. Characters such as type of stipule (narrow, minute), standard (lined/veined from outside), bracts and bracteoles bring it closer to Crotalaria than to Calycinae. Based on morphological, taxonomical, anatomical studies, a Himalayan species *C. tetragona* appeared to be the closest among species related to *C. juncea*. So far only a few workers (Rani Mangotra and Bhargava, 1989) have used other markers like the flavonoid characteristics to classifying genus *Crotalaria*. Their studies also supported the closeness of the two species.

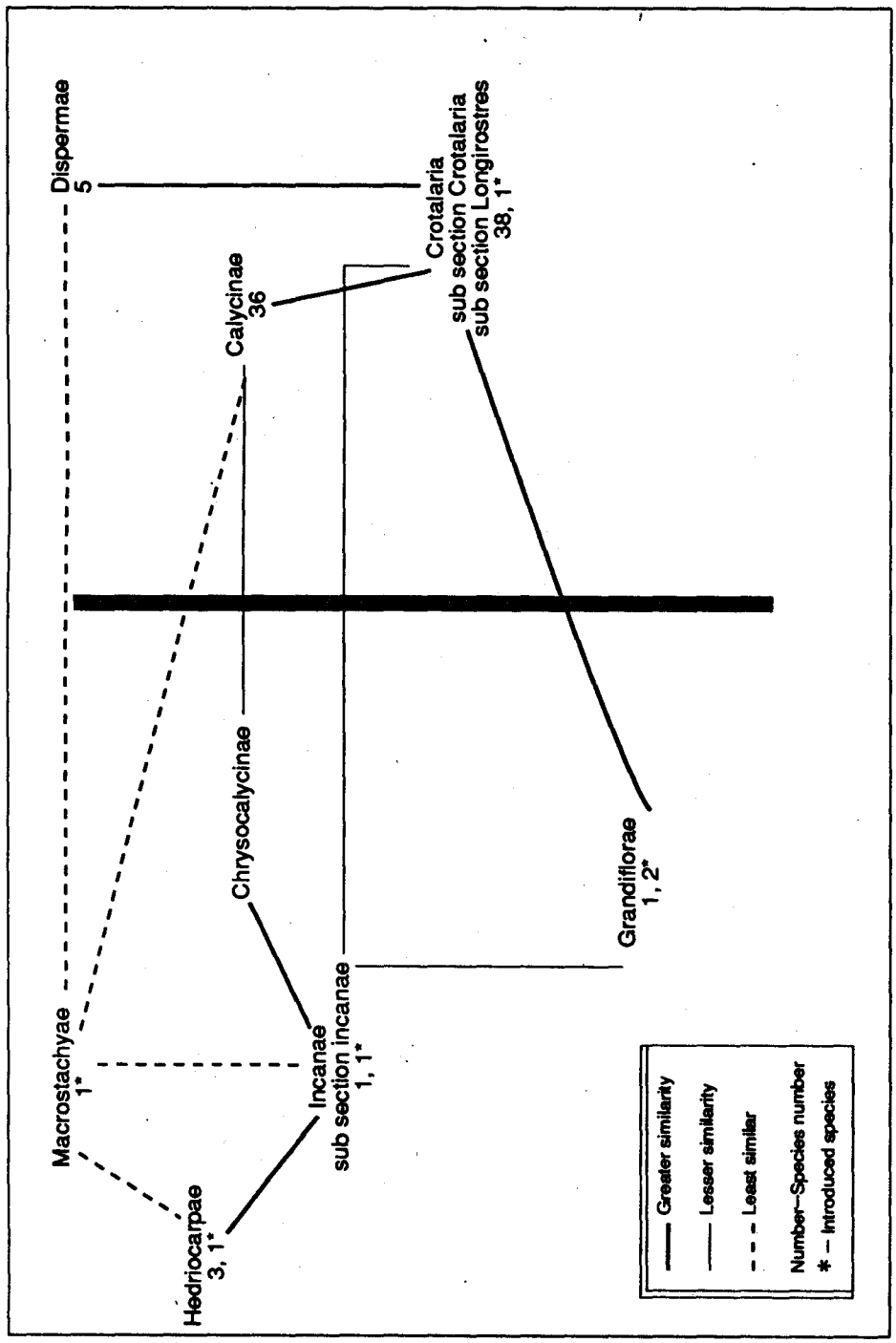


Fig. 1. Schematic arrangement of various sections (Polhill, 1968) and species in genus Crotalaria in India

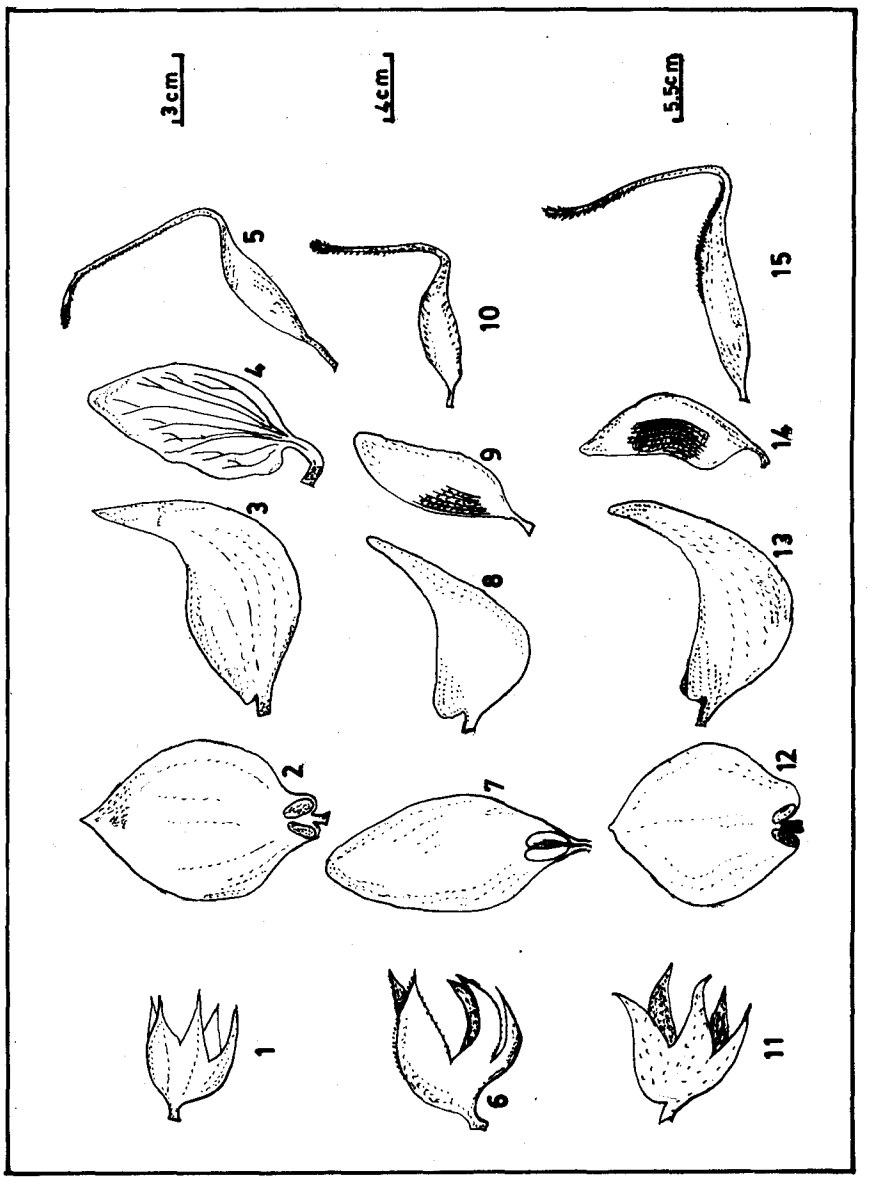
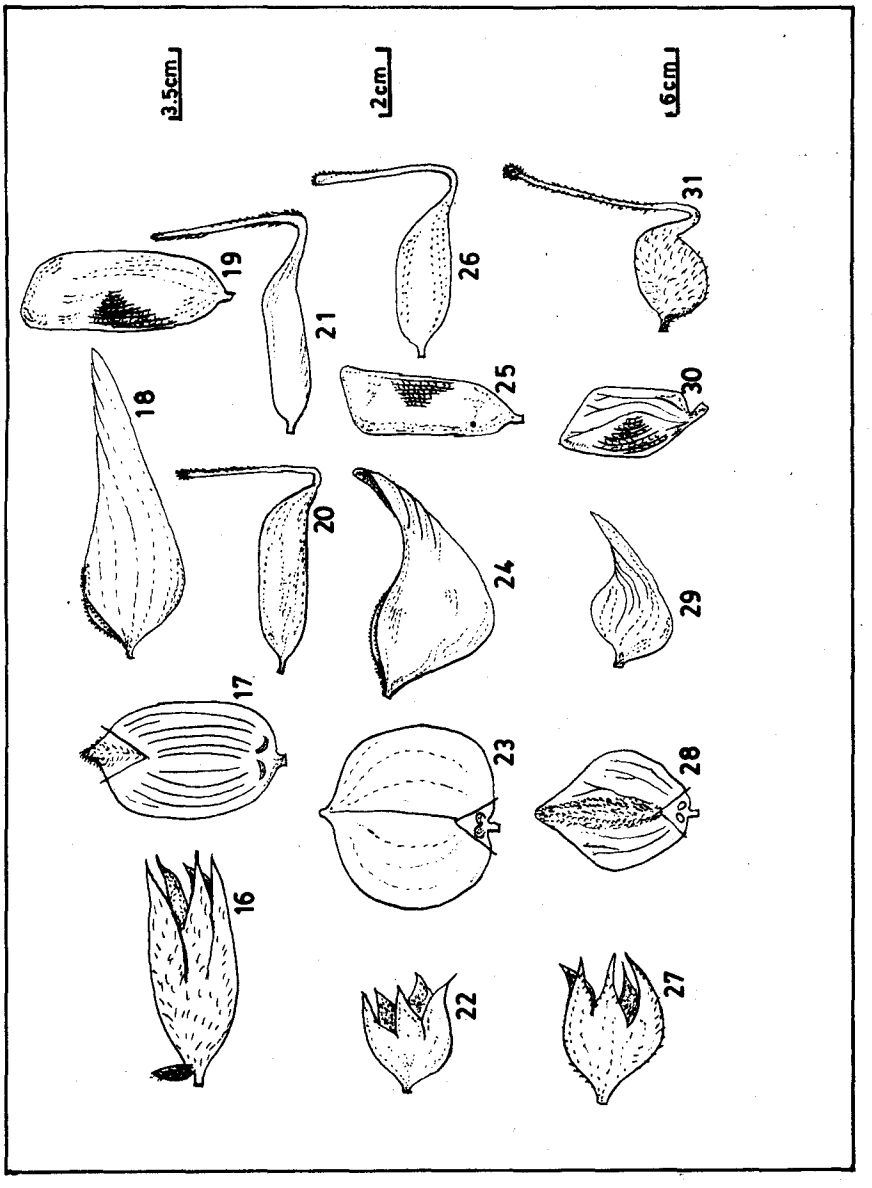


Fig. 2. Line Diagrams of Floral parts of some *Crotalaria* species : C. laburnifolia (sec. Grandiflorae), 1. Calyx; 2. Standard (inner view); Keel (side view); 4. Wing; 5. Gynoecium. C. *incana* (sec. Incanae), 6. Calyx; 7. Standard; 8. Keel (side view); 9. Wing; 10. Gynoecium. C. *striata* (sec. Macrostachyae), 11. Calyx; 12. Standard (inner view); 13. Keel (side view); 14. Wing; 15. Gynoecium. C. *calycina* and C. *albida* (sec. Calycinae)



16. Calyx; 17. Standard (inner view and a part of top outer view; 18. Keel (side view); 19. Wing; 20 & 21. Gynoecium of *C. calycina* and *C. albida*. *C. grahamiana* (sec. Crotalaria), 22. Calyx; 23. Standard (outer with a sector of inner basal view); 24. Keel (side view); 25. Wing; 26. Gynoecium. *C. medicaginea* (sec Dispermae), 27. Calyx; 28. Standard (outer with a section of inner basal view); 29. Keel (side view); 30. Wing; 31. Gynoecium

Key to the species

1 Leaves multifoliolate

1A Leaves 5-7 foliate

2 Leaflets 5, linear-oblong or rarely narrow, oblanceolate; petioles with narrowly lanceolate stipules

..... *C. quinquefolia*

2 Leaflets 5-7, oblanceolate, petiole long & stout with very thin, stipule linear, stem angular

..... *C. grahamiana*

1A Leaves 3 foliate, petiole articulate

3 Seeds 2; pod obliquely sub-globose, small, sessile, beaked, seeds in different shades of gray to brown

..... *C. medicaginea*

3 Seeds many;

4 Pod and stalk less than 2.5 cm, seeds 8-10, mottled, cylindrical, obtuse at both ends, glabrous

..... *C. orixensis*

4 Pod and stalk more than 2.5 cm

5 Stalk of pod shorter than 2.5 cm

6 Pod and stalk less than 2.5 – 3.5 cm, pod cylindrical, recurved, loosely pubsecent, 20-30 seeded, seeds yellowish to dark brown, leaflets membranous, obovate

..... *C. incana*

6 Pod and stalk 3.5-5 cm, cylindrical-falcate, puberulous when young, seeds many, leaflets thick, obovate-emarginate, seeds brown

..... *C. striata*

5 Pod stalk more than 2.5 cm;
Pod cylindrical, 20-30 seeded, glabrous, gynophore filiform, seeds grayish, mottled, glabrous, flowers very large with prominent incurved keel

..... *C. laburnifolia*

1 Leaves unifoliolate; petiole not articulated

7 Stipule decurrent as persistant wing on the branchlets/stem

7 Stipule none or small, not decurrent

8 Raceme terminal and lateral

9 Raceme terminal and lateral, many flowered, low shrubs, deciduous, stifly branched with erecto-patent branchlets- terminal, leaf opposed, often 1-flowered; postrate herbs, leaves obliquely ovate to cordate, rigid

10 Pos small, 10 seeded, shortly stalked, 1-3 flowers, seeds dark brown

..... *C. filipes*

10 Pods longer up to 20 seeded, sessile/nearly so, pods linear oblong, peduncle finely silky, 2-4 flowered, seeds greenish maroon and shiny

..... *C. prostrata*

8 Recemes mainly terminal or a few lateral, many flowered, rarely in age opposite leaves

11 Pods glabrous or very nearly so, stipule none or very minute (may be deciduous)

12 Pod several times longer than calyx, rarely twice long as long as calyx

13 Erect herbs/shrubs, glabrous throughout, leaves membranous, narrow-lanceolate, 6-15 flowers distantly arranged, gynophore=calyx, pod-attenuate, broadening upwards

..... *C. lutescence*

13 Erect herbs/shrubs with silky /pubescent foliage

14 Stipule and bracts minute, linear, leaves retuse at apex, obtuse, glabrous above, puberulent below, pods distantly stalked, linear-oblong, flowers 12-20, seeds in shades of brown, not shiny

..... *C.retusa*

14 Stipule and bracts ovate-acuminate, reflexed, foliaceous, leaves acute, mucronate at apex, pubescent beneath, many flowered, pods rounded at base with flat stalk, seeds dark brown-black, shiny

..... *C.spectabilis*

12 Pods shorter or little longer than calyx, rarely twice as long, glabrous/pubescent, diffused annuals

15 Upper calyx lobe connate except at tip, flowers very small, leaf opposed, in umbells, corolla shorter than calyx, pods slightly exerted, 10-12 seeded, black

..... *C. nana*

15 Upper calyx lobe not connate or only from below; pods shoter than calyx

17 Plants with densely silky hairs, turn golden brown on maturity

18 Flowers not yellow;

Herbs very small with adpressed brown silky hairs, stipule 0, flowers white with pink tinge, become wooly on maturity, 4-8 seeded

..... *C. pusilla*

18 Flowers yellow

19 Diffused undershrubs, thinly clothed with short spreading hairs, stipule setaceous, deciduous,raceme capitate, 2-4 flowered, corolla yellow, pods oblong, seeds 15-20, maroon

..... *C. hirta*

19 Erect plants with long silky, erecto-patent hairs, stipule persistant, linear, flowers many, corolla yellow with maroon streaks, pod ovate, seeds 30 or more, shiny, maroon

..... *C. mysorensis*

17 Plants with short adpressed silky pubescence, turn gray on drying; no stipules, few seeded;

Low diffused undershrubs, flowers 15-20 in laxy terminal/rarely lateral racemes, leaves thick, cuneate, gland- dotted, pods 8-10 seeded, seeds greenish brown

..... *C. albida*

11 Pods hairy

Pods = or shorter than calyx

20 Flower in raceme

21 Flower yellow

22 Flowers in single racemes, terminal or lateral or terminal and lateral both;

stipule ovate or lanceolate, branches 3-angled, very slender, flowers pale yellow, pod thinly silky/ velvetty, seeds blackish brown

..... *C.triquetra*

22 Flower in racemes, generally branched, stiff shrubs with pubescent slender branches, raceme laxy, terminal/ lateral, calyx very deep, densely silky, velvetty with persistant hairs

23 Seeds more than 20

Flowers large (2.5 cm), leaves variable, standard yellow ovate, rounded/ emarginate, with tuft of hairs on back, otherwise glabrous, pods 20-30 seeded, seeds ivory coloured, shiny, whole plant silky.

23 Seeds not more than 20

24 Leaves membranous, calyx 2-2.5 cm, corolla lemon yellow, standard orbicular with blunt apex, scanty hairs on back, pods 12-20 seeded, seed blue-black

..... *C.tetragona*

24 Leaves firm, calyx 1-2 cm, corolla bright orange/ yellow, with maroon stripes, standard ovate-elliptical with acute apex, long dense hairs on mid rib on back, otherwise scattered, 10-20 seeded, seeds brown-black

..... *C.juncea*

21 Flower not yellow

25 Corolla not exerted, standard glabrous except a few tuft of hairs on back (tip), emarginate, moderately firm leaves;

Leaves narrow on both the ends, flower blue or white, in elongated racemes, pod = calyx, seeds blackish gray/gray, stipule setaceous, minute

..... *C.sessiliflora*

25 Corolla exerted, blue/white with violet rays, standard glabrous, pod much longer than calyx, glabrous at maturity, seeds 10-15, deep yellow, rugose, leaves variable - elliptical to lanceolate, membranous, stipule semi - lunate, stem / branches angular

..... *C. verrucosa*

20 Flowers in panicle

Pods short, scarcely if at all longer than calyx, leaves obovate- lanceolate, densely silky with shiny golden hairs, stipule subulate, small or 0, erect, standard elliptical, pods with recurved persistant style, seeds 2, shiny, light brown

..... *C. berteriana*

ACKNOWLEDGEMENTS

Authors express their sincere thanks to Dr. M.N. Koppar, Head, and Shri Umesh Srivastava, Senior Scientist, Exploration Division, NBPGR, New Delhi for critical criticism, necessary suggestions and help.

REFERENCES

Bentham, G. 1943. Enumeration of Leguminosae indigenous to South Asia and Central and South Africa. XV. *Crotalaria*. Hook. *Lond. J. Bot.* **2** : 472-81

Cook, T.1958. Fl. Pres. Bombay. I : 310-24 (repr. ed.).

Gamble, J.S. 1957. Fl. Pres. Madras. I : 280-302 (repr. ed.).

Hooker, J.D. 1982. Fl. British India. Vol. 2. : 65-85. Baker, E.G. 1914. The African Species of *Crotalaria. Jour. Linn. Soc. Bot.* **42** : 241-45.

Lawrence, G.H.M. 1964. Field and Herbarium Techniques. *In* : Taxonomy of Vascular Plants p. 234-62. Oxford and IBH Publishing Co. New Delhi. 823p.

Mangotra, Rani and R. Bhargava. 1989. Flovonoids as an aid in solving taxonomic problems in genus *Crotalaria* L. *J. Econ. Tax. Bot.* **13**(2). p. 284-89.

Nayar, M.P. and A.R.K. Sastri. 1987. Red Data Book of Indian Plants. I. p. 147-159 and Vol. II. p. 109-118. Botanical Survey of India, Howrah, India.

Polhill, R. M. 1968. Miscellaneous notes on Africa species of *Crotalaria* L. II. **22**(2) p. 169-348.

Senn, H.A. 1939. The North American Species of Crotalaria. Rhodora **41** (488): p. 317-57.

Watt, G. 1889. A Dictionary of Economic Products of India, Calcutta. Vol. II. p. 595 - 614.

Wlth. India. 1950. The Wealth of India- Raw Materials. Vol. II. p. 372-83. Publications and Information Directorate (CSIR), New Delhi.

Indian J. Pl. Genet. Resources 7(2): 147-150, 1994; Special Issue

CYTOGENETICS OF *CAJANUS CAJAN* (L.) MILLSP. × *ATYLOSIA* SPECIES

Satyendra Nath Tripathi

Division of Plant Improvement
Indian Grassland and Fodder Research Institute,
Jhansi 284 003 (Uttar Pradesh)

The cross between *Cajanus cajan* amd *Atylosia* spp. was successful and viable hybrids were obtained. The genomic affinities between *Cajanus cajan* and *Atylosia* spp. were determined following hybridization through studies on chromosomal pairing and pollen fertility. The present investigation revealed the existence of considerable degree of homology between the chromosal complements of these species. The partial pollen sterility and occurrence of unpaired chromosomes can possibly be attributed to the structural differences in the parental genomes to some extent or to the action of different genetic factors which inhibit chromosome pairing. The hybrids of *C. cajan* and *Atylosia* species manifest forage potentiality.

Key words : *Cajanus cajan, Atylosia* spp., *cytogenetics*

Cajanus cajan is a pantropical species and is most adopted and productive in the semi-arid tropics. Species of *Atylosia* constitute the wild germplasm of *Cajanus cajan*. Of the thirty species or so in *Atylosia*, most of them occur in Asia. But about 1/3 are found in Australia (Raynolds and Pedly 1981). *Atylosia cajanifolia* and *Atylosia lanceolata* are drought hardy and well adapted to fertile soil (De, 1974; Pedly, 1980). *Atylosia scarabaeoides* and *Atylosia albicans* are considered to be the sources of high protein (Reddy *et al.*, 1979). The present investigation reports the cytogenetics of hybrids between *C. cajan* and *Atylosia* species.

MATERIALS AND METHODS

Materials comprised *Cajanus cajan* (2n=22). *Atylosia cajanifolia* (2n=22). *Atylosia scarabaeoides*(2n=22), *Atylosia albicans* (2n=22) and *Atylosia lanceolata* (2n=22). For the intergeneric crosses, *C.cajan* was used as female parent and F_1 hybrids of *Atylosia* spp. as pollen parent. Meiotic studies were done following propionocarmine staining technique and the pollen grains were stained in 1 per cent acetocarmine.

RESULTS AND DISCUSSION

A. Intergeneric hybrids

1. *Cajanus cajan* × *Atylosia cajanifolia*

In the F_1 hybrid the homoeologous chromosomes participating in pairing were identified. The synopsis in these bivalents was complete. This has indicated close homology between the parents. However one bivlent exhibited heteromorphism in the hybrid. Pollen fertility was near normal. The hybrid showed high leafiness.

2. *Cajanus cajan* × *Atylosia lanceolata*

During meiois, bivalent chromosomal association was the most common at metaphase I in the hybrid. The low occurrence of univalents at metaphase I in the hybrid indicated considerable chiasma formation and hence crossing over between *C.cajan* and *Alanceolata.* Partial pollen sterility was noticed in the hydrid.

B. Trispecific hybrids

3. *Cajanus cajan* × (*Atylosia albicans* × *Atylosia scarabaeoides*)

Meiosis in the trispecific hybrid revealed formation of 7 bivalents and 8 univalents. Most of the bivalents showed loose pairing. Also, precious separation in one of the bivalents could be seed. Partial pollen sterility was observed in the hybrid. The on shattering nature of the mature pods of the trispecific hybrid revealed greater possibility of increased seed harvest.

4. *Cajanus cajan* × (*Atylosia cajanifolia* × *Atylosia scarabaeoides*)

In this trispecific hybrid, one heteromorphic bivalent was invariably present. Pollen sterility was seen to be higher in the trispecific hybrid as compared to those of the parents. The F_1 hybrid showed very high leafiness. The trispecific F_1 hybrid was erect with branch end drooping as compared to erect and semi erect growth habits of female and male parents respectively. In the segregating progeny of the hybrid, different plant types viz., erect, semi erect, semi erect with branch end drooping and spreading were semi erect with branch end drooping and spreading were scored. The fertility percentage in such plants ranged from 48.5-66.0 and days to flowering from 115-170. These new plant types were invariably associated with high leafiness and smooth leaf surface, which are important characteristics from the forage point of view.

Species of *Atylosia* with diverse growth habits (Table 1) and *C. cajan* (an erect shrub) have hermaphorodite flowers which require hand emasculation and pollination for hybridization. The possibility of hybridization between *Atylosia* species and *C.cajan* was first pointed out by Deodikar and Thakar

Table 1. Growth habits of *Atylosia* species used in crosses with *Cajanus cajan*

Species	Growth habit
A. *cajanifolia* Haines	Erect shrub
A. *scarabaeoides*	Herbaecous creeper
A. *albicans*	Perennial climber
A. *lanceolata*	Erect shrub

(1956). They have suggested that it may be possible to transfer wilt resistant character of *Atylosia* and combine it with the desirable agronomic characters of *C.cajan*. Both, the wild *Atylosia* spp. and cultivated crop, *Cajanus cajan* have chromosome number n = 11. Thus, it is clear that the development of crop took place without alteration in the chromosome number.

The high cross compatibility of *C.cajan* and *A.cajanifolia* indicate that they have diverged from each other in the recent past or both have originated from a common ancestral stock. This further supports the contention of vander Maesen (1980) that *A.cajanifolia* is the putative progenitor of *C.cajan*. The affinities of *C. cajan* and *A.lanceolata* was determined following hybridization through studies of pollen and chromosomal pairing. Trispecific cross between *C.cajan* and F_1 of *A.albicans* × *A.scarabaeoides* were successfully attempted. Parental plants having different morphological traits have shown close affinity in their chromosome complements as evident by the formation of high degree of bivalents during meiosis.

The present studies and the earlier works (Reddy *et al.*, 1980; Pundir and Singh, 1985) on the cytogenetics of *C.cajan* × *Atylosia* spp. revealed an important fact about the existence of considerable degree of homology between the chromosome complements of these species. The partial pollen sterility and the occurrence of unpaired chromosomes can possibly be attributed to the structural differences int he parental genomes to some extent or to the action of different genetic factors which inhibit chrmosome pairing. In some cases, the heteromorphism exhibited by single bivalent indicated that the genomes involved in hybridization have attained some degree of non-homology in their chromosomes.

The hybrids of *C. cajan* and *Atylosia* species manifest forage potentiality. It is emphasized that *Atylosia* spp. can very well be utilized in breeding superior strains of *C.ajanus cajan*.

ACKNOWLEDGEMENTS

Sincere thanks are due to Dr. Panjab Singh, Director, Indian Grassland and Fodder Research Institute, Jhansi, for providing facilities and for useful suggestions.

REFERENCES

Deodikar, G.B. and C.V. Thakar. 1956. Cytotaxonomic evidence for the affinity between *Cajanus indicus* spring and certain erect species of *Atylosia* W. & A. *Proc, Indian Acad Science* **43** (B) : 37-45.

De, O.N. 1974. Pigeonpea. *In* : J.B. Hutchinson (ed.). Evolutionary studies in World Crops, p. 79-87, Cambridge University, Cambridge.

Pedley, L. 1980. *Atylosia* in Australia. *In* : Proceedings International Workshop in Pigeonpea, ICRISAT, Patancheru, India **2**: 51-52.

Pundir, R.P.S. and R.B. Singh. 1985. Crossability relationships among *Cajanus, Atylosia* and *Rhynchosia* species and detection of crossing barriers. *Euphytica* **34** : 103-108.

Reddy, L.G., J.M. Green, U. Singh, S.S. Bisen and R. Jambunathan,. 1979. Seed protein studies on *Cajanus cajan, Atylosia* spp. and some hybrid derivatives. Proceedings Symposium on seed protein improvement **2**: p. 105-117. International Atomic Energy, Vienna, Austria.

Reddy, L.J., Green, J.M. and D. Sharma 1980. Genetics of *Cajanus cajan* (L.) Millsp. × *Atylosia* spp. Proceedings, International workshop on Pigeonpea, ICRISAT, Patancheru, India **2**: 15-19.

Reynolds, S.T. and L. Pedley. 1981. A revision of *Atylosia* (Leguminosae) in Australia. *Austrabalieya* **1**(4): 420-428.

Vander Maesen, L.J.G. 1980. Taxonomy of *Cajanus*. Proceedings, International workshop on pigeonpea, ICRISAT, Patancheru, India **2**: p. 9-13.

Indian J. Pl. Genet. Resources 7(2): 151-155, 1994; Special Issue

COLLECTING CEARA RUBBER (*MANIHOT GLAZIOVII* Muell) Arg. GERMPLASM

P. J. George and C. P. Reghu

Rubber Research Institute of India
Kottayam 686 009 (Kerala)

The restricted cultivation of *Hevea brasiliensis* in the tropical zones due to its agroclimatic preference, necessitates an alternative source of natural rubber for the semi-arid marginal lands. Preliminary studies showed that *Manihot glaziovii* known as ceara rubber, is a potential plant for such semi-arid marginal lands. The plant was introduced to India in 1902 during the regime of the British. it is well adapted to the dry granitic highlands with scanty rainfall. Under such stress affected conditions, the unselected wild plants yield an appreciable quantity of latex containing more than 80% rubber. Since there is no organised cultivation of *M. glaziovii* in India, genetic materials are not commonly available. An exploration to the semi-arid hill tracts of Tamil Nadu resulted in the collection of a large semi-wild seedling population. Mature trees were tapped at random and on the basis of the preliminary observations on the bark characteristics, Latex flow pattern and morphological variation in germplasm were also observed.

Key words : Ceara rubber, *Manihot glaziovii*, exploration/collextion

For every crop, an alternative source or life support species is highly necessary. Moreover, it is today's need to cultivate the marginal lands and upgrade the poor soil with species adapted to the extreme hostile environment (Randhawa, 1987; Paroda, 1987; Smith, 1987). The major rubber yielding crop *Hevea* is under a potential threat due to South American Leaf Blight (SALB) caused by *Microcyclus ulei* (Thomson, 1986; National Acad. Sci., 1977). The increasing demand for natural rubber and paucity of suitable areas, warrants the identification of a suitable stress tolerant species adapted to the drought prone semi-arid marginal lands (Menon, 1983). Under the circumstances, *Manihot glaziovii* (ceara rubber) was examined as the potential alternative rubber yielding plant with certain extent of drought tolerance. *M. glaziovii* was one of the source of natural rubber in the early part of the century (Seeligman, 1910; Polhamus, 1962). It is a native of the central regions of NE Brazil and introduced in India in 1902 (Serrier, 1988).

There are reports on the occurrence of few trees of *M. glaziovii* in different parts of South India (Singh, 1983). It is also grown in the Central Tuber Crops Research Institute, Thiruvananthapuram (Kerala) for cassava breeding purpose. Two other species viz., *M. dichotoma* Ule and *M. piauhyensis* Ule are also

reported to be available in the Botanical Gardens at Calcutta and Bangalore (Wlth India , 1962).

EXPLORATION AND COLLECTION

A large seedling population of *M. glazlovii* growlng in a semi-arid condition, varying from huge trees to small seedlings were explored in the Mettur hills of Tamil Nadu. This hill station is situated about 60 km. from Salem District ad is continuation of the Yercaud-Shevroy hill tract. Fifty seedling trees were identified and a preliminary screening were conducted. Out of these, 10 genotypes were tentatively selected on the basis of certain attributes. Accessions collected included IC 101, 102, 103, 104, 105, 106, 107, 108, 109, 110.

EXTENT OF GENETIC DIVERSITY

M. glaziovii - a quick growing tree, belongs to the family Euphorbiaceae. It thrives well in areas where soil is degraded and rocky. Adversities like low rainfall, low humidity, drought and other stress environments seldom affect the survival of the plant. It can grow well at high attitutde up to 1800 m. The tree grows to a height of 8-12 m with ramified trichotomous branches and canopy. Girthing of the trunk is fast that it attains 40-50 cm at 4th year. It can be propagated by seeds as well as through vegetative cuttings. Wintering starts from January to April and flowering follows after refoliation. Flowering is noticed usually in March-April (Ramrao, 1914), but off season flowering has also been observed (George, 1993). The trunk of the trees is almost straight, covered by a leathery, peelable rhytidome under which the smooth bark is visible with numerous lenticels. Leaves are alternate, oblong- oval and palmately lobed. Leaf lobes vary from 2-7. Flowers are monoceious and unisexual. Male flowers are seen at the top of the panicles. Female flowers are located at the lower pedicels. Flower colour varies from white to violet. Flowering starts at the age of 18 months. Fruit is a capsule with three locules. Seeds are small, plano-convex with mottled tough integument. Each seed weighs about 0.58 gm. The endosperm contains about 40-99 per cent oil (George, 1993). Bark of *M. glaziovii* is smooth and soft beneath the rhytidome. Bark colour varies from white to green. The green bark contains chlorophyll. Bark retains moisture during frought season.

The laticifers in *M. glaziovii* are compound, articulated and anastomosing as in *Hevea*. The inter-connected latex tubes are sandwiched with secondary phloem elements (Scoor, 1884; George, 1993). Table 1 depicts the variation in the girth, bark thickness and bark anatomical traits of samples collected from Mettur hills. The trees can be tapped for latex collection, when they attain a girth of 40-50 cm at a height of 100 cm from ground level. The rhytidome has to be removed prior to tapping from the portion of the trunk marked

for opening the channel. The tapping channel may be opened at a slope of 30°, using a Jebong knife. Half spiral cut and 'V' shaped cuts also can be tried. During every latex collection operation, the channels are to be reopened by shaving off a thin layer of bark. Tapping may be done on alternate days. The latex thus oozing out, will be directed through a spout to the collection cups.

Table 1. Variation in the girth, bark thickness and anatomical traits

Tree No.	Girth (cm)	Bark thickness (mm)	No. of latex vessel rows	Density of latex vessel/mm circumference of the plant	Diameter (m)
1	112	15	19.7	34.0	17.39
2	107	16	29.7	36.0	16.45
3	130	18	10.0	35.4	18.36
4	112	16	25.5	32.6	13.79
5	115	16	11.6	36.0	14.04
6	142	15	24.5	47.4	14.40
7	140	16	8.0	39.4	16.20

The wild population of *M. glaziovii* showed wide variation in their various characteristics like bark colour, latex flow duration, volume of latex, rubber content etc. Dry rubber yield varies from 4.6 g to 10 g per tree per tap. The estimated potential yield is 276 to 600 kg.hectare per year. Latex is milky white and thick. Unlike in *Hevea*, the latex flow is affected by spontaneous coagulation. Preliminary studies showed that low latex vessel turgor and high plugging index (PI) are certain prominent adverse characters present in the specie (Table 2).

Table 2. Latex flow characteristics of *M. glaziovii*

Tree	Initial vol. of latex ml (5 mts)	Total vol. of latex (m)	Plugging index (PI)	Dry rubber
1	7	15	9.33	7.97
2	22	32	13 .75	9.04
3	23	47	9.78	10.55
4	11	22	10.00	7.81
5	11	30	7.33	7.37
6	24	33	14.55	6.92
7	20	34	11.76	7.78

It has also been observed that upon dilution with water viscosity of latex increases significantly eventually resultant in coagulation.

Properties of air dried sheet prepared from *Manihot* latex have been assessed in comparison with that of *Hevea* latex. The appearance of sheet rubber is similar to that of *Hevea*. However, ash content (1.18%) and nitrogen content (0.99%) of *Manihot* rubber are higher than that of *Hevea* rubber. Acetone extract is significantly higher (5.64%) in the case of the former indicating a higher concentration of resins.

M. glaziovii can be listed as a potential alternative source of natural rubber. Ceara rubber plantation will be a solution for the afforestation of marginal with degraded soil unsuitable for other crops. The drawbacks experienced in latex production can be eleminated through breeding and selection. No crop improvement attempt has so far been made with a view to increasing rubber production in *M. glaziovii*. Genetic resources available at stray locations have to be collected and conserved before they are destroyed. Breeding cycle and selection constraints can be reduced considerably due to the early flowering habit and vegetative propagation facilities. Important technological properties of *Manihot* rubber is comparable with that of *Hevea* rubber. In addition to rubber, the tree yields wood and seed oil. Ceara rubber Garden is the most ideal place for bee-keeping (Nehru *et al.*, 1989).

REFERENCES

Wlth India. 1962. Manihot *In* : Wealth of India - Raw Materials. Vol. VI. Publications and Information Directorate, CSIR, New Delhi.

George, P.J. 1993. Studies on *Manihot glaziovii*, Mell. Arg. with special reference to its potentiality as an alternative source of Natural Rubber. Ph.D. Thesis. Mahatma Gandhi University, Kerala.

Menon, K.K.G. 1983. Plantation opportunities - Need for long term planning. *In* : Plantation Crops - Opportunities and constraints. Vol. I. Oxford & IBH. New Delhi.

National Academy of Science. 1977. Guayule - An alternative Source of Natural Rubber. National Academy of Sciences, Washington. D.C.

Nehru, C.R., S. Thankamony, K. Jayaratnam and P.M.L. Joseph. 1989. Nector and pollen plants for extending the flow period in rubber growing areas of India. Bee World. Cardiff. International Bee Research Association. Vol. 70

Paroda, R.S., P. Kapoor, R.K. Arora and Bhag Mal. 1988. Life Support Species: An Indian Perspective. Proc. CSC/ICAR. International workshop. NBPGR, New Delhi.

Polhamus, L.G. 1914. Rubber - Leonard Hill Books, Ltd. London.

Rama Rao, M. 1914. Flowering Plants of Travancore. Dehradun.

Randhawa, N.S. 1987. Concept of Life Support Species for emergency and extreme environemtal conditions. *In*: Life Support Plant Species: Diversity and Conservation. NBPGR, New Delhi.

Scoot, D.H. 1984. On the Laticiferous tissue of *Manihot glaziovii*. (The Ceara Rubber. O.J. Micros). *Science* **24** : 193-203.

Seelingman, T., L. Torrilhon and H. Falconnet. 1910. Indian Rubber and Guttapercha. Scott, Green wood and Sons - London.

Serier, J.B. 1988. Le Manicoba: historie, biologie, culture interest economique. Caou ate houses et Plastiques n 677. p117- 122.

Smith, R.W. 1987. The place of Life Support Species in hostile or risk-prone environemtns: An overview. *In* : Life Support Plant Species. Diversity and Conservation. NBPGR, New Delhi.

Thomson. T. Edathil. 1986. South American Leaf blight - A potential threat to the Natural rubber industry in Asia and Africa.

Singh, Umrao, A.M. Wadhwani and B.M. Johri. 1983. Dictionary of Economic Plants in India. 2nd ed. ICAR, New Delhi.

Indian J. Pl. Genet. Resources 7(2): 157-164, 1994; Special Issue

JUVENILE CHARACTERIZATION OF WILD HEVEA GERMPLASM

Saji T. Abraham, C.P. Reghu, A.O.N. Panikkar, S.N. Potty and P.J. George

Rubber Research Institute of India
Kottayam 686 009, (Kerala)

Certain vigorous clones of *Hevea brasiliensis* selected from the population representing the three provenances in Brazil i.e., Acre, Rondonia and Matto Grosso were morphologically characterised to define the juvenile plant type of the wild clones, at the age of one year after planting, in field conditions using the parameters, habit of the plant, nature of axillary buds and leaf scars, shape and appearance of leaf storey and leaf characters. Specific variations were noted for most of the characters between the wild clones belonging to the three provenances. The importance of characterization in maintaining the identity of the hitherto under scribed wild germplasm is emphasised.

Key words : *Hevea brasiliensis*, characterization, population

Germplasm collection, conservation and evaluation has assumed great significance in various crops, and is carefully pursued by many national and international agencies, on a priority basis. *Hevea brasiliensis*, the most important source of natural rubber (Family : Euphorbiaceae), is a native of Brazil. The resultant narrow genetic base of the crop, the potential threat from diseases and genetic erosion and the requirement for environment friendly clones highly demand the broadening of the genetic base and its conservation. Plant breeders in the field of rubber research has thus urged to take steps to replenish the breeder's stock by collecting new genotypes from the Amazonian rain forests. (Ahmed, 1986). The 1981 exploration conducted by International Rubber Research and Development Board (IRRDB) to the primary centre of origin of the Para rubber tree has resulted in a large collection of wild genotypes of *Hevea* which can be utilised in crop improvement by introgression of new genetic traits in the present cultivars expecially for disease resistance and cold and drought tolerance.

While the role of germplasm in the improvement of cultivated plants has been well recognized, the successful utilization of the genetic pool, particularly in the developing countries, is still only to a very limited extent.

(Holden and William, 1984; Gill, 1984). One of the serious constraints is the delay in characterisation and cataloguing. Until a particular collection is properly evaluated and its attributes made known to breeders, it is of little practical use. The process of evaluation begins with characterisation chosing proper descriptor list followed by recording of data for each accession. Standardised methods for observation and recording of these characters are essential to provide means for classifying germplasm and is necessary for studying the pattern of variability. The present work was undertaken to characterise the morphological traits of the wild *Hevea* germplasm at juvenile stage, as the first step in the cataloguing and evaluation of a large population. Only limited efforts have been reported in morphological characterisation of *Hevea* clones in general (Dijkman, 1951; Silvia and Satchuthananthavale, 1961; Jayasekara *et al.*, 1984 and Mercykutty *et al.*, 1991) and that of the wild genotypes in particular.

MATERIALS AND METHODS

Clonal population raised from 80 genotypes of *Hevea brasiliensis* (Willd. ex. Adr. de. Juss.) Muell. Arg., procured through 1991 IRRDB collection trip were chosen for the study. The genotypes represented three provenances (Acre, Matto Grosso, Rondonia) in more or less equal proportions. Budding was carried on to assorted seedling sticks and the successful budgrafts were raised in polybags. The budded plants raised in polybag were planted at the age of five months in a field trial in July 1992, adopting 2.5 × 2.5 m spacing with four replications of four plants each. Observations were taken for the qualitative characters at the age of thirteen months after planting. Leaf characters were recorded from the top most mature whorl. The characters observed were recorded in a format (Table 1) designed for the purpose.

RESULTS AND DISCUSSIONS

Of the 80 wild genotypes, 28 belonged to Matto Grosso, 25 to Acre and 27 to Rondonia. The genotypes showed considerable variation of the most of the characters described. Individual plants within a genotypes showed in general similar character expressions. There was no specific pattern in the expression of traits between the three provenances. The variation in the expression of the characters were thus distributed over the 80 genotypes. The genotypes showed variations for the characters such as habit, girth of the plant, leaf scar margin, seperation of the leaf storey, shape and size of petiole, petiolule orientation, petiolule size, prominance of extra floral nectary, leaf colour shape and size, leaf margin, cross sectional appearance of leaf blade, leaf tip, lateral appearance, leaflet arrangement and prominance of vein. Branching habit, nature of axillary buds and leaf scars leaf storey shape,

external appearance of the leaf whorls, prominance of pulvinus, petiole angle, luster and texture of leaves, leaf thickness, leaf vein colour and nature of dorsal surface of the leaf blade exhibited very little variation and more of a uniformity over the entire genotypes. The frequency of distribution of the genotypes in the different scores is given in Table 1.

The general habit of the plants showed that majority of Acre and Matto Grosso genotypes had a medium height and lean habit, while most of the Rondonian genotypes were tall and lean, with the remaining genotypes distributed over other classes. The vigour of the plants was found to be generally more for Rondonian genotypes as indicated by their girth, while the Acre and Matto Grosso genotypes followed with average girth for majority of them. Dijkman (1951) and Polhaums (1962) had reported the relevance of the axillary buds and leaf scars in identifying different clones. In this study, it was noticed that almost the entire sample population characterised, had normal axillary buds. Majority of the Acre genotypes showed prominant leaf scars with pronounced margin while the genotypes of the other two provinances had normal leaf scars. One of the most easily identified character in the genotypes studied was the shape of the first mature top most leafwhorl. This was also reported by Silva and Satchuthananthavale (1961) and Mercy Kutty *et al.* (1991). Here, the majority of the genotypes had hemispherical leaf whorls while a few genotypes from the three provenances had genotype specificity for this character with conical, truncate and bow shaped whorls. It was noted that in general, majority of the genotypes had well separated leaf whorls except for certain genotypes with intermediate separation and a few with closely placed whorls. In general, the genotypes expressed open whorls. In leaf characters, there were marked open whorls. In leaf characters, there were marked variation for the petiole shape and size where majority of the genotypes had concave and straight petioles. A few of the Rondonian genotypes had long 'S' shaped petiole and one genotypic from each of the provenance showed arched petioles. Considerable variation was noted in the petiole length. Majority of the plants had petioles with acute angle and only a few had wide angle of insertion. Petiolule orientation and its size were also found to be distributed over the entire class, with the majority of the genotype possessing upwardly oriented medium size petiolules. In a limited number of genotypes, leaflets were easily distinguishiable by specificity in the colour, luster, texture, size, shape, leaf margin, lateral appearance, leaflet arrangement, cross sectional appearance, leaf apex, nature and colour of vein and appearance of dorsal surface of leaflets. However majority of the genotypes were found to have green coloured leaves with dull luster, leathery texture, elliptic leaf shape, medium size, thin, apiculate leaf apex, flat lateral appearance, well separated leaflets, yellowish and less prominant veins and smooth leaf blades. The smooth and wavy nature of leaf margin was distributed over the two classes.

Table 1. The descriptors and frequency (no) of distribution of genotypes

Morphological Traits		Matto Grosso	Acre	Rondonia
1.	**Habit**			
	1.1 Tall and stout	1	4	4
	1.2 Tall and lean	10	4	18
	1.3 Medium stout	1	2	0
	1.4 Medium and lean	15	14	4
	1.5 Dwarf and stout	0	0	0
	1.6 Dwarf and lean			
2.	**Girth of the plant**			
	2.1 Above average	8	3	11
	2.2 Average	13	14	13
	2.3 Below average	7	8	3
3.	**Branching**			
	3.1 Early branching	0	0	0
	3.2 Late branching			
	3.3 No branching			
4.	**Nodes**			
	4.1 Axillary buds			
	4.1.1 Protuding	0	0	0
	4.1.2 Sunken	0	0	0
	4.1.3 Normal	28	25	27
	4.2 Leaf Scars			
	4.2.1 Pronounnced margin	8	20	12
	4.2.2 Normal margin	20	5	15
	4.3 Nature of leaf scars			
	4.3.1 Sunken	0	5	3
	4.3.2 Normal	28	20	24
5.	**Leaf storey**			
	5.1 Shape			
	5.1.1 Conical	0	0	1
	5.1.2 Truncate	2	1	1
	5.1.3 Bow shaped	1	1	1

(Continued on page 161)

Morphological Traits	Matto Grosso	Acre	Rondonia
5.1.4 Hemispherical	25	23	24
5.2 Separation			
5.2.1 Well separated	20	20	13
5.2.2 Not well separated	1	0	3
5.2.3 Intermediate	7	5	11
5.3 External appearance			
5.3.1 Open	28	25	25
5.3.2 Close	0	0	2
5.3.3 Intermediate	0	0	0
6. Leaves			
6.1 Pulvinus	MT	AC	RO
6.1.1 Swollen	25	24	26
6.1.2 Normal	3	1	1
6.2 Petiole			
6.2.1 Shape			
6.2.1.1 Arched			
6.2.1.2 Concave	8	17	18
6.2.1.3 Straight	19	7	4
6.2.1.4 'S' Shape	0	0	4
6.2.2 Size			
6.2.2.1 Long	1	4	5
6.2.2.2 Medium	20	17	16
6.2.2.3 Short	7	4	7
6.2.3 Angle			
6.2.3.1 Acute	27	22	24
6.2.3.2 Horizontal	1	3	3
6.2.3.3 Optuse	0	0	0
6.3 Petiolule			
6.3.1 Orientation			
6.3.1.1 Upward	16	14	17
6.3.1.2 Horizontal	7	2	3
6.3.1.3 Downward	5	9	7

(Continued on page 162)

Morphological Traits	Matto Grosso	Acre	Rondonia
6.3.2 Size			
6.3.2.1 Long	2	1	8
6.3.2.3 Medium	22	18	18
6.3.2.3 Short	4	6	1
6.3.3 Extra floral			
6.3.3.1 Prominent	21	14	10
6.3.3.2 Less prominent	7	11	17
6.4 Leaflets			
6.4.1 Colour			
6.4.1.1 Green	22	20	21
6.4.1.2 Dark green	6	5	6
6.4.1.3 Yellowish green	0	0	0
6.4.2 Luster			
6.4.2.1 Glossy	5	0	4
6.4.2.2 Dull	23	25	23
6.4.3 Texture			
6.4.3.1 Smooth	0	0	0
6.4.3.2 Leathery	28	25	27
6.4.4 Shape			
6.4.4.1 Elliptic	26	24	21
6.4.4.2 Lanceolate	0	0	0
6.4.4.3 Obovate	2	1	6
6.4.5 Size			
6.4.5.1 Large	2	11	11
6.4.5.2 Very large	0	1	
6.4.5.3 Medium	26	13	16
6.4.5.4 Small	0	0	
6.4.6 Thickness			
6.4.6.1 Thick	28	23	23
6.4.7 Margin			
6.4.7.1 Smooth	15	14	8
6.4.7.2 Wavy	13	11	19

(Continued on page 163)

Morphological Traits	Matto Grosso	Acre	Rondonia
6.4.8 Appearance (S.S)			
6.4.8.1 Straight	24	11	12
6.4.8.2 'V' shape	1	2	1
6.4.8.3 Boat shaped	3	11	14
6.4.9 Leaf Apex			
6.4.9.1 Aristate	0	1	0
6.4.9.2 Accuminate	5	2	2
6.4.9.3 Cuspidate	1	0	3
6.4.9.4 Apiculate	22	22	22
6.4.10 Lateral appearance			
6.4.10.1 Flat	21	16	15
6.4.10.2 Convex	0	1	0
6.4.10.3 'S' shape	7	8	12
6.4.11 Arrangement			
6.4.11.1 Margin toughing	7	4	6
6.4.11.2 Overlapping	1	0	4
6.4.11.3 Separated	20	21	17
6.4.12 Vein colour			
6.4.12.1 Yellow	28	23	25
6.4.12.2 Light green	0	2	2
6.4.13 Nature of vein			
6.4.13.1 Prominent	4	9	12
6.4.13.2 Not prominent	24	26	15
6.4.14 Leaf blade dorsa			
6.4.14.1 Smooth	22	25	25
6.4.14.2 Irregular	6	0	2

The observations thus reveal that there are variation in the genotypes studied for many of the characters and also that some of them like stature, leaf storey arrangement and petiolar architecture are of breeding value when hybridizations are programmed for specific non conventional objectives. The study also projects the need of a well defined set of descriptors for characterisation and cataloguing. However, more discriptors will have to be added based on the experience gained as well as the stage at which the parameters are recorded.

REFERENCES

Ahmed, 1986. IRRDB 12th Assembly Statement. ANRPC 26-27 March. 1986.

Dijkman, M.J. 1951. *Hevea*; Thiry years of research in the Far east. University of Miami Press, Florida. p. 155-177.

Gill, K.S. 1984. Research imperatives beyond the green revolution in the 3rd World. *In :* Human Fertility, health and Food Impact on Molecular Biology and Technology. p. 195-231.

Holden, J.H.W. and J.T. WIlliams. eds. 1984. Crop Genetic Resources; Conservation and Evaluation. George Allen and Unni. London.

Jayasekara, N.E.M, D.M. Fernando and K.B.A. Karunasejara. 1984. Identification of clones. *In*: A practical guide to rubber planting and aprocessing (Eds. A.de.S. Liyanage and O.S. Peries). Rubber Research Institute of Sri Lanka. p. 10-18.

Mercy Kutty, V.C., Y. Annamma Varghese, J. Lycy and A.O.N. Panikkar. 1991. Juvenile characters and seed morphology of the certain modern *Hevea* clones. *Indian J. Nat. Rubb. Res.* 49(1): 16-25.

Polhamus, L.G. 1962. Rubber. Leonard Hill (Books) Ltd., London. p. 62-90.

Silva, C.A. de and R. Satchuthananthavale. 1961. History and description of promising RRIC clones. *J. Rubb. Res. Inst. Ceylon* 37 (2): 112-128.

Indian J. Pl. Genet. Resources 7(2): 165-172, 1994; Special Issue

EVALUATION OF TOMATO GERMPLASM ADAPTABLE TO ABIOTIC STRESS CONDITIONS OF NORTHERN INDIA

Umesh Chandra and P.N. Gupta

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

Over large areas, tomato production in India is being adversely affected by less favourable environmental conditions (abiotic factors) such as low and high temperature, drought, flooding and soil salinity. The National Bureau of Plant Genetic Resources (NBPGR), over the years, has assembled *ca* 2900 germplasm lines from diverse agro-climatic zones of the world (over 45 countries) and from within India. This includes several wild species viz., *Lycopersicon pimpinellifolium, L. hirsutum, L. cheesmanii, L. peruvianum, L. glandulosum, L. chilense, L. chmieliwskii, L. parviflorum, L. esculentum* var. *cerasiforme, L. hirsutum* f *glabratum, L. peruvianum* var. *humifusum*. Development of resistant cultivars against abiotic factors is an economical proposition. Realising possibilities of use of stress resistance, the germplasm were tested/evaluated under field conditions during hot summers (April-June) in Delhi (max. temp. 40° - 44°C) and attempts were made to identify germplasm pertaining to definite sources of resistance i.e., ability for tolerance to temperature stress, drought conditions and reaction to diseases and pests, to develop lines possessing resistance to stress and other propositions. Evaluation studies (at Delhi when temperature is about 38°-40°C) revealed that 46 accessions are heat tolerant/moderately heat tolerant including the wild species, 21 of processing types, 12 accessions suitable for transportation and 29 and 56 accessions are resistant/tolerant to diseases and fruit borer, respectively. Forty accessions were scored for high yielding potentiality. *L. pimpinellifolium* required more number of days for expressing wilting, thus showing tolerance to drought conditions. Wild species *L. esculentum* var. *cerasiforme* - tolerant to stress, *L. hirsutum* - tolerant to drought) possess resistance to abiotic factors.

Key words : Tomato, *Lycopersicon* sp., evaluation, heat tolerance, disease resistance, donor germplasm

Tomato is one of the most widely grown vegetable crops in India. It occupies an area of over 82,000 ha with a total production of 802,000 t and an average yield of 9.78 t/ha. Over large areas, tomato production in the country is being adversely affected by less favourable environmental conditions (abiotic factors). Generally high and low temperature, drought, excessive moisture, salinity and alkalinity are associated conditions which limit tomato production. Development of resistant cultivars against these abiotic factors is an economical proposition. The possibility of use of stress resistance has been realised and attempts are made to identify donor germplasm pertaining to definite sources of resistance to develop lines possessing resistance to stress.

GERMPLASM ASSEMBLAGE AND PRELIMINARY EVALUATION

The National Bureau of Plant Genetic Resources (NBPGR), over the years, has assembled *ca* 2900 germplasm lines on systematic basis from diverse agro-climatic zones of the world (from over 45 countries including Taiwan) and from within India. This includes several wild species viz., *L. pimpinellifolium, L. hirsutum, L. peruvianum, L. chessmanii, L. pissisi, L. glandulosum, L. chilense* and *L. esculentum* var. *cerasiforme* L. *hirsutum* f. *glabratum*, L. *peruvianum* var. *humifusum* and *L. chmieliwskii.* Realising possibilities of use of stress resistance and other traits, the germplasm were tested/ evaluated under field conditions in a phased manner (Thomas and Umesh Chandra, 1989a; ibid, 1989b; 1993; NBPGR, 1991) during hot summers (maximum temperature ± 38 – 42°C) at NBPGR Experimental Farm, Issapur (latitude 28° 35'N; longitude 70° 18'E; altitude 226. 16m above msl; annual rainfall 400mm; soil texture-sandy loam and pH 6.5 – 8.2) in Delhi. Each accession was grown in 2 rows plot of row length 4m and row to row distance 60 cm, during summer seasons of 1990, 1991 and 1992 in augmented block design. Donor germplasm pertaining to definite sources of resistance, i.e., ability for tolerance to temperature stress, drought condition (Table 1), resistance/tolerance for reaction to *Fusarium* wilt and fruit rot and to fruit borer and other attributes like high yield potential, large fruit size, fresh market types, processing types and suitability for long shelf life (Table-2) were identified to develop lines possessing resistance to stress and other propositions. For enhancing the adaptation of this vegetable to the hot humid tropical/sub-tropical condition of India, tomato breeding programme can be achieved with the help of these donor germplasm to develop breeding lines carrying heat tolerance, resistance to diseases, improved fruit size and better external fruit quality such as firmness and resistance to cracking etc.

Table 1. Genetic resources for heat, drought tolerance in tomato and related wild species

Attributes	Donor Germplasm
Genotypes setting fruits at high temperature (43 accessions)	EC number : 1127, 4639, 11960, 16465, 27910, 31515, 35446, 37226, 37284, 89248, 94181-6, 106265, 110578, 114503, 122063, 125754, 130042, 130053-1, 162598, 162935, 163690, 163704, 164636, 164666, 165393, 165700, 165751, 168064, 168070, 168281, 169308, 170662, 251636, 251674, T-41, NC-57299, PI-205009, *L.cheesmanii, L.pimpinellifolium*- Pan American, Punjab Tropic, Merz, HS-101, HS-102.
Drought tolerant	EC numbers : 65992, 104395, 130042, Sel-28, *L. pimpinellifolium* (PI-205009)

EC numbers represent exotic collections obtained from other countries and maintained at NBPGR, New Delhi - 110 012, India.

HIGH TEMPERTATURE TOLERANCE

Heat tolerance is measured by the ability of the plant to set fruits under high temperature. Growing hot summer season tomatoes is a common problem in India and elsewhere. Generally when temperature exceeds ± 32° – 35°, depending on the variety, flowering and fruit set are adversely affected in tomato. Fruit set is one of the sensitive stages at high temperatures and this area has been given adequate treatment in respect of screening of germplasm to isolate appropriate sources of resistance. The germplasm were screened in the natural stress environment when conditions become less than optimum. Generally under such natural stress conditions, a germplasm line, if performs well, it may be considered stress tolerant, for example growing tomato in summer for screening of fruit set at high temperature is a direct selection.

Table 2. Donor Germplasm in tomato for breeder's use

Traits	Notable accessions
Heavy fruiting types	EC numbers : 31515, 101652, 106625, 110578, 118292, 129081, 129354, 130053-1, 145515, 163591, 163598, 170373, 170662, 173856, 232427, 238307, 246028, 251538, 251558, 253271, 267725, 283538, 283539, 277690, 277696, 294697, 6049, 281060, IC-90604 and IC-90905
Larger fruits	EC numbers : 212469, 246028, 232429, 232436, 144295, 168070, 159038, 163671, 165893, 253263, 25364, 253271, 11960, 125754, 267728, 251606, 251751 and 267725.
Fresh market types	EC numbers : 260628, 177294, 232429, 241153, 161245, 168070, 35520, 200676, 7286, 25169, 41025, 32611, 6049, 164660 and A-1.
Processing types	EC numbers : 126776, 12754, 4708, 11960, 12527, 129600, 159966, 1154, 2790, 8822, 232, 427, 241150, 246028, 159038, 164677, 177824, 163611.
Long shelf life	EC numbers : 161252, 7352, 100845, 110268.
Mimic type	EC 251679
Nematode resistant	NT-3, NT-8 and NT- 12, Nemered, Nematex, Atkinson, Pusa-120.
Resistant to wilt, fruit rot and early blight	*L. pimpinellifolium* (EC-65992, 65993, 86517, 86522, 7353, 121453)
Resistance to Leaf curl, Fusarium wilt and fruit rot	*L. hirsutum* (EC-486, 65999, 127985) *L. peruvianum* (EC-2630
Resistance to Fusarium wilt and Fruit rot	*L. pimpinellifolium x L. esculentum* EC- 66007, 86516, 99935, 106295, 116039 and 128013).
Resistance to Fruit borer	EC- 129354, 124406, 129599, 66005, 118266, 114947, IC-59067.

IC numbers represent collections from India

There was a wide range of variation among genotypes for fruit set under high temperature conditions and the evaluation studies (at Delhi when temperature of about 38 - 40°C) reveals that 43 accessions set fruits at high temperature (Table-1). In addition, the fruit set was recorded at high temperature by several workers for example in Saladette (Leeper, 1974), L-125, L-226, L-232, L-2972 (Villareal *et al.*, 1978); *L. pimpinellifolium* (Villareal and Lai, 1979; Rana and Kalloo, 1989a); BL-6807, S-6916, CL-5-0-0-1 and Saladette (Hanna and Hernandez, 1982); PS 84 # 84, *L. cheesmanii*, EC-130042 and EC-162935 (Rana and Kalloo 1989a) and Land point (84#42), PS Mini Rose (84#58), PI-205009 and *L. pimpinellifolium* Pan American (Kalloo and Banerjee, 1990). Cultivar Philippines could set fruit even upto 44°C (Chaudhary, 1973). However Punjab Tropic, Merz, P-4 and F1 hybrids have shown good performance under high temperature condition of Punjab (Nandpuri *et al.*, 1975). The expression of heat tolerance in a genotype is influenced by several external environmental factors, therefore heat tolerant lines should be tested at various locations and environments (Villareal and Lai, 1979). Varieties HS-101, HS-102 had the ability to set fruit in April when temperature is about 35 to 38°C at Hisar (India). These varieties have performed well at Delhi conditions also under considerably high temperature at 38 - 40°C in the month of May. The ability to set fruits at high temperature in these genotypes varied depending on their physiological basis. Tolerance to heat may be expressed through heat avoidance and morphogenesis of flower parts, pollen fertility, rate of fertilization and fruit development (Kalloo, 1988). Meiosis before 7-8 days of anthesis is highly sensitive to high temperature. This leads to drop of buds due to formation of abscission layer in the pedical. When flower fails to be pollinated and / or fertilized, it triggers the formations of abscission layer. The most noticeable effect of high temperature is the production of exserted styles which prevent pollination. In heat tolerant lines, stigma position is near the staminal cone and in heat sensitive cultivars, the style is elongated and exscerted (Rana and Kalloo 1989 b). EC 130042, *L. cheesmanii* and EC-162935 setting fruits at high temperature exhibited stigma exsertion of less than 1 mm whereas other sensitive genotypes produced more than 1 mm stigma exsertion (Rana and Kalloo 1989 a,b). The most serious problem of high temperature effect is the reduced size of fruits. Generally there is fruit set in heat tolerant lines but development of such fruit is very slow and poor and as a result, the fruits remain smaller in size. At Delhi conditions, heat tolerant accessions EC-168070, 130053-1, 165393 were recorded to have larger fruit size as well.

When temperature falls below 0°C, tomato crop generally suffer chilling/frosting effect, under field conditions. In Hisar (India), *L. hirsutum* f. *glabratum* (Kalloo, 1988) adapated well under chilling/frosting conditions. *L. peruvianum* and *L. cheemanii* also sustain chilling temperature. At high

altitude of Ladakh (Himalayas), Early Lethbridge, Fireball and Early North (Canadian lines) were found suitable (Singh and Mital, 1966).

TOLERANCE / RESISTANCE TO OTHER BIOTIC / ABIOTIC FACTORS

Wild species show remarkable variation in their inherent adaptation to different kinds of stress environments and thus possess resistance to several abiotic factors. *L. pennellii* is a drought tolerant genotypes, *L. esculentum* var *cerasiforme* - tolerant to stress, *L. hirsutum* species are both tolerant and resistant to cold and drought. EC-130042, Sel-28, EC-65992 and *L. pimpinellifolium* (PI-205009) required longer number of days for expressing wilting, thus showing tolerance to drought conditions. If yield is the critation; Sel-28, *L. cheesmanii*, K-14, EC-104395, *L. pimpinellifolium* (EC-65992) and *L.pimpinellifolium* - Pan American are the potential breeding material for drought resistance (Rana and Kalloo 1990). *L. pennellii, L. chilense* and a few accessions of *L. pimpinellifolium* have an inherent capacity to adapt under drought conditions. By utilizing these sources, there is possibility of developing salt and drought resistant commercial cultivars.

At several places, the problem of high temperature is linked with drought and humidity, therefore efforts should be made to develop heat + drought and heat + humidity resistant genotypes.

Wild species/ relatives of tomato have assumed considerable importance as these are known to possess high degree of resistance to various pests and diseases and thus could be utilized in breeding programmes. In order to explore the possibilities of utilization of these species as a source of disease resistance under hot summer season of Delhi, 88 germplasm collections of different wild species, viz., *L. pimpinellifolium* (30), *L. hirsutum* (15), *L. peruvianum* (20), *L. glandulosum* (2), *L. cheesmanii* (1) and progenies of *L. pimpinellifolium* x *L. esculentum* (20) were studied for field reaction to diseases (Table 2) Most of the *L. pimpinellifolium* lines were resistant to Fusarium wilt, fruit rot and early blight but didn't show any marked resistance to leaf curl. *L. hirsutum* and *L. peruvianum* showed high degree of resistance to leaf curl. *L. pimpinellifolium* x *L. esculentum* were resistant to Fusarium wilt and fruit rot. Some of the accessions showing resistance to more than one disease were as follows : *L. pimpinellifolium* (EC-65992, 65993, 86517, 86522 all from USA; - 7353 (Australia), - 121453 (Netherland) - resistant to wilt, fruit rot and early; *L. hirsutum* EC-486, -65999 and 127985 (USA) - resistant to leaf curl, Fusarium wilt and fruit rot; *L. peruvianum* (EC-2630, -65984, - 106293 (all from USA) and EC-86512 (from Japan) - resistant to leaf curl, wilt and fruit rot; *L. pimpinellifolium* x *L. esculentum* (EC-66007, -86516, -99935, -106295 (all from USA) - resistant to Fusarium wilt and fruit rot (Bisht *et al.*, 1989).

CONCLUSION

a) Heat tolerant, moderately heat tolerant, drought tolerant lines identified.

b) Better yield types, large fruited types, processing and suitability for long shelf life were also scored.

c) Sources of resistance to Fusarium wilt, fruit rot/late blight, leaf curl and equally important fruit worm scored from hitherto unexploited *Lycopersicon* germplasm.

d) Multiple resistance to wilt, fruit rot and early blight and other combinations and fruit attributes, firmness, smooth shape screened.

e) Genetic manipulation to combine traits for tropical/sub-tropical adaptation - may lead to development of breeding lines carrying heat tolerance, resistance to diseases, improved fruit size, firmness and resistance to cracking which may be utilized in evolving better varieties.

f) There is a need to screen germplasm even more for tolerance to high and low temperature, drought, excess moisture/flooding, poor soil fertility; to up grade absence of crack, reduce blotchy ripening, improved colour and long shelf life properties.

Stepwise approach to genetic improvement can be tried and emphasis should be given in bringing together heat tolerance and bacterial wilt resistance among the advanced breeding lines to grow a successful tomato crop in India. Broad- based genetic material are essential to meet a number of breeding objectives. Breeders can no longer be dependent on the basic stocks of cultivars which they inherited from their predecessors, and therefore it is obvious that much wider range of germplasm is required today. Also there is a need to develop cultivars which can set and produce large fruits at high temperature. Genetic manipulation to combine the requisite traits for tropical adaptation will lead to development of many breeding lines. Selection for high yield under non- stress and stress condition and incorporation of important heat tolerance (specific for hot dry conditions), drought resistance characteristics, tolerance to excess soil moisture or flooding, and even tolerance to poor soil fertility may be added into the physiological arsenal of the future tropical tomatoes. Breeding for heat tolerance is thus a challenge, and also an opportunity for breeders and heat tolerance researchers in developing countries. They can make advancement in this emerging field as they have at their disposal enormous variability adapted to specific situations of ecological stresses.

There will be a need to upgrade the quality of tomatoes also in visible parameters of acceptability such as increased longevity in transit and storage through better firmness and/or inherently long shelf life properties, absence of cracks, improved colour and reduced blotchy ripening etc.

ACKNOWLEDGEMENTS

The authors wishes to express sincere gratitude to Dr. R.S. Rana, Director, National Bureau of Plant Genetic Resources, New Delhi 110 012 for facilities provided. Technical assistance by Sri Harinder Singh is also acknowledged.

REFERENCES

Bisht, I.S., Umesh Chandra and T.A. Thomas. 1989. Field reactions of wild tomato species to various diseases. *Veg. Sci.* **16**(1): 104-106.

Chaudhary, R.C. 1973. Summer tomatoes in north Indian plains: Problems of fruitlessness and parthenocarpy. *Bhartiya Krishi Anusandhan Patrika* **1**: 39-44.

Hanna, H.Y. and T.P. Hernandez 1982. Response of siox tomato genotypes under summer and spring weather conditiosn in Louisiana. *Hort. Sci.* **17**:758.

Kalloo. 1988. Vegetable Breeding. Volume II. CRC press, Inc, Boca Raton, Florida. 213 pp.

Kalloo, G. and M.K. Banerjee. 1990. Evaluation of tomato genotypes for heat tolerance. *Veg. Sci.* **17**: (in press)

Leeper, P. 1974. Saladette tomato : Basis for new industry. *Ann. Rep. Texas Agric. Exp Stn.* 1974.

N.B.P.G.R. 1991. Annual Report for 1990-91. National Bureau of Plant Genetic Resources, New Delhi, India, 172 p.

Nandpuri, K.S., J.S. Kanwar, S. Singh and M.S. Saimbhi. 1975. Performance of tomato varieties under low and higher temeprature conditions. *Haryana J. Hort. Sci.* **4** : 46-50.

Rana, M.K. and G. Kalloo. 1989a. High temperature tolerance in tomato: evaluation of genotypes. *Veg. Sci.* **16**: 156-167.

Rana, M.K. and G. Kalloo. 1989b. High temperature tolerance in tomato: flower and pollen studies. *In*: 12th Eucarpia Congress. Vortrage Pflanzenzucht. **15**: 23.

Singh, H.B. and S.P. Mital. 1966. New Bred varieties fetch better return. *Indian Hort.* **10**:11-16.

Thomas, T.A. and Umesh Chandra. 1989a. Genetic resources of tomato in India, their build-up, evaluation, maintenance and utilization. p. 22-27. *In*: S.K. Green, T.D. Griggs and B.T. Mclean (eds.). Tomato and Pepper production in the Tropics, AVRDC, Shanhua, Tainan, Taiwan.

Thomas, T.A. and Umesh Chandra, 1989b. Genetic resources of tomato and their evaluation. *Indian J. Plant Genet. Resources* **2**(1): 15-31.

Thomas, T.A. and Umesh Chandra. 1991. Evaluation and identification of donor germplasm in tomato adaptable to Indian climates. Paper presented in Golden Jubilee Symp. on Genetic Research and Education : Current trends and the next fifty years, organized by Indian Society of Genetics and Plant Breeding, New Delhi from Feb 12-15; Vol I (Abstr): 71-72.

Umesh Chandra and T.A. Thomas. 1993. Sources of tomato germplasm adaptable to the hot summer season in India. p 501-502. *In*: C.George Kuo (Ed.) Adaptation of Food crops

to temperature and water stress. Asian Vegetable Research and Development Center, Shanhua, Tainan, Taiwan.

Villareal, R.L. and S.H. Lai. 1979. Development of heat tolerant tomato varieties in the tropics. Proc. 1st Intl. Symp. Trop. Tomato. Asian Vegetable Research and Development Center, Tainan, Taiwan. 188.

Villareal, R.L., S.H. Lai and S.H. Wong. 1978. Screening for heat tolerance in the genus *Lycopersicon*. *Hort. Sci.* **13**: 479.

Indian J. Pl. Genet. Resources 7(2): 173-179, 1994; Special Issue

RADIATION INDUCED VARIATION IN *PHASEOLUS VULGARIS* L. FOR SEED YIELD TRAITS AND BIOTIC STRESS

J.D. Sharma and V.P. Gupta

Department of Plant Breeding and Genetics
Himachal Pradesh Krishi Vishvavidyalaya
Palampur 176 062 (Himachal Pradesh)

Significant within line and between lines variation was induced for seed yield under 5kR, 10kR and 15kR doses of gamma-rays in M_2 of 'Jawala' and 'HPR35' varieties; and for biological yield, number of seeds and number of pods under 5kR and for seeds per pod under 10KR in M_2 of 'Jawala' variety. between lines variation was also observed for seed yield under 20kR in M_2 of 'Jawala'. Within line and between lines, variation was induced for seed yield under 10kR, and for plant height under 10kR and 15kR in M_3 of 'Jawala;'. However, within line variation was also observed for seed yield under 5kR, 10kR and and 15kR in M_3 of 'Jawala' whereas between lines, variation was induced for seed yield under 5kR and for biological yield under 5kR and under 15kR in M_3 of 'HPR35'. However, within line variation was also observed for harvest index, seeds per pod, pod yield and pod length under 15KR and for seeds per pod and pod length under 5kR in M_3 of HPR 35. Mutants 128 (10kR) of 'Jawala; and 232-1 (5kR), 236-2 and 238-1 (10kR) and 208 (15kR) of 'HPR 35' were found moderately resistant against anthracnose (*Colletotrichum lindemuthianum*) in M_3 when tested under laboratory conditions. Mutants 32-1, 236-2, 238-1 and 208 (all of 'HPR 35') also had higher seed yields than the parent 'HPR 35'.

Key words : *Phaseolus vulgaris*, variability, radiation, biotic stress, mutation

Induction and selection of mutations in crop plants offer the prospects of generating variability which may not be present in the natural gene pool. In rajmash (*Phaseolus vulgaris* L.), where crossing is little tedious and there is not sufficient variation in the available germplasm with respect to resistance to diseases, the use of mutations would be more efficient. In the present studies, radiation induced mutation was used as a tool for creating variability for desired traits including disease resistance in two released varieties of *Phaseolus vulgaris* L.

MATERIALS AND METHODS

The experimental material consisted of M_2 and M_3 generations of 'Jawala' and 'HPR 35' which are the two released varieties of *P.vulgaris* L. for Himachal

Pradesh. One hundred dry seeds of each variety were got irradiated with 5, 10, 15 and 20kR doses of gamma-rays at IARI, New Delhi. These seeds were raised as M_2 generation in rows of 3m length with plant to plant and row to row distance of 15cm and 30cm, respectively, during 1991-92. On the other hand, the M_2 generation, of earlier generated material under the same doses of these two varieties, was raised in single plant completely randomized design (SPCRD) alongwith parents (control) during 1991-92. During 1992-93, the M_2 generation was raised in SPCRD alongwith control and M_3 generation, under each dose of the two varieties, was raised alongwith control in randomized block design (RBD) with two replications.

The data in M_2 were recorded on plant basis in each dose in each variety, whereas the data were recorded on five random plants and then averaged in M_2 per replication in each dose and in each variety. The observations were recorded on seed yield/plant (g), biological yield/plant (g), harvest (%), plant height (cm), number of seeds, seeds/pod, number of pods, pod yield (g), pod length (cm), number of nodes and internode length (cm). The analysis of variance in M_2 and M_2 in each dose was carried as suggested by Yonezawa (1979). In M_2 within line analysis of variance was also done for the individual lines. The M_3 mutants were screened against anthracnose in the laboratory by detached hypocotyle method as per Chakrabarty and Bambawale (1991).

RESULTS AND DISCUSSION

Both between lines and within line variation was induced in M_2 of 'Jawala' variety of *Phaseolus vulgaris* L. for seed yield under all the doses, i.e. 5kR, 10kR and 15kR of gamma-rays, except for 20kR where under only between lines variation was induced for this trait (Table 1). Within line and between lines variation was also induced for biological yield, number of seeds and number of pods under 5kR. and for seeds per pod under 10kR of gamma-rays (Table 1). Table 1 also revealed that within line variation was induced in M_2 of 'Jawala' for biological yield and number of seeds under 10kR and 15kR, for seeds per pod under 5kR and 20kR, and for pod yield under 10kR. Only between lines variation was observed for pod length under 5kR and 10kR, for number of pods under 10kR, and for seeds per pod under 15kR doses. Data in Table 2 indicated the induction of within line and between lines variation for seed yield under 5kR, 10kR and 15 kR doses in M_2 of 'HPR 35' variety whereas only between lines variation was induced under 5kR for number of nodes in the M_2 of this variety. Persual for Table 3 revealed the induction of within line and between lines variation for seed yield under 10kR doses in M_3 of 'Jawala'. Within line variation also existed for seed yield under 5kR and 15kR in M_3 in this variety. Table 4 revealed that between lines variation was induced for seed yield, harvest index and pod yield under 15kR doses in M_3 of 'HPR 35' variety.

Kozera and Roszoko (1986) also found that irradition of seeds with 4 doses of neutrons (6-15 J/kg) increased the range of variation for seed yield per plant, 1000-seed weight, pod length, pods per plant, plant height and branch number in M_2.

Variable results were obtained with respect to radiation induced variation in *P.vulgaris* L. which suggest that sufficient amount of variation, both within and between lines, was induced for seed yield M_2 generation of both the varieties ('Jawala' and 'HPR 35') and for some other traits in 'Jawala' under all the doses of gamma-rays. Besides between lines variation, within line variation was also observed for seed yield and some related traits under different doses in the M_3 generation of both the varieties. This indicates that within line selection can be practiced in M_3 alongwith between line selection for seed yield and some other traits.

Table 1. Analysis of variance for induced genetic variation for various traits in M_2 generation of 'Jawala' variety of rajmash (*Phaseolus vulgaris* L.) under different doses of gamma rays

Traits	Mean sum of squares								Parental variance
	5kR		10kR		15kR		20kR		
	L	WL	L	WL	L	WL	L	WL	
df	39	140	13	63	4	6	2	2	3
SY	10.03*	16.77*	10.70*	17.40*	16.22*	12.33*	15.70*	2.57*	0.63
BY	67.58*	98.91*	28.42	140.97*	66.43	107.99*	67.19	19.81	7.68
HI	215.41	109.84	175.76	107.25	218.23	72.35	12.58	28.78	44.92
pH	33.82	57.95	71.33	75.93	30.32	21.07	37.35	1.25	36.42
NS	65.80*	90.46*	54.06	90.80*	106.56	70.11*	50.50	12.50	7.58
SP	0.26	0.66*	4.37*	0.99*	0.92*	0.16	0.05	0.65*	0.05
NP	11.69*	7.92	8.43*	7.37	6.50	5.70	5.40	8.00	0.92
PY	22.49	31.15*	17.22	31.35*	28.42	22.64	27.03	4.81	3.48
PL	15.90*	2.25	38.38*	2.88	0.95	0.21	1.86	1.04	1.54
NN	0.25	1.39	0.68	0.66	0.39	0.53	1.15	0.25	0.17
IL	1.13	0.25	0.56	0.36	0.39	0.33	0.79	0.06	0.20

SY = Seed yield (g), BY = Biological yield (g), HI = Harvest index (%)
PH = Plant height (cm), NS = no. of seeds, SP = Seeds/pod
NP = No. of pods, PY = pod yield (g), PL = Pod Length (cm)
NN = No. of nodes, IL = Internode length (cm)
L = lines, WL = Within lines
* Significant at 5% level when tested against parental MS

Table 2. Analysis of variance for induced genetic variation for various traits in M_2 generation of 'HPR 35' variety of rajmash (*Phaseolus vulgaries* L.) under different doses of gamma rays

Traits	Mean sum of squares						Parental variance
	5kR		10kR		15kR		
	L	WL	L	WL	L	WL	
df	31	72	59	91	4	2	2
SY	46.71*	21.45*	21.31*	10.50*	43.37*	11.73*	0.14
BY	93.38	78.18	87.56	33.17	123.51	27.09	44.81
HI	404.37	176.77	165.91	134.29	75.68	95.86	85.84
PH	191.83	115.81	107.70	73.14	57.30	81.09	126.77
NS	142.99	107.78	100.65	52.65	220.83	86.34	117.00
SP	0.98	0.36	0.01	0.49	0.20	0.39	0.41
NP	10.23	8.83	9.28	4.71	28.00	26.34	13.00
PY	53.44	39.66	36.70	16.57	84.39	19.65	45.20
PL	1.72	1.73	3.09	1.47	2.90	4.21	1.63
NN	6.20*	0.77	0.87	0.78	0.86	1.00	0.19
IL	0.60	1.41	1.97	0.72	0.32	0.08	0.44

SY = Seed yield (g), BY = Biological yield (g), HI = Harvest index (%)
PH = Plant height (cm), NS = No. of seeds, SP = Seeds/pod
NP = No. of pods, PY = Pod yield (g), PL = Pod length (cm)
NN = No. of nodes, IL = Internode length (cm)
L = Lines, WL = Within lines
* Significant at 5% level when tested against parental MS

The mutants were also screened for resistance against anthracnose disease (*Colletotrichum lindemuthianum*) under laboratory conditions. The mutants number 128 (10kR) of 'Jawala'; and 232-1 (5kR), 236-2 and 238-1 (10kR), and 208 (15kR) of HPR 35 were found moderately resistant against anthracnose in M_3 generation (Table 5). The mutants number 232-1, 236-2, 238-1 and 208 (all of 'HPR 35') also had higher seed yield than the parent ('HPR 35'). These mutants can be used un breeding programme for obtaining novel genotypes or can be released as improved varieties after proper evaluation. Rubaihayo (1975) also reported that seed yield of a variety of *P. vulgaris* L. was increased in M_3 to M_5 following mutagenesis with 7-21kR gamma-rays. Hussain and Abdalla (1979) showed that some mutants of field bean surpassed their control significantly in two successive generations from M_4 to M_3 for seed yield. Popa *et al.* (1982) observed that some high yielding induced mutants were found resistant to *Colletotrichum lindemuthianum* in an adapted variety of *P. vulgaris* L.

Table 3. Analysis of variance for induced genetic variation for various traits in M_3 generation of 'Jawala' variety of rajmash (*Phaselus vulgaris* L). under different doses of gamma rays

Traits	Mean sum of squares							
	5kR		10 kR		15 kR		LB (Error)	Parental variance
	L	WL	L	WL	L	WL		
df	11	53	3	27	15	81	32	8
SY	0.75	2.14*	2.77*	2.80	1.84	2.67*	2.22*	0.63
BY	2.08	9.84	9.98	16.55	6.03	8.63	7.24	6.00
HI	100.98	120.98*	60.10	114.11*	77,33	194.03*	92.81	33.25
PH	14.41	14.80	41.56*	62.61*	40.62*	29.26	20.05*	5.42
NS	3.90	11.67	16.75	16.29	12.74	12.17	13.74	21.00
SP	0.33	0.79*	0.23	0.60*	0.45	0.52*	0.37	0.14
NP	0.23	1.16	1.34	1.99	0.82	1.16	1.47	2.15
PY	1.57	3.24	2.19	5.83	4.19	3.74	4.63	3.65
NN	0.08	0.34	0.75	0.67	0.41	0.69	0.25	0.45
IL	0.18	0.18	0.05	0.38	0.22	0.29	0.17	0.38

SY = Seed yield (g), BY = Biological yield (g), HI = Harvest index (%)
PH = Plant height (cm), NS = No. of seeds, SP = Seeds/pod
NP = No. of pods, PY = Pod yield (g), PL = Pod length (cm)
NN = No of nodes, IL = Internode length (cm)
L = Lines, WL= Within lines, LB = Line x Block i.e. Error variance
*Significant at 5% level when tested against parental MS

Table 4. Analysis of variance for induced genetic variation for various traits in M_3 generation of 'HPR 35' variety of rajmash (*Phaseolus vulgaris* L.) under different doses of gamma rays

Traits	Mean sum of squares							
	5kR		10kR		15kR		LB (Error)	Parental variance
	L	WL	L	WL	L	WL		
df	13	92	7	45	26	178	49	7
SY	5.70*	4.36	1.83	4.11	3.79	4.08	4.03	1.51
BY	15.85	16.38	6.45	16.50	20.95*	15.74	16.59	5.94
HI	140.05*	108.66	49.90	107.49	73.56	147.59*	89.19	37.38
PH	41.63	48.44	41.53	58.58	52.18	59.51	44.30	27.65
NS	34.14	30.44	14.52	23.24	24.93	24.67	28.35	19.31
SP	0.39	6.26*	0.13	0.23	0.14	0.54*	0.19	0.16
NP	3.47	3.17	2.24	3.31	2.03	2.28	2.41	1.82
PY	10.46*	7.75	3.20	6.97	7.19	13.74*	7.17	2.85
PL	0.75	1.34*	2.54*	0.67	0.87	1.57*	0.98	0.31
NN	0.39	0.78	0.60	0.01	0.43	1.15	0.43	0.46
IL	0.33	0.74	0.17	0.53	0.22	0.38	0.27	0.48

SY = Seed yield (g), BY = Biological yield (g), HI = Harvest index (%)
PH = Plant height (cm), NS = No. of seeds, SP = Seeds/pod
NP = No. of pods, PY = Pod yield (g), PL = Pod length (cm)
NN = No. of nodes, IL = Internode length (cm)
L = Lines, WL = Within lines, LB = Line × Block i.e. Error variance
*Significant at 5% level when tested against parental MS

Table 5. Reaction types of moderately resistant radiation induced mutants of rajmash (*Phaseolus vulgaris* L.) in M_3 generation against *Colletotrichum lindemuthianum* on four point scale

Mutant number	Seed yield (g/plant)	No. of infection points on detached hypocotyle	Reaction type							
			After 4 days				After 7 days			
			1	2	3	4	1	2	3	4
'Jawala' variety										
128 (10kR)	5.13	3	1	2	0	0	0	0	0	0
Control	5.95	7	0	1	3	3	0	0	3	4
'HPR 35' variety										
232-1 (5kR)	5.50	10	9	1	0	0	7	1	1	1
236-2 (10kR)	5.38	6	4	2	0	0	3	3	0	0
238-1 (10kR)	4.52	6	1	5	0	0	1	5	0	0
208 (15kR)	5.02	8	7	1	0	0	7	0	0	1
Control	4.14	-	-	-	-	-	-	-	-	-

REFERENCES

Chakrabarty, P.K. and O.M. Bambawale. 1991. Detached hypocotyle method-an efficient technique for screening beans for anthracnose. *Indian Phytopath.* **44**:246.

Hussain, H.A.S. and H.M.F. Abdalla. 1979. Gamma-rays and EMS induced mutations in *Vicia faba* L. seed protein improvement in cereal grain legumes, IAPA, Vienna : 23.

Kozrea, W. and A. Roszoko. 1986. The influence of fast neutron on the size and variation of morphological characters in M_2 plants to two varieties of dwarf bean (*Phaseolus vulgaris* L.) *Genetica Polonica* **26**: 367.

Popa, G., V. Dinca, S. Dencescu, I. Trifu and G. Preteasa. 1982. New variities and promising lines of french bean for dry bean. Analele Institutuui de cercetari pentru cereals is plante *Technica Fundulea* **50**: 167.

Rubaihayo, P.R. 1975. Gamma-rays induced mutations in *Phaseolus vulgaris* L. *East African Agricultural and Forestryu Journal* **41**: 134.

Yonezawa, K. 1979. Some additional considerations on the method of genetical analysis for induced continuous variation of self fertilized plants. *Heredity* **43**: 191.

Indian J. Pl. Genet. Resources 7(2): 181-185, 1994; Special Issue

STUDIES ON COMBINING ABILITY FOR GRAIN YIELD AND HARVEST INDEX OVER ENVIRONMENTS IN BREADWHEAT

Uma Menon and S. N. Sharma

Department of Genetics and Plant Breeding
Rajasthan Agricultural University
Agricultural Research Station
Durgapura, Jaipur 302 018 (Rajasthan)

Combining ability studies on grain yield per plant and its important component of harvest index from an 10 × 10 half-diallel cross of wheat over three environments each at two locations indicated that both goa and soa variances were important for controlling the traits. Additive gene effect in F_2 and non-additive gene effect in F_1 was of greater importance in the genetic control of traits. gca x E and sca x E interactions exhibited greater importance of environment in influencing the variances. Raj 1482 and HD 2204 were good general combiners for both grain yield and harvest index. The most consistent cross for high sca effect was Kharchia 65 x Chiroca which showed high sca under all the situations for the traits studied. The best crosses for grain yield were the combinations of Indian x exotic types and all these crosses also exhibited high harvest index. Diallel selective mating system, which exploit both additive and non- additive gene effects, simultaneously, could be useful in the genetic improvement of the characters studied.

Key words : Bread wheat, quantitative traits, combining ability, gene effects, heterosis

Improved harvest index represents increased physiological capacity to mobilise photosynthetes efficiently and their proper translocation from source to sink. Since economic yield is only a fraction of the dry matter produced, the harvest index forms an useful measure on a large number of plants. Strong positive correlation between harvest index and grain yield has been established (1-4). Moreover, it is known that both these quantitative characters are influenced by the environment. In view of this, the present study has been undertaken to analyse a 10 × 10 diallel cross over the three environments at both Jaipur and Ludhiana for grain yield and its important component of harvest index for estimating combining ability, component of variance, and combining ability x environment interation.

MATERIALS AND METHODS

Ten varieties of breadwheat (*Triticum aestivum* (L.) Thell), namely, Moncho, Pavon, Brochis, Chiroca, HD 2204, Raj 1482, WL 711, Raj 821, D-65 and Kharchia 65, were crossed in all possible combinations excluding reciprocals. The resulting 45 F_1's were grown to get F_2 seeds. Parents alongwith their 45 F_1's and F_2's at Agricultural Research Station, Durgapura, Jaipur and parents alongwith 45 F_2's at Punjab Agricultural University, Ludhiana location were grown in a randomised block design with three replications under three diverse environments created by different dates of sowing in each location. Each plot consisted of single 5 m long row of parent and F_1 and ten rows of F_2 with the spacing of 30 × 15 cm. Ten competitive plants in parent F_2's progenies were selected randomly for recording observations for harvest index (%) and grain yield per plant (g) under each environment and location.

The mean of each plot was used for statistical analysis. The data were first subjected to the analysis followed for a randomised block design for pooled over environment in each location. The combining ability analysis was done in each location (pooled over three environments) following Method II and Model I of Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance for combining ability over environments for F_1 and F_2 generation at Jaipur and F_2 generation at Ludhiana (Table 1) revealed that the gca x environment and sca x environment interactions were highly significant for both harvst index and grain yield in both the generations at both the locations. In the presence of high gca x environment interaction, the gca variance was observed to be non-significant for both the traits in F_1 but significant in F_2 data at both the locations. However, sca variance was found to be non-significant only in F_2 at Jaipur for harvest index which may be due to drastic reduction in sca variances for this trait in F_2 generation. Thus, it is clear that both the additive and non-additive gene effects were important to control the inheritance of harvest index and grain yield in bread wheat but both were highly influenced by environment (Kumar *et al.*, 1983; Nanda *et al.*, 1983; Dasgupta and Mandal, 1988; Sharma *et al.*, 1980). The gca variance was found to be higher than sca in F_2 for both the traits at both the locations, indicating the preponderance of additive gene effects. However, sca variance was, predominant in F_1 generation for both the traits, signifying the important role of non-additive gene effects in this generation. The findings of Sharma and Sharma (1982), Lhatrath *et al.* (1986), Pawar *et al.* (1988), Rajorea (1992), Yadava *et al.* (1993), Singh *et al.* (1993) and Solanki *et al.* (1993). are in agreement with the present results.

Table 1. Analysis of variance for combining ability under diverse environments

Source of variation	d.f.	Harvest Index (%)			Grain Yield (g)		
		Jaipur		Ludhiana	Jaipur		
		F_1	F_2	F_2	F_1	F_2	F_2
Environment (E)	2	1947.88**	1285.47**	12856.47**	2971.46**	2108.22**	1110.69**
gca	9	30.19	39.40*	112.28**	24.23	57.77*	20.21**
sca	45	24.71**	12.27	73.73*	59.84**	36.10**	2.69**
gca x E	18	19.50**	11.93**	25.95**	13.41**	18.05*	1.81**
sca x E	90	11.03**	9.31**	43.05**	15.50**	18.61**	1.15**
Error	324	2.42	3.21	5.85	1.46	11.86	0.63

*,P = 0.05 **, 0.01

A persual of gca estimates (Table 2) revealed that for harvest index and grain yield there was no significant differences between the parental types for gca estimates in F_1. On the basis of F_2 analysis, parents HD 2204 ad WL 711 were the highest combines while Chiroca was the lowest combiner for harvest index at Jaipur. However, parent Raj 1482 was the highest combiner while Kharchia 65 and Brochis were the poorest combiners for harvest index. There seemed to be no similarity of the gca estimates for this trait in the two locations.

For grain yield, Raj 1482 was found to be the best combiner. Pavon and Brochis were the poorest combiners, while all others were average combiners. At Ludhiana, Raj 1482 and HD 2204 were found to be high combiners, Kharchia 65 and Brochis the low combiners and all others were average combiners for grain yield. From the overall position, HD 2204 and Raj 1482 seems to be the best parents for combining harvest index in bread wheat and both these parents were also found to be best combiners for grain yield. it is, therefore, recommended that we should breed for superior combining ability for the harvest index which ultimately improves the grain yield in wheat.

The analysis of sca effects revealed that WL 711 x Chiroca showed the highest sca effects for grain yield in F_1 and F_2 at Jaipur. This cross also exhibited the maximum heterosis of 89 per cent in F_1 at Jaipur. Apart from this cross, however, there seem to be no correlation between the rank for sca and the rank for heterosis. This could be expected also because heterosis estimates are worked out from the mean values whereas the sca estimates

Table 2. Estimates of general combining ability effects under diverse environemts

Parents	Harvest Index (%)		Grain Yield (g)	
	Jaipur	Ludhiana	Jaipur	Ludhiana
	F_2	F_2	F_2	F_2
Moncho	0.08	–0.92	–1.15	0.07
Pavon	–0.36	–0.17	–1.54L	0.18
Brochis	–0.37	–2.75L	–1.85L	–0.80L
WL 711	1.55H.	–0.08	1.29	0.12
D 65	–0.68	0.75	1.08	–0.51
Kharchia 65	–0.52	–3.33L	0.11	–1.77L
Chiroca	–1.77L	0.75	–0.92	0.48
HD 2204	1.41H	1.92	1.23	1.16H
Raj 1482	0.43	2.92H	1.38	0.73H
Raj 821	0.72	0.92	0.38	0.41
S. Em.±	0.55	0.80	0.67	0.21
C.D.	1.60	2.35	1.96	0.62

are relative to the gca of the parents. The most consistent cross for high sca effect was Kharchia 65 x Chiroca which showed high sca under all situations. Brochis x Kharchia 65 also showed high sca in F_1 and F_2 at Jaipur. Apparently, therefore, there is some consistency of sca effects over generations. Other crosses Brochis x Raj 821 and Brochis x D 65 also showed high sca effects for grain yield. It is noteworthy that all the best five crosses for grain yield also showed high sca for harvest index, which confirms the strong relationship between these two traits in wheat (Gill *et al.*, 1980; Sharma and Singh, 1983; Singh and Upadhyay, 1986; Dindsa and Bains, 1987). Another interesting feature of the present investigation was that all the crosses showing high sca effects in both F_1 and F_2 generations were combinations of Indian x exotic types. This emphasis the need for combining the two diverse germplasms.

The present study suggested that improvement for grain yield may be expected by exploiting the additive genetic variance first, and at the same time retaining the non-additive genetic variances in the population. The diallel selective mating system which allowes the infusion of new germplasm at various stages of breeding seems to be the best available method.

ACKNOWLEDGEMENT

The authors are thankful to the Director of Research, Rajasthan Agricultural University for providing necessary facilities during the course of investigations.

REFERENCES

Dasgupta, T. and A.B. Mandal. 1988. Diallel analysis in wheat. *Indian J. Genet.* 4(2): 167-170.

Dindsa, G.S. and K.S. Bains. 1987. Genetics of harvest index in wheat. *Indian J. Agric. Sci.* 58: 529-534.

Gill, K.S., G.S. Nanda, Gurdev Singh and L.K. Bajaj. 1980. Genetic analysis of harvest index in wheat. *Crop Improv.* 7 : 119-122.

Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing system. *Aust. J. Biol. Sci.* 9 : 463-493.

Kumar, H., G.S. Sharma and R.B. Singh. 1983. Genotype x environment interaction in relation to combining ability in spring wheat. *Indian J. Genet.* 43 (2): 232-238.

Lhatrath, R., D.R. Satiya and V.P. Gupta. 1986. Genetic analysis of grain yield in wheat. *Indian J. Genet.* 46: 466-471.

Nanda, G.S., P.S. Virk and K.S. Gill. 1983. Diallel analysis over environments in wheat yield and its components. *Indian J. Genet.* 36(2): 184-196.

Pawar, I.S., R. S. Paroda and S. Singh. 1988. Gene effects for six metric traits in four spring wheat crosses. *Indian J. Genet.* 46:48:195-199.

Rajora, M.P. 1992. Heterosis, Combining ability and stability parameters in wheat. Ph.D. Thesis. RAU, Bikaner, India.

Sharma, S.K. and R.K. Sharma. 1982. Note on diallel cross analysis of harvest index and its components in wheat. *Indian J. Agric. Sci.* 50: 451-461.

Sharma, S.K., R.K. Sharma, M. Singh and I.D. Tiwari. 1980. Genetic studies of harvest index (HI) and its components in wheat. *In*: Proc. National Seminar on Genetic and Wheat Improvement, *Hissar.* (2) 12.

Sharma, S.K. and R.K. Singh. 1983. Combining ability for harvest index and its component in wheat. *Indian J. Genet.* 43 : 229-231.

Singh, Iqbal, A.S. Redhu, S.C. Sharma, Y.S. Solanki and R.P. Singh. 1993. *In*: Abstr. National Symp. on Plant Strategies for India 2000 A.D. and Beyond. Dec. 25-27, 1993, Parbhani - Aurangabad.

Solanki, Y.S., A.S. Redhu, Iqbal Singh, R.B. Srivastava and R.S.A. Lamba. 1993. Combining ability analysis in diallel crosses in wheat. *In*: Abstr. National Symp. on Plant Breeding Strategies for India 2000 A.D. and Beyond. Dec. 25-27, 1993, Parbhani - Aurangabad.

Singh, M. and M.K. Upadhyay. 1986. Wheat improvement in India. *Indian J. Genet.* 46: 187-197.

Yadav, B., Mohd. Yunus and S. Madan. 1993. Genetic control of yield components and quality traits in wheat. *In*: Abstr. National Symp. on Plant Breeding Strategies for India 2000 A.D. and Beyond. Dec. 25-27, 1993, Parbhani - Aurangabad.

Indian J. Pl. Genet. Resources 7(2): 187-192, 1994; Special Issue

VARIABILITY STUDIES IN GLADIOLUS

L. C. De and R. L. Misra

Division of Floriculture and Landscaping
Indian Agricultural Research Institute
New Delhi 110 012

Twelty five varieties (11 hybrids and 14 varieties as the respective parents of these hybrids) of gladiolus were used to study the variability for 16 characters. Heritability estimates and genetic advance were high for the characters like number of cormels produced per plant, weight of corms and cormels and propagation coefficient, leaf area, rachis length and number of seeds per capsule, showing additive gene effects. Thus the selection of the basis of these characters will be very effective for the improvement of this crop.

Key words: Gladiolus, variability, heritability, genetic advance, gene effect

Gladiolus is one of the best cut flower crop in the world. The improvement in this crop depends upon the variability for different characters present in this crop. The present study was undertaken to ascertain the extent of genetic variability by determmining the magnitude of genetic coefficient of variation, heritability estimates and genetic advance of the different characters of gladioli.

MATERIALS AND METHODS

Twenty five varieties of gladiolus consisting of 11 hybrids of indigenous origin, one variety each of Indian and Dutch origin and 12 from United States of America were grown in randomized block design with three replications during 1991-92 in the Division of Floriculture and Landscaping, IARI, New Delhi giving feeding area of 40 × 15 cm per plant and putting 10 corms (uniform size) per replication in one row where data were recorded only on six plants (leaving first two and last two plants in the row). The aspects of study were days for 50 per cent sprouting and flowering, days for last flowering, number of leaves and leaf area per shoot, diameter of the first flovet after two days of opening, number of florets per spike, plant height, rachis length, number of capsules per spike and number of seeds per capsule, number and weight of corms and cormels per plant and propagation coeffcient.

Standard statistical procedures were applied for calculation of genetic constants as described by Burton and De Vane (1953), Keller and Linkens (1955), Kneebone (1958) and Frakes *et al.* (1961). Heritability in broad sense was calculated according to the formula suggested by Hanson *et al.* (1956). Genetic advance was calculated as per formula suggested by Lush (1949) and Johnson *et al.* (1955) with 5 per cent select intensity. The data were analysed with the aid of computer.

RESULTS AND DISCUSSION

The difference among the varieties were found to be highly significant although the days for last floret opening, it was significant only at 5 per cent level (Table 1). For all these characters there was a wide range of phenotypic variability. Significant treatment differences between the varieties were discernible at 1 per cent level (Table 1). Significant block effects were seen for days for flowering, number of leaves per shoot, diameter of foremost floret, number of seeds per capsule, rachis length, average weight of aughter corm, number of florets per spike and number of capsules per shoot. The estimate of phenotypic (6^2 ph), genotypic (6^2g) and error (6^2e) variance of varietal means (Table 2) indicated variance to be very high for the characters like propagation coefficient followed by number of cormels aproduced per plant, leaf area and plant height. Misra and Saini (1988) also stated to have found high variance for number of cormels produced per plant.

The gcv ranged from 5.51 for number of days required for last flore opening to 93.54 for weight of a daughter corm (Table 2). The higher values for gcv were observed for the characters like number of cormels produced per plant, propagation coefficient, number of seeds per capsule, leaf area, number of capsules per shoot and average weight of a daughter corm whereas the components with low gcv were days for last floret opening, dys for floweing, number of leaves per shoot, diameter of foremost floret, days for sprouting, plant height, number of florets per spike, rachis length and number of corms produced per plant (Table 2) which is in line of the work of Misra and Saini (1988). By itself the gcv is not a correct measure to ascertain the heritable variations present, and should be considered together with the heritability estimates to obtain the best picture of the amount of advance to be expected from the selections (Burton, 1952), thus the heritable portion of the variation was ascertained with the help of heritability estimates which ranged from 32.7 for days to last floret opening to 99.0 for number of cormels produced per plant. Most of the characters possessed high heritability where important ones are plant height, days for flowering, rachis length, lead area, weight of cormels produced pe rplant, number of seeds per capsule, average weight of a daughter corm and number of florets.

Table 1. Analysis of variance for different characters in gladious

Characters	Range	Mean	F value	S.Em.
Days for 50% sprouting	5.60-12.47	10.07	5.84**	0.62
Days for initial flowering	98.93-138.84	121.54	106.40**	0.84
Number of leaves (excluding flag leaves) per shoot	6.12 - 8.39	6.81	6.95**	0.21
Leaf area (cm^2)	40.78 - 115.80	74.99	66.89**	2.26
Diameter of foremost floret after 2 days of opening	8.26 - 12.50	10.16	22.06**	0.25
Number of seeds per capsule	18.18-54.78	33.99	47.50**	1.44
Plant length (cm)	60.02- 106.25	82.48	118.05**	1.13
Rachis length (cm)	26.14 - 52.17	38.95	85.82*8	0.74
Days for last floret opening	113.99 - 159.88	133.75	2.45*	6.09
Number of corms produced per plant	1.00 - 2.51	1.59	3.82**	0.176
Average weight of a daughter corm (g)	19.00 - 54.97	35.54	34.97**	1.38
Number of cormels produced per plant	9.67 - 161.67	33.19	306.76**	1.77
Weight (g) of cormels produced per plant	1.57 - 17.86	5.98	48.3**	0.53
Propagation coefficient (%)	71.67 - 338.33	175.32	9.99**	20.42
Number of capsules per shoot	4.68 - 12.64	8.25	18.44**	0.54
Number of florets per spike	6.50- 15.05	11.87	31.56**	0.37

** P = 0.01, *P - 0.05

per spike. However, number of corms produced per plant showed low estimates of heritability followed by days for sprouting, number of leaves per shoot, propagation coefficient, number of capsules per shoot and diameter of foremost floret, while days for last floret opening had lowest heritability estimates (Table 2) which is contrary to the findings of Misra and Saini (1988) who reported lowest heritability estimates in plant height although studied the number of capsules formed per spike.

High heritability estimates are helpful in making selection of suprior genotypes on the basis of phenotypic performance of characters as has been reported by Johnson *et al.* (1955) on soybean that heritability estimates alongwith genetic grain is more useful than the heritability alone in predicting the resultnat effect for selecting the best individual. Present study showed a wide range of estimates of genetic advance i.e. 6.48 to days for last floret opening to 191.77 for number of cormels produced per plant which is in confirmity to the findngs of Misra and Saini (1988) as they also reported that number of cormels produced per plant expressed highest genetic advance. Apaprt from

Table 2. Variance, coefficient of variation, heritability and genetic advance for different characters in gladiolus

	Variance		Coefficient of variation		Herita-bility	Genetic advance as per cent of mean
	Pheno-typic (6^2ph)	Geno-typic (6^2g)	Pheno-typic (6^2e)	Geno-typic (gcv)		
Days for 50% sprouting	3.07	1.90	17.41	13.69	61.2	22.14
Days for flowering	79.38	77.19	7.33	7.23	97.2	14.68
Number of leaves per shoot	0.43	0.29	9.79	7.99	66.5	13.36
Leaf area (cm^2)	354.49	339.06	25.10	24.55	95.6	49.47
Diameter of foremost floret after two days of opening	1.56	1.37	12.34	11.55	87.5	22.24
Number of seeds per capsule	104.55	98.22	30.08	29.15	93.9	58.22
Plant height (cm)	156.80	152.89	15.18	14.99	97.5	30.49
Rachis length (cm)	49.56	47.87	18.07	1776	96.6	35.96
Days for last floret opening	165.81	54.22	9.36	5.51	32.7	6.48
Number of corms produced per plant	0.17	0.08	26.73	18.62	48.5	27.04
Average weight (g) of a daughter corm	70.81	65.07	23.68	22.69	91.9	44.82
Number of cormls produced per plant	973.40	963.95	94.00	93.54	99.0	191.77
Weight (g) of cormels produced per plant	14.76	13.89	64.21	62.28	94.1	124.58
Propagation coefficient (%)	5009.02	3756.45	40.37	34.98	75.0	62.36
Number of capsules per shoot	4.28	3.66	25.10	23.18	85.3	44.12
Number of florets per spike	4.83	4.40	18.53	17.68	91.1	34.79

this character the weight of cormels produced and the propagation coefficient expressed higher genetic advance followed by number of seeds per capsule,

leaf area, weight of a daughter corm and number of capsules per shoot (Table 2). Characters like number of leaves per shoot, days for flowering, days for sprouting, diameter of foremost floret and number of corms produced per plant showed lower estimated and the lowest percentage of genetic advance was recorded to days for last floret opening.

The characters like number of cormels produced per plant followed by weight of cormels per plant showed a very high genetic advance together with high heritability which reveals that high heritability obtained in these characters is probably due to additive gene effectes (Panse, 1957). The characters like number of seeds per capsule, leaf area and weight of a daughter corm had moderate high genetic advance accompanied by moderate to high heritability. The characters such as days for flowering, diameter of foremost floret, plant height, rachis length and number of florets per spike had high heritability values but a low genetic advance, suggesting that high heritability for these characters may have occurred due to non-additive gene action (Panse, 1957). The selection of individual plants for the characters number and weight of cormels and weight of corms per plant, propagation coefficient, number of seeds per capsule, number of capsules per spike and diameter of the foremost floret might therefore be effective which is in conformity to the findings of Misra and Saini (1988). Negi *et al.* (1982) also advocated selection criteria on the basis of number and weight of cormels and weight of corms produced per plant.

ACKNOWLEDGEMENTS

Sr. Author (LCD) is highly grateful to the Director, IARI, New Delhi for providing financial assistance in the form of J.R.F. for conducting this study. The authors are also thankful to Dr. H.C. Saini for his kind help in the preparation of the manuscript, and to the Head, Division of Floriculture and Landscaping, IARi, New Delhi for providing the facilities for the present investigation.

REFERENCES

Burton, G.W. 1952. Quantitative inheritance in grasses. Proc. 15th Int. Grassland Conf. **1**: 227-283.

Burton, G.W. and E.W. De Vane. 1953. Estimating heritability in tall fescue (*Festuca arudinacea*)from replicated clonal material. *Agron. J.* **45**: 478-481.

Frakes, H.V., R.L. Davis and S.L. Patterson. 1961. The breeding behaviour of yield and related variables in alfalfa replicated clonal plants. *Crop. Sci.* **1**: 205-207.

Hanson, C.H., H.F. Robinson and R.E. Comstock. 1956. Biometrical studies of yield in segregating generation of Korean Lespedeza. *Agron. J.* **48**: 268-272.

Johnson, H.W., H.F. Robinson and R.E. Comstock. 1955. Estimates of genetic and environments variability in soybeans. *Agron. J.* **40**: 514-518.

Keller, K.R. and S.T. Linkens. 1955. Estimates of heritability in hops (*Humulus lupulus*). *Agron. J.* **47**: 518-521.

Kneebone, W.R. 1958. Heritabilities in sand blue stem (*Andropogon hallis*) as estimated from parental clones and open-pollinated progenies *Agron. J.* **50**: 459-461.

Lush, J.L. 1949. Animal Breeding plans (Edn. 3), 443 p. Collegiate Press, Ames, Iowa, USA.

Misra, R.L. and H.C. Saini. 1988. Genotypic and phenotypic variability in gladiolus. *Indian J. Hort.* **45**: 148-152.

Negi, S.S., T.V.R.S. Sharma, S.P.S. Raghava and V. R. Srinivasan. 1982. Variability studies in gladious. *Indian J. Hort.* **39**: 269-272.

Panse, V.G. 1957. Genetics of quantitative characters in relation to plant breeding. *Indian J. Genet.* **17**: 318-328.

Indian J. Pl. Genet. Resources 7(2): 193-199, 1994; Special Issue

SCREENING SALINITY TOLERANT GENOTYPES OF INDIAN MUSTARD (*B. JUNCEA* (L.) CZERN & COSS.) AT SEEDLING STAGE

N.K. Thakral, H. Singh[1] and M.L. Chhabra[1]

Forage Section
Department of Plant Breeding
CCS Haryana Agricultural University
Hisar 125 004 (Haryana)

Thirty two diverse but promising genotypes of Indian mustard (B. juncea (L.) Czern. & Coss.) were screened under two chloride predominating salinity levels viz; 125 meq/l and 175 meq/l in petriplates. Per cent reduction in seedling vigour, speed of germination and per cent germination, respectively were used as preferential parameters for screening the genotypes under salinity. Salt stress delayed the seed germination but had little or no effect on the ultimate seed emergence. Seedling vigour increased at 125 meq./l salinity, whereas it decreased at 175 meq/l salinity level. Based upon per cent reduction in seedling vigour, speed of germination and per cent germination in salinity over control, genotypes RH-7846, RH-7859 and RH-781 were identified as tolerant to salinity, whereas genotypes RH-8315, RWH-1 and RH-8113 as susceptible.

Key words : *Brassica juncea*, germplasm, evaluation, salinity tolerance

Rapeseed and mustard are generally grown in dry land conditions which are manifested with soil salinity and alkalinity problem which is one of the responsible factor for low crop productivity (Srivastava and Jana, 1984). Among rapeseed and mustard group, the Indian mustard (*Brassica juncea* (L.) Czern. & Coss.) is high yielding and widely grown species in India. The breeding for salt tolerance has progressed slowly particularly due to limited sources of genes, lack of efficient screening procedures and poor understanding of genes involved in controlling salt stress problems (Balum, 1988). Screening procedure important for any breeding programme, used to efficiently identify salt tolerant plants have not been conclusively defined for any plant species (Shannon, 1979). However, among the vegetative growth phase, the seedling stage was the most efficient stage for screening of large number of genotypes for salt tolerance (Devine, 1982). In the present study, 32

[1]Oilseeds Section, Department of Plant Breeding, CCS Haryana Agricultural University, Hisar - 125 004 (Haryana)

promising but diverse genotypes of Indian mustard were screened for salt tolerance at seedling stage.

MATERIALS AND METHODS

The seeds of thirty two genotypes of Indian mustard were surface sterlised with 0.1 per cent solution of sodium hypochloride for 5 minutes and then thoroughly washed with water. Ten seeds of uniform size were put on whatman filter paper in 23 cm dia meter petriplates. Each petriplate contained 10 ml double distilled deionized water (control), 125 or 175 meq/l chloride predominating salinity solution prepared by addition of NaCl, $CaCl_2$, $Mgcl_2$ and $MgSO_4$ (Using Na: Ca + Mg ratio as 1 :1 and Ca: Mg ratio as 1 : 3 and Cl : SO_4 ratio as 7 : 3 on meq. basis) in distilled water. Each salinity level including control was replicated thrice. The petridishes were kept at room temperature (usually max. temp. ranging between 20-25°C and min. temp. 10-15°C). Daily record of germination was recorded and speed of germination was calculated using formula given by Maguire (1962).

Speed of germination (index)

$$= \frac{\text{Number of normal seedlings}}{\text{Days to first count}} + \frac{\text{Number of normal seedlings}}{\text{Days to final count}}$$

At the end (Eight days after sowing), data was recorded on root length and shoot length of seedlings. Five seedling from each genotype were oven dried at 80°C and weighted. Seedling vigour was calculated as :

Seedling vigour = (root length + Shoot length) × seedling dry weight.

Higher the value, more will be seedling vigour. The per cent reduction in seedling vigour was used as preferential parameter over others for final screening purpose followed by speed of germination and reduction in germination per cent, respectively.

RESULTS AND DISCUSSION

(a) *Germination per cent* : In control, the germination usually ranged between 90 to 100 per cent (except in Krishna). Germination in general was not affected by 125 meq salinity and there was very low reduction in 175 meq/l salinity level (Table 1). Out of 32 genotypes, 10 showed no reduction at this salinity level. Maximum per cent reduction in salinity over control was noticed in genotype Krishna followed by RH 7513. Contrary to the present findings, a significant decrease in germination has earlier been observed by Kumar (1984) and Dhawan *et al.* (1987) in *Brassicas*. These differences may be attributed to the

varying salts and their concentrations used by various workers (Levitt, 1980; Sheoran and Garg, 1983). When varieties show similar level of germination, as in the present experiment, the speed of germination or seedling vigour may be helpful in bringing the differences in varietal responses (Singh Rana, 1989).

(b) *Speed of Germination* : In control, the speed of germination ranged from 2.85 (Krishna) to 4.67 (RH-7859). Speed of germination reduced in 125 meq/l salinity and a further reduction was observed in 175 meq/l (Table 1). Reduction in speed of germination has earlier been reported in many crop species viz., pea and Chickpea (Bishnoi, 1984); alfalfa (Allen *et al.*, 1986) and wheat (Francois *et al.*, 1986) etc.

(c) *Seedling vigour* : Lower salinity level i.e. 125 meq/l increased seedling vigour over non saline medium for all the genotypes except Krishna, RC-199, Purple mutant and Prakash with a grand mean of 143.77 and 220.73 in control and 125 meq/l salinity, respectively. But it reduced in 175 meq/l salinity over control in all the genotypes ranging from 8.6 per cent (RH-7846) to 75.0 per cent (RH-8113).

The effectiveness of screening at the seedling stage has though been questioned by Millington *et al.* (1951) and Shannon (1979), but, a positive correlation for salt tolerance between the seedling stage and later development stage in India mustard was found by Jain (1991). Thus the genotypes which show more tolerance at this stage are likely to establish better in saline soils. Moreover, if the correlation does not exists between seedling and adult stage, the germination in itself is one of the most essential part and screening at seedling stage is hence extremely important.

The genotypes RH-7846, RH-7859, RH-781 and RLM-514 were having less than 30 per cent reduction in seedling vigour, whereas RH-8113, Prakash, RWH-1 and RH-8315 were having more than 70 per cent reduction in 175 meq/l over control. The genotyopes RH-7859, RH-7846 and RH-781 were having comparitively faster speed of germination alongwith high seedling vigour and hence are tolerent to salinity, whereas the genotypes showing reverse trend i.e. RH-8315, RWH-1 and RH-8113 were identified as susceptible to salinity. Variability for salt tolerance at seedling stage has also been reported by Dhawan *et al.* (1987) and Kuhad *et al.* (1989). Therefore it is suggested that these characters can be effectively employed in screening large collection at a very early stage to identify tolerant genotypes.

Table 1. Screening of Indian mustard (*Brassica juncea*) genotypes under two levels of salinity for germination per cent and seedling characteristics

Genotypes	% Germination				Speed of germination				Seedling vigour			
	E_1	E_2	E_3	% reduction in E_3 over E_1	E_1	E_2	E_3	% reduction in E_3 over E_1	E_1	E_2	E_3	% reduction in E_3 over E_1
	1	2	3	4	5	6	7	8	9	10	11	12
RC 1425	100.0	97.0	97.0	3.0	3.87	2.73	2.05	47.0	95.14	120.56	42.39	55.4
RH 8602	97.0	97.0	93.0	4.1	4.16	3.20	1.73	58.4	83.42	268.64	63.02	65.6
RH 781	90.0	90.0	87.0	3.7	3.68	2.70	2.27	38.3	97.86	145.36	75.60	22.7
RH 819	97.0	97.0	97.0	0.0	3.87	3.00	2.16	44.2	161.86	237.995	92.31	43.0
RH 8605	100.0	100.0	100.0	0.0	4.30	3.55	1.79	58.4	209.50	262.08	88.91	57.6
RH 8315	100.0	100.0	93.0	7.0	3.45	3.33	1.42	58.8	217.65	248.25	61.54	71.7
RH 8812	97.0	97.0	97.0	0.0	3.39	3.03	1.67	50.7	238.07	444.03	110.82	60.1
RH 7846	100.0	100.0	100.0	0.0	4.50	3.22	2.56	43.1	132.30	425.71	120.90	8.6
RH 7859	100.0	100.0	100.0	0.0	4.67	3.49	2.89	38.1	161.55	310.26	132.74	17.8
RC 781	100.0	100.0	97.0	3.0	3.92	3.15	1.93	50.8	37.38	41.13	18.59	50.3
RH 839	97.0	100.0	93.0	4.3	3.86	3.57	1.90	50.8	164.70	253.96	116.54	29.3
Krishna	67.0	60.0	57.0	14.9	2.85	1.80	1.78	37.5	114.14	105.98	75.04	34.3

(Cont. on next page)

Genotypes	% Germination				Speed of germination				Seedling vigour			
	E_1	E_2	E_3	% reduction in E_3 over E_1	E_1	E_2	E_3	% reduction in E_3 over E_1	E_1	E_2	E_3	% reduction in E_3 over E_1
	1	2	3	4	5	6	7	8	9	10	11	12
RWH-1	90.0	90.0	87.0	3.7	3.32	2.82	1.66	50.0	92.96	93.94	25.77	72.3
Varuna	97.0	93.0	90.0	7.2	4.08	2.34	1.78	56.4	222.34	296.34	126.78	43.0
RH 8113	97.0	93.0	90.0	7.2	3.98	3.33	1.83	54.0	127.52	184.72	31.86	75.0
RH 30	90.0	90.0	87.0	3.3	3.85	3.04	1.40	63.6	244.02	339.89	106.41	56.4
RLM 514	100.0	100.0	100.0	0.0	3.98	2.83	2.18	46.5	95.45	142.04	68.98	27.7
RC 199	90.0	90.0	87.0	3.3	3.85	3.04	1.40	63.6	51.24	41.26	18.27	64.3
Purple Mutant	93.0	83.0	83.0	10.8	2.86	2.34	1.29	54.8	64.13	64.06	26.32	59.0
Prakash	100.0	97.0	97.0	3.0	4.28	3.14	2.80	34.6	118.38	116.52	31.26	73.6
RH 8313	97.0	97.0	97.0	0.0	3.76	3.05	2.13	43.4	150.87	324.99	49.15	67.4
RLC 1105	100.0	100.0	100.0	0.0	4.63	3.49	2.08	55.1	112.76	197.16	49.86	55.8
RH 8702	100.0	100.0	97.0	3.0	3.97	3.46	2.02	49.1	160.31	315.39	92.73	42.4
Pusa Bold	100.0	97.0	97.0	3.0	3.93	2.90	1.82	53.7	190.10	222.66	75.88	60.1
RH 846	100.0	100.0	97.0	3.0	4.04	3.36	2.24	44.5	182.97	221.08	104.32	43.0

(Cont. on next page)

Genotypes	% Germination				Speed of germination				Seedling vigour			
	E_1	E_2	E_3	% reduction in E_3 over E_1	E_1	E_2	E_3	% reduction in E_3 over E_1	E_1	E_2	E_3	% reduction in E_3 over E_1
	1	2	3	4	5	6	7	8	9	10	11	12
NDR 841	97.0	97.0	90.0	7.2	4.14	3.28	1.82	56.0	212.02	371.54	102.03	51.8
Kranti	97.0	93.0	93.0	4.1	3.91	3.03	2.02	48.3	177.23	273.98	57.75	67.4
Vaibhav	100.0	100.0	100.0	0.0	3.18	2.85	1.40	56.0	80.33	115.62	39.55	50.8
Rohini	100.0	100.0	100.0	0.0	3.54	3.29	1.52	57.1	143.52	238.02	58.50	59.4
RH 8606	97.0	93.0	87.0	10.3	4.00	3.28	1.93	51.8	201.19	244.20	100.17	49.7
RH 7513	100.0	100.0	87.0	13.0	3.89	3.12	2.02	48.1	96.84	182.24	41.31	57.3
Wardan	100.0	100.0	93.0	7.0	4.00	3.69	1.81	54.8	101.29	145.08	37.01	63.5
Grand mean	96.56	95.34	92.59		3.85	3.06	1.93		143.77	220.73	70.12	
	±2.19	±2.83	±2.94		±0.25	±0.20	±0.19		±18.19	±15.05	±6.99	
C.D. at 5%	6.08	7.84	6.66		0.72	0.57	0.53		52.49	43.43	20.18	
Range	67.0	60.0	57.0	0.0	2.85	1.80	1.40	34.6	41.23	41.26	18.27	86
	to 100.0	to 100.0	to 100.0	to 14.9	to 4.67	to 3.69	to 2.89	to 63.6	to 238.07	to 444.03	to 132.74	to 75.0

where, E_1 = contril; E_2 = 125 ,eq/1 litre; E_3 = 175 meq/litre Salinity levels

REFERENCES

Allen, S.G., A.K. Dobrenz, and P.G. Bartels, 1986. Physiological response of salt tolerant and nontolerant alfalfa to salinity during germination. *Crop. Sci.* **26**: 1004-1008.

Bishnoi, N.R. 1984. Studies on the effect of salinization and nitrogen fixation in pea (*Pisum sativum* L.) and chickpea (*Cicer arietinum* L.). M.Sc. Thesis, H.A.U., Hisar

Blum, A. 1988. Plant Breeding for Stress Environments. C.R.C. Press, Inc. Boca Raton, Florida.

Devine, T.E. 1982. Genetic fittings of crops to problem soils. *In* : Breeding plants for Less favourable environments. John Willey and Sons, New York, p. 143-174.

Dhawan, Rupa S., D.R. Sharma, and J.B. Chowdhury. 1987. Effect of salinity on germination and yield components in three species of Brassica. *Indian J. agric. Sci.* **57**: 107-111.

Francois, L.E., E.V. Mass and T.J. Donovan. 1986. Effect of salinity on grain yield, vegetative growth and germination of semidwarf and durum wheat in arid environment. *Agron. J.* **78**: 1- 53-58.

Jain, Sunita, 1991. Biochemical Studies on *in vitro* selected salt tolerant somaclones of Indian mustard (*Brassica juncea* L.). Ph.D. Thesis, H.A.U., Hisar.

Kuhad, M.S., I.S. Sheoran and N.R. Bishnoi. 1989. Variability in *Brassica* genotypes under simulated salt and osmotic stress at iso-osmotic level during germination. *Haryana agri. Univ. J. Res.* **23**: 193-96.

Kumar, D. 1984. The value of certain plant parameters as an index of salt tolerance in India mustard (*Brassica juncea* L.). *Plant and Soil* **79**: 262-272.

Levitt, J. 1980. Responses of plants to environmental stresses Vol. 2. Academic Press, New York.

Maguire, J.D. 1962. Speed of germination. Aid in selection and evaluation for seedling emergence and vigour. *Crop Sci.* **2**: 176- 177.

Millington, A.J., G.H. Burvill and B. Marsh. 1951. Soil salinity investigations, salt tolerance germination and growth tests under controlled salinity conditions. *J. Agric. West Australia* **28**: 198-210.

Shannon, M.C. 1979. In quest of rapid screening techniques for plant salt tolerance. *Hort. Sci.* **14**: 587-589.

Sheoran, I.S. and O.P. Garg. 1983. Effect of different types of salinities on gram (*Cicer arietinum* L.) during germination. I. Seedling growth and water relations. *Indian. J. Plant Physiol.* **26**: 363-369.

Singh, K.N. and R.S. Rana. 1989. Seedling emerging rating:A criterion for differentrating varietal responses to salt stress in cereals. *Agric. Sci. Digest* **9**: 71-73.

Srivastava, J.P. and S. Jana 1984. Screening wheat and barley germplasm for salt tolerance. *In*: Staples, R.C. and Tolnnissen, G.H. (eds.). Salinities tolerance in plants. Strategies for crop improvement. John Willey Publishers, New York, p. 73-84.

Indian J. Pl. Genet. Resources 7(2): 201-204, 1994; Special Issue

IN VITRO CONSERVATION STRATEGIES FOR A RARE MEDICINAL HERB-SAFED MUSLI (*CHLOROPHYTUM BORIVILIANUM* SANT. ET FERNAND.)

S.D. Purohit, Ashish Dave and Gotam Kukda

Plant Biotechnology Laboratory, Department of Botany,
M.L. Sukhadia University,
Udaipur 313 001 (Rajasthan)

In vitro clonal multiplication of 'safed Musli' (*Chlorophytum borivilianum*) a rare Indian medicinal herb has been achieved on MS medium supplemented with 22.2 μM BA using young shoots. All shoots produced roots on 3/4 strength MS medium containing 9.8 μM IBA. Sixty seven per cent of plantlets could be established in pots and soil. Multiplication was also achieved through somatic embryogenesis. Callus raised from zygotic embroys produced somatic embroys on MS medium containing 4.53 μM 2, 4-D. Somatic embroys were maintained on low concentration (1.13 μM) of 2, 4-D. A few somatic embroys (20 per cent) produced plants when inoculated on a medium without any growth regulator. Precocious germination of somatic embroys and profuse rhizogenesis was frequently observed.

Key words : Safed musli, *Chlorophytun borivilianum*, *in-vitro* conservation

Chlorophytum borivilianum Sant. et Fernand. (Safed Musli) belonging to family Liliaceae is an important medicinal herb of commercial importance in India. Red-data book (Nayar and Shastry, 1988) has described this plant under 'Rare' category. The fascinated storage roots of *Chlorophytum* have aphrodisiac properties and form an important ingredient of herbal tonics prescribed in the Ayurvedic system of medicine in India (Kirtikar and Basu, 1975). The natural regeneration of this herb is through tuberous roots that have become scarce because of its indiscriminate collection from wild populations. The seed germination is only 14-16 per cent (Jat and Bordia, 1990). Therefore, there is a strong need for multiplication of this plant for conservation using *in-vitro* methods. *In vitro* propagation enables a broad range of species to be cloned rapidly under highly controlled conditions (Hussey, 1986). Clonal multiplication of plants via tissue culture methods can be carried out by three methods namely (a) enhanced axillary bud breaking (b) production of adventitious buds and (c) somatic embryogenesis (Thorpe and Harry, 1990. *In vitro* culture of several ornamental species of Liliaceae have been described (Krikorian and

Kann, 1986) but very few medicinal species of this family have so far been established *in vitro* (Jha *et al.*, 1984). This paper reports *in-vitro* methods of multiplication and conservation fo *C. borivilianum.*

MATERIALS AND METHODS

Plants of *C. borivilanum* collected from natural habitat were maintained in the University Botanical Garden. Cultures were initiated from stem discs possessing shoot buds and from post-pollinated zygotic embryos. Stem disc explants were treated with sodium hypochlorite (1% V/V) and 2-3 drops of Tween-20 for 5-20 min. followed by surface disinfestation with 0.1 per cent (W/V) aqueous mercuric chloride solution for 3-10 min, and rinsed several times with autoclaved distilled water, before inoculation. For callus induction and somatic embryogenesis, post-pollinated immature seeds were rescued from the fruits and surface sterilized with 0.1 per cent mercuric chloride ($HgCl_2$) for 5 min and washed 4-5 times with autoclaved distilled water. Immature embryos (2-3mm) were dissected out with the help of needles under stereomicroscope in a Laminar Flow Hood. Embryos were placed horizontally on the medium. Murashige and Skoog's (1962) medium fortified with different concentrations of cytokinins (Kinetin and BA) individually and in combination with auxins was used for shoot cultures. For callus cultures, MS medium containing different concentrations of 2, 4-D was used. The pH of the medium was adjusted to 5.8 prior to autoclaving at 106 kPa (121°C) for 125 min. Shoot cultures were maintained in light (16 h photo period of 3000 lux) while callus cultures were initially kept under dark. Temperature of the growth room was maintained at 28 ± 2°C and relative humidity at 45-60 per cent.

Tissue culture plants obtained through shoot cultures were established in pots containing soil-soilrite mixture (1:1 by volume). These pots were initially maintained under high humidity conditions in locally fabricated polythene tents which are misted with water thrice a day.

RESULTS AND DISCUSSION

Shoot cultures : On MS medium containing different cytokinins, the inoculated shoots produced shoot primordia varying in number and length at all the concentrations within 21 days to inoculation. Basal MS medium containing 22.2 µM BA produced 11 shoots per explant with an average length of 1.5 - 2.0 cm. In comparison to BA, kinetin was less effective since maximum 4-5 shoots were obtained at 23.2 µM. Combined cytokinins (4.4 µM BA and 4.7 µM kinetin) produced a maximum of 14 shoots per explant with an average length of 6.5 cm. There was however, intense callusing on this medium. It was concluded that 23.2 µM of BA was the best for shoot proliferation. A

four fold shoot multiplication rate was achieved when cluster of shoots were inoculated after every 21 days on fresh medium.

One hundred per cent rooting was observed in shoots inoculated on 3/4 strength MS medium containing different concentrations of auxins (IAA, IBA and NAA). However, the best rooting occurred on the medium containing 9.8 µM IBA. Out of 300 plantlets, 200 (67%) survived in pots when they were kept initially under high humidity conditions and gradually exposed to external environment. Such established plants were transferred to soil where they produced normal fasciculated storage roots similar to their wild parents. None of the plants showed any phenotypic variation.

Callus cultures and somatic embryogenesis: Callus induction was observed in embryos on the 10th day after their inoculation on the MS medium containing 4.52 µM - 22.62 µM , 4-D. However, the best callus response was observed in presence of 4.52 µM 2, 4-D. Initially the growth of callus was slow but after six weeks in culture, it grew faster and produced embryogenic cultures, which were maintained on low concentration (1.13 µM) of 2, 4-D. For healthy growth of cultures, 567.0 µM ascorbic acid was also added in the medium. Mature somatic embryos were transferred on medium without growth regulators for germination and were kept under light conditions. Twenty per cent (42 out of 200) of the inoculated embryos produced shoots and roots alongwith a mixed population of precociously germinating embryos showing profuse rhizogenesis. The recovered plantlets could not be transferred to pots due to their poor formation.

Use of mature explant for the *in vitro* multiplication strategy is advantageous, since the clonal fidelity can be maintained in culture. In this investigation, stem discs containing shoot primordia were used. Care was taken to avoid even a trace of callus, which can create genetic variability.

Somatic embryogenesis is a preferred method of micropropagation when a large number of genetically uniform plants are required. Unicellular origin and thus providing uniformity among the regenerating plants has been critically discussed by Haccius (1978). Production and maintenance of vigorous callus from tissues of Liliaceae family have traditionally been viewed as difficult (Krikorian and Katz, 1968). Z, 4-D has been considered the most of the monocotyledons (Choi and Sung, 1989). In this study also, 2,4-D has been used to induce callusing and somatic embryogenesis.

The *in vitro* methods demonstrate the potential of shoots and zygotic embryos in multiplication and conservation of 'Safed musli' (*Chlorophytum borivilianum*). There is however, need to further refine the procedure to recover large number of plantlets through somatic embryogenesis.

REFERENCES

Choi, J.H. and Z.R. Sung. 1989. Induction, commitment and progression of plant embryogenesis. *In*: Kung and Arntzenm eds. Plant Biotechnology, p. 141-158, Butterworths, USA.

Hussey, G. 1986. Vegetative propagation of plants by tissue culture. *In* : M.M. Yeoman, ed., Plant Cell Culture Technology, p. 29-66, Blackwell Scientific publications.

Jat, R.D. and P.C. Bordia. 1990. Propagation studies in safed musli (*Chlorophytum* species). *In*: Chaudhary *et al.*, (eds)., Proceedings of National symposium on Advances in Plant Sciences. Current status and Emerging challenges, p.46, Department of Botany. M.L. Sukhadia University, Udaipur.

Jha, S., G.C. Mitra and S.Sen. 1884. *In vitro* regeneration from bulb explants of Indian squill, *Urginea indica* Kunth. *Plant Cell Tissue and Organ Culture* 3:91-100.

Kirtikar, K.R. and B.D. Basu. 1975. Liliaceae *Chlorophytum, In* Kirtikar and Basu, (eds)., Indian Medicinal Plants, p. 2508- 2509, published by L.M. Basu, Allahabad, India.

Krikorian, A.D. and G.M. Katz. 1968. The aseptic culture of onion roots and root tissues. A preliminary report. *Phytomorphology* 18: 207-211.

Krikorian, A.D. and R.P. Kann. 1986. Regeneration in Liliaceae, Iridaceae and Amaryllidaceae. *In* : I.K. Vasil, (ed)., Cell Culture and Somatic Cell Genetics of Plants, p. 187-205, Academic Press, New York.

Murashige, T. and F. Skoog. 1962. A revised medium for rapid growth and bioassays with tobacco tissue cultures. *Physiol. Plant* 15: 473-497.

Nayar, M.P. and A.R.K. Shastry. 1988. *Chlorophytumborivilianum. In*: Nayar and Shastry, (ed)., Red Data Book of Indian Plants, Vol. 2, p. 142, Published by Botanical Survey of India, Calcutta.

Thorpe, T.A. and I.S. Harry. 1990. Special problems and prospects in the propagation of woody species. *In*: R. Rodriguez *et al.*, (eds)., Plant Ageing Basic and Applied Approaches. p. 67-74, Plenum Press, New York.

Indian J. Pl. Genet. Resources 7(2): 205-208, 1994; Special Issue

EFFECT OF GEOGRAPHICAL PARAMETERS, SOWING DATE AND FLOWERING DURATION ON GRAIN YIELD OF RICE*

R.K. Mahajan

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

Coordinated rice experimental data of 5 varieties belonging to different maturity groups for 5 years (1985-90) grown during the wet seasons was scanned to study the relationship between grain yield and latitude, longitude, altitude, sowing date and days to 50 per cent flowering from amongst 60 test locations in the country. Longitude and days to 50 per cent flowering had a significant effect on grain yield in all the 5 varieties. From the cause effect analysis, it was noticed that relatively dry weather favours higher grain yield besides more days to flowering. Further, it was pointed out that low grain yoields in Eastern India could be attributed to high relative humidity, higher night temperture coupled with low evapotranspiration values resulting in low nutrients uptake.

Key words: Rice, yield relationship, geographical parameters, cause effect analysis, harvest index

Rice is grown under diverse agro-climatic conditions in India from 8° N - 36° N latitudes, 68° E - 97°E longitudes and at varying altitudes sometimes even higher than 4,000 feet. The crop can be grown even upto 6,500 feet height (Wilsie, 1974). The geographical parameters alongwith sowing date and days taken to 50 per cent flowering of a rice variety affect the grain yield substantially. Undoubtedly, the application of inputs at their optimum levels based on the nature of soil and other factors also enhances the grain yield to a great extent in a particular environment. Grain yield is influenced by days to 50 per cent flowering (Das and Borthakur, 1975; Mahajan and Rao, 1990) in dry and wet season under irrigaqted conditions. Effect of geographical parameters on days to 50 per cent flowering were studied by Mahajan and Rao (1991). This study was undertaken to study the effect of latitude, longitude, altitude, date of sowing (number of days to sowing from 1st June) and days taken to 50 per cent flowering on the grain yield of rice varieties belonging to different maturity groups.

*Studies conducted at Directorate of Rice Research, Rajendranagar, Hyderabad 500 030 (Andhra Pradesh)

MATERIALS AND METHODS

Data on sowing dates (X_4), days taken to 50 per cent flowering (X_5) and grain yield (Y) of 5 rice varieties, 'Rasi' (very early duration), 'IR 36 and Ratna' (early duration), 'Jaya' (medium duration) and 'Pankaj' (late duration) for 5 years from *kharif* 1985 to 1990 at 60 locations were extracted from the Annual Reports of the Directorate of Rice Research, Hyderabad from the Uniform Variety Trials only. Averages of flowering duration, sowing date and grain yield were computed. Location wise data on latitude (X_1), longitude (X_2) and altitude (X_3) were taken from Randhawa (1958) and their ranges are presented in Table 1. The X_i's were then regressed against grain yield through multiple regression technique. The bi's are the partial regression coefficients to the corresponding X_i's.

RESULTS AND DISCUSSION

Nearly 60-80 per cent variation in grain yield was explained by latitude, longitude, altitude, sowing date and days to 50 per cent flowering in all the varieties except 'Rasi'. This indicated that some other factors are also responsible for variation in grain yield. Longitude and days taken to 50 per cent flowering affected the grain yield significantly in all the varieties.While sowing date had a significant negative effect on grain yield of 'Ratna', altitude had a significant effect of 'Rasi' and 'Pankaj'. An increase in longitude was resulted in decreasing the grain yield, the magnitude depending upon the variety. Similarly, delayed 50 per cent flowering resulted in increasing the grain yield potential, with the maximum in 'IR 36'. From the results, it was quite clear that as we move from Western (lower longitude values) to Eastern (higher longitude values) India, the grain yield of five varieties belonging to different maturity groups were decreasing. A look at the agroclimatic map of the country indicates that the mean daily temperature for October month is slightly higher (27.5°C) in the central than in the western coast (25°C). But the mean minimum temperatures (i.e., night temperature) are slightly higher in the eastern coast belt, around 22.55°C, than in the interior 20-22.5°C (IMD, 1978). Rice requires relatively lower minimum temperature for better grain yields (Papadakis, 1970). Secondly, the relative humidity during afternoon hours in October was found to increase from around 60 per cent to 75 per cent in the eastern coast. The related evapotranspiration (ET) values showed a decreasing trend from around 6 mm/day in the interior to almost 4 mm/day in the east coast indicating thereby lower potential transpirational rates because as the relative humidity increases the vapour pressure deficit decreases. This ultimately results in lower grain yields as the uptake quantum of nutrients like Ca, Mg, Mn etc. depends on mass flow mechanism. With the decrease in transpirational rate, the level of uptake of these nutrients will also be low and thereby resulting in lower yields (Tomar and Toole, 1980; Hirai *et al.*, 1985). The lower grain yield in

east coast are thus likely to be due to the combined influence of low ET values and relatively higher night temperature than in the interior of the country.

Among the varieties tested, it is clear that as the days to 50 per cent flowering increases, the grain yield also shows an increasing trend. Naturally, as the flowering gets delayed, the chances for accumulating greater biomass during the pre-flowering period are more. On the assumption of a more or less stable harvest index for different varieties, the grain yields will be more with higher biological yields (total dry matter). In varieties with less duration to flowering, there will be a heavy competition between the simultaneously growing organs (viz., vegetative tillers and generative panicles) for the available photosynthates (Yoshida, 1981)

Table 1. Range of latitude, longitude, altitude, sowing date, flowering duration and mean grain yield of 5 rice varieties

Variety	X_1(°N)	X_2(°E)	X_3(m)	X_4(days)	X_5(days)	Y(t/ha)
'Rasi'	9.5-30.2	72.4-94.2	1.5-961.5	10-56	76.96	3.61
'IR 36'	10.5-31.5	72.4-94.2	1.5-961.5	15.68	84-102	4.10
'Ratna'	10.5-31.5	72.4-94.2	1.5-961.5	15-70	81-104	4.17
'Jaya'	9.5-32.0	72.4-92.3	1.5-764.5	6-48	94-116	4.38
'Pankaj'	12-26.6	74.5-88.2	8.6-764.5	18-44	116-132	4.59

Table 2. Estimates of partial regression coefficients for different varieties

Variety	a	b_1	b_2	b_3	b_4	b_5	R^2
'Rasi'	17.74	0.006	–0.132**	0.002**	0.011	–0.011	61.2
'IR 36'	5.36	–0.032	–0.085**	0.000	0.003	0.066*	60.3
'Ratna'	15.04	0.011	–0.081**	0.000	–0.023*	0.038*	63.2
'Jaya'	14.42	0.000	–0.185**	0.000	0.014	0.044*	81.1
'Pankaj'	12.56	0.104	–0.179**	–0.002*	0.038	0.035*	73.2

* $P \leq 0.05$, ** $P \leq 0.01$

With regards to altitude, only two varieties showed significance viz., 'Rasi' (positive effect) and 'Pankaj' (negative effect) relationship with grain yield. It is known that with increasing altitude, for every 100 m, rise, a decrease of 1° C in temperature will result (Anonymous, 1972). It is also reported that at higher attitudes, the solar spectrum wil be richer in ultra-violet rays and the diurnal range in temperature is greater than at lower altitudes

(Critchfield, 1975). Seshu *et al.* (1989) reported that with increase in altitude, the dsays to 50 per cet flowering will increase as was noticed in this study (original data is not reported here. As already stated, the delay in flowering in 'Rasi' resulted in higher grain yield. However, in the case of 'Pankaj' the same analogy of not seem to be applicable perhaps due to too much of delay in flowering, the variety might have encountered sufficiently too low temperature affecting anthesis besides being subjected to harmful ultra- violet radiation for a longer time than in 'Rasi'.

From this study, it can be concluded that the lower yields in areas with higher longitudes (Eastern India) could be due to higher relative humidity, higher night temperature coupled with lower evapotranspiration values which might have resulted in lesser uptake of nutrients, viz. Ca, Mg, Mn etc. and thereby in poor grain yields.

REFERENCES

Anonymous. 1972. Meteorological Glossary, HMSO, London.

Critchfield, M.J. 1975. General climatology, Third edition. Prentice Hall of India Ltd., New Delhi.

Das, G.R. and Borthakur. 1975. Optimum duration of semi-dwarf rice in Assam. *Indian J. Genet.* 35(3): 446-449.

Hirai G., Takahashi M., Tanaka P., Nasu T. 1985. Studies on the effects of relative humidity of the atmosphere upon the growth and physiology of rice plant IV. Influence of humidity on absorption of mineral nutrients of rice plant. *Japanese Journal of Crop Science* 54(2): 141-145.

Indian Meteorological Department. 1978. Agroclimatic Atlas of India, Pune.

Mahajan, R.K. and A.V. Rao. 1990. Effect of flowering time on grain yield of rice *Crop Improvement* 17(1): 59-63.

Mahajan, R.K. and Rao, A.V. 1991. Note on the effect of latitudes, longitude, altitude and sowing date on flowering duration of rice. *Crop Improvement* 18(1): 75-76.

Papadakis, J. 1970. Agricultural potentialitis of world climates. Buenos Aires, Argentina 70p.

Randhawa, M.S. 1958. Agricultural Research in India - Institutes and Organisations, Indian Council of Agricultural Research, New Delhi.

Seshu, D.V., T. Woodhead, D.P. Garrity, and L.R. Oldeman. 1989. Effect of weather and climate on production and vulnerability of rice, climate and food security. International Rice Research Institute, Manila Philippines. p 93-113

Tomar, V.S. and J.C.O. Toole. 1980. Measurement of evapotranspiration. Agrometeorology of Rice Crop, International Rice Research Institute, Manila, Philippines, p 87- 93.

Wilsie, C.P. 1974. Crop adaptation and distribution. Eurasia Publishing Housing (P) Ltd., New Delhi.

Yoshida, S. 1981. Fundamentals of Rice Crop Science. 269. International Rice Research Institute, P.O. Box 933, Manila, Philippines.

Indian J. Pl. Genet. Resources 7(2): 209-215, 1994; Special Issue

POST ENTRY QUARANTINE FOR IMPORTED PLANTING MATERIALS

A. Majumdar and Shamsher Singh

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

The purpose of post entry quarantine isolation growing of imported planting materials is to isolate these from the existing indegenous plants that may be susceptible to exotic pests and pathogens. It is also to detect any disease which may be present in the plant but not evident at the time of entry or can not be detected in the laboratory. Seed samples, found to be heavily treated with chemicals, that can not be tested in the laboratory and those which are known to harbour pathogens like downy mildews, smuts and crops particularly leguminous which are known to carry high risk viruses, are grown in post entry quarantine nurseries/insect- proof net houses or glass houses. Ultimately only healthy progeny is released to the indentors/importers. The importers/indentors should understand the basic philosophy of the post-entry isolation growing of materials. These are held in quaratine until the quarantine personnels are fully satisfied that material in question is free from exotic pests/diseases. Basic minimum post-entry quarantine facilities are still now lacking in India. These require proper linkage between private seed growers, research organizations and agricultural universities to bring them to a satisfactory level.

Key words : Plant species, quarantine, pests / diseases

Exchange of planting material has undoubtedly helped many countries both in the conservation of genetic resources and development of high yielding varieties of food grain and other crops. This obviously has given scope to the introduction of dangerous pests/pathogens from one corner to another part of the world. There are numerous examples of introduction of potential diseases/pests/weeds in different countries that resulted in heavy losses to concerned crops. The well known Irish potato famine of 1845, is believed to be due to introduction of late blight pathogen (*Phytophthora infestans*) with potato tubers from North America into Europe. Phylloxera and the downy mildew (*Plasmopara viticola*) of grapes alongwith nursery stock from USA into France, resulted in total collapse of the wine industry in that country. The Colorado potato beetle (*Leptinotarsa decemlineara*), a native of USA, is a serious menace to potato cultivation all over Europe, the mediterranean fruitfly (*Ceratitis*

capitata). introduced from Mexico into Florida in 1929. In India, late blight of potato from Europe in 1883, downy mildew of grape (*Plasmopara vitivcla*) from Europe in 1910, downy mildew of maize (*Selerospora philippinesis*) from Java in 1912, bunchy top of banana from Sri Lanka in 1940, wart of potato (*Synchytrium endobioticum*) from Holland in 1952, bacterial leaf blight (*Xanthomonas oryzae*) of rice from South East Asian countries in 1960, resulting in devasting damage to their respective host plants.

When plants/seeds are introduced through Government channels, then the responsibility of the quarantine officials is to ensure and to screen the material in question and to see that it is free from exotic pests/pathogens from quarantine angle. In majority of the cases the laboratory examination is sufficient for the imported planting material and can be handed over to the indentors without any quarantine risk. But certain type of seed and planting material and also vegetative propagules (like rooted plants, cuttings, bulbs, rhizomes, suckers, tuber etc.) may carry number of pests and pathogens like viruses, mycoplasmas, certain bacteria, downy mildews, nematodes etc. These are not easily detectable during routine laboratory examination. The behaviour of such pests/pathogens are often unpredictable under different agro-climatic conditions of the importing country/countries, which may be congenial for their establishment and spread. Hence, the vigilance against the introduction of such pests/pathogens can not be reduced. So, it is necessary to grow them in post- entry quarantine (PEQ) nurseries, screen or glass houses depending on the risk involved.

BASIC QUARANTINE REQUIREMENTS

It is therefore essential that each country should be familiar with her own important pests/diseases and provide reliable surveys of the pests known in their territory. Another aspect is to make lists of foreign pests/diseases, their occurance, distribution, host range and mode of spread that may be regarded as potentially dangerous to important crops of each country, should be established. A list of major pests/pathogens of quarantine importance to India is listed in Table 1.

With regard to quarantine precautions, it is necessary to categorise pests/pathogens countrywise. Then only the quarantine officials will be in a position to justify the exclusion of an exotic pest/pathogen on the basis of scientific information. True quarantine objects are: a) pests/pathogens not present in the area to be protected by quarantine precautions, (b) pests/pathogens dangerous by their direct pathogenic potential, and (c) pests/pathogens dangerous because of their epidemic potential.

Table 1. Major pests of Quarantine importance to India against which precautions to be taken to prevent introduction

Scientific name	Common name	Host range	Geographic distribution
(A) INSECTS AND MITE			
Anthonomus grandis	Cottonboll weevil	Cotton hollyhock, okra, *Abutilon Thespesia papulnea, Thurberia thespesioides*	USA
Ceratitis capitata	Mediterranean fruitfly	Citrus, coffee, cocoa, ficus, guava, *Prunus, Solanum*	Africa Australia (SW), Berumuda, Hawaii, S.Europe, USA
Leptinotarsa decemlineata	Colorado potato beetle	Belladona, groundcherry, eggplant, potato, tomato, tobacco, pepper	Europe, USA
Prophantis smaragdina (= Hypothenemus hampei)	Coffee berry borer	Coffee, woody Rubiaceae	Africa, Colombia, Mexico
Brevipalpus lewisi	Citrus flat mite	Citrus, grape pomegranate, walnut	Australia, Bulgaria, Egypt, Japan, Lebanan, USA
Ditylenchus dipsaci	Stem & bulb nematode	Garlic, braodbean, flower bulbs, onion	Most temperate regions of the world: Australia, Europe, Japan S. Africa, N&S USA, USSR
Globodera tabacum G.solanacearum	Tobacco cyst nematode	Tobacco & other solanaceous plants	USA
Heterodera schachtii	Sugarbeet cyst nematode	beet Cruciferous plants & chenopodiaceae	Africa, Australia, Europe, Isreal, 40 North & South USA
Rhadinaphelenchus cocophilus	Coconut palm nematode	Cocount,datepalm oilpalm	Brazil, Costa Rica, Carribean Islands, Mexico, Tobago, Trinidad, W. Indies

(Continued on page 212)

(C) FUNGI, BACTERIA, VIRUS AND VIRUS LIKE ORGANISMS

Fusarium nivale	Snow mould/bown foot rot	Wheat, Barley, Rye	Australia, Europe, Japan, Canada, Newzealand, NE & NW USA, USSR
Peronospora manshurica	Downy mildew	Soybean	Asia, Africa, N&S America, Europe
P. tabacina	Blue mould/ downey mildew	Tobacco	Africa, America, Australia, Asia/ Iran, Iraq, Burma, Europe
Tilletia contraversa	Dwarf bunt	Wheat	Africa, Asia, N&S America, Europe
(ii) Bacteria			
Corynebacterium flaccumfaciens pv. *flaccumfaciens*	Bacterial wilt	Bean soybean	Australia, Europe (Bulgaria, Yugoslavia) N & Central America
Erwinia stewartii	Bacterial wilt/ stewart's wilt	Maize	Asia, Europe, N&S America
Pseudomonas syringae pv. *astrofaciens*	Spikelet rot	Wheat	Australia, Europe, New Zealand, South Africa, Nolth America
(iii) Viruses and virus like organism			
Fiji disease virus		Sugarcane	Australia, Fiji, Madagascar & Thailand
Swollen shoot virus		Cacao	Malaysia, Srilanka, West Africa
Lethal yellowing (MLO)		Cocounut	Bathamas, Cuba, Dominican Republic, Jamaica, USA

Adopted from : (a) Insects: Lal and Kapur, 1992, (b) Nematode: Lal and Mathur, 1987, (c) Fungi etc: Agarwal, Majumdar and Parakh, 1990.

PURPOSE OF POST ENTRY GROWING

As stated above, certain categories of seed and planting material which may harbour pests/pathogens, not easily detectable during routine laboratory examination require to be grown in isolation in post-entry quarantine. The purpose of growing of imported planting materials is to isolate these from

the existing indegenous plants that may be susceptible to exotic pests/pathogens. The detention period should be long enough to break the life cycle and the virulence of the exotic pests/pathogens. It is also to be noted that while growing imported material in isolation, one must be careful that no vector or alternate host is present in the vicinity. To prevent cross infection occuring between different imported materials in the PEQ areas/glasshouses, they must be grown at a safer distance or placed in separate benches/racks in the net/glass houses. The plants in quarantine must be examined regularly during the growing season of the crop for the presence of any disease, insect/pests or other abnormality.

The usual PEQ detention period is atleast for one growing season. The importers/indentors should understand the basic philosophy of the PEQ isolation growing of material. These are held in quarantine until the quarantine officials are fully satisfied that material in question is free from exotic pests/diseases, and that it will be ordered to be destroyed should any disease/pest may be present or suspected to be present that offers a quarantine risk.

Another problem connected with the quarantine examination of the imported material concerns the pre-export chemical seed dressing by some organizations/countries as a prophylactic measure. Such heavily chemical coated seed can hardly be recognized as to which plant it comes from. Furthermore, the external symptoms produced by the presence of pathogens or pests are completely masked. In fact, even in some cases soil clods (which may carry nematodes) and weed seeds when present in the seed consignment also receive chemical as well as dye coating for which they look very similar to the seed under import. In such cases routine examination in the laboratory is not possible, hence require to be grown in PEQ nurseries/insect-proof net houses or glass houses. Some of the pathogens detected from imported treated seeds are listed in Table 2.

Table 2. Pathogens detected from imported seed, that were given pre-exported treatment, after washing with acetone and incubated*

Seed	Origin	Pre-export treatment	Pathogens detected
Maize	Pakistan	Vitavax	*Drechsleras maydis*
	USA	NS	*Drechslera maydis*
Sorghum	USA	NS	*Drechslera maydis*
Soybean	USA	NS	*Colletotrichum dematium, Phomopsis phaseolorum, Cercospora kikuchii Verticillium* spp.
Barley	Canada	NS	*Drechslera sorokiniana*

NS - Not specified

* Experiment conducted at Plant Quarantine Division of N.B.P.G.R., Pusa Campus, New Delhi - 110 012

POST ENTRY QUARANTINE SYSTEM IN INDIA

Three types of materials are being imported into India:

(i) bulk consignments of grains/pulses for consumption,

(ii) bulk consignments of seeds/planting material for farmers/commercial growers, and

(iii) germplasm materials for research purpose

Directorate of Plant Protection, Government of India has the responsibility of quarantine clearance of the first-two categories. National Bureau of Plant Genetic Resources has been entrusted for quarantine processing of germplasm materials.

(a) Directorate of Plant Protection

To provide the best planting material to the Indian farmers available in the world and to increase the agricultural productivity, farm income and export earnings, the Government of India liberalised the import of seed/plant material by announcing "New Policy on Seed Development (NPSD) with effect from October, 1988. (Ministry of Agriculture, 1988). The pre and post entry quarantine requirements and inspection parameters of the imported planting materials have been specified in the NPSD. All the imported plants/seeds are required to plant quarantine screening at the port of entry. There are 26 plant quarantine stations in India. Out of these 5 stations viz., Amritsar, Bombay, Calcutta, Madras and New Delhi have been identified under NPSD for import of seed and planting materials. In case of cuttings, saplings, budwoods etc. of flowers and fruits, PEQ is essential. PEQ facilities as prescribed by PPA (Plant Protection Adviser, Government of India) has to be established by the eligible categories of importers (under OGL). Such facility has to be certified by either PPA or by DIA's (Designed Inspection Agency of AAU's) authorized by PPA.

The DIA's certificate indicating that the importer has established the prescribed PEQ facilities then only the imported material is given quarantine clearance by PPA. The period for which the cuttings, saplings, budwoods etc. to be grown in such a facility (PEQ) is prescribed in the import permit issued by the PPA. If PEQ grown material reveal any exotic pest or disease the material in question is destroyed immediately by DIA's under intimation to PPA.

(b) National Bureau of Plant Genetic Resources

NBPGR handles quarantine examination of material for research purposes. After laboratory examination, certain materials specially legumes are grown

in PEQ net/glass houses for the detection of exotic viruses or mycoplasmas. Chemically treated germplasm of wheat, barley and triticale mainly for loose and false smut and soybean against downy mildew are grown in PEQ isolation nurseries. In all the above cases only healthy material is released to the indentors. Germplasm material like potato, sugarcane, tuber crops, plantation crops after initial laboratory examination at NBPGR are forwarded to the respective crop based institute for PEQ growing under the supervision of crop protection scientists. Though some facilities are existing in these institutes, these are to be strengthened in view of the volume of material they handle in PEQ. It is a fact, that quarantine organization of any country cannot fullfil the total requirement of PEQ facilities needed for all material. Therefore, the practical and appropriate approach for our country will be to have a proper linkages between the private importers, research institutes, agricultural universities along with NBPGR. They must share responsibilities to provide basic facilities necessary for PEQ growing of imported material. So that, much needed germplasms and elite materials could be made available to the user scientists/institutes/indentors with proper quarantine safeguard.

REFERENCES

Agarwal, P.C., A. Majumdar and D.B. Parakh. 1990. Plant pathogens of quarantine importance to India. NBPGR Pub., New Delhi, 4p.

Lal, A. and V. K. Mathur. 1987. Plant parasitic nematodes of quarantine importance. NBPGR Pub., New Delhi, 5p.

Lal, B. and M.L. Kapur. 1992. Major insect and mite pests of quaratine significance to India with legislative measures and techniques for their detection and disinfection. NBPGR Pub., New Delhi, 9p.

Ministry of Agriculture. 1988. New Policy on Seed Development. Department of Agriculture and Co-operation, Gazette No. 11-71/88- So.I. dated September 18, 1988. 15p.

Indian J. Pl. Genet. Resources 7(2): 217-222, 1994; Special Issue
Short Communication

GERMPLASM RESOURCES OF OKRA IN ANDAMANS

A.B. Mandal, T.Ram and S.D. Singh

Central Agricultural Research Institute,
Port Blair 744 101 (A & N Islands)

Key words : Okra, germplasm, evaluation

Okra (*Abelmoschus esculentus* (L) Moench) holds a prominent position on the vegetable canvas of the Bay Islands. In the present paper, an attempt has been made to document the morpho- physio-agronomical traits of a few germplasm lines which have so far been collected. They have been evaluated and catalogued. One germplasm ANC-1 was found to be a dwarf with extremely short internodes. It has a profuse bearing habit and is a high yielder but it is bottle-necked by photosensitiveness and 'shaddy' looking fruits, and so needs genetic improvement. Another notable germplasm ANC-6, which was found to bear tolerance to multiple diseases viz., *Alternaria* leaf spot, powdery mildew and *Cercospora* leaf spot, may be used in disease resistance breeding programmes. Okra is an important vegetable crop in Andamans probably because of its year round production potentiality in the humid tropics (with about 3000 mm rainfall distributed over 8 months) and being unsuitable for the growth of a number of other vegetable crops especially winter crops. Since long back, a number of okra lines have probably been introduced to these islands which have undergone tremendous selection pressure in this unique climate nitche. The present paper describes a few such germplasm which are still growing inspite of the introduction of modern high yielding varieties.

In three consecutive years from 1987-1989, local survey were conducted and germplasm were collected from different parts of Andamans. Collected materials were evaluated during rainy and dry season each year. Standard agronomical protocols were adopted to ensure proper plant growth. Duplicate materials were discarded while growing, on the basis of visual judgment and ultimately 6 lines were identified as separate entry and designated as ANC-1, 2, 3, 4, 5 and 6. Through recurrent evaluation across years, seasons and locality, these materials were characterized in respect of morphological, agronomical,

physiological and biochemical traits. Nitrogen, phosphorus, iron and chlorophyll were estimated as per Yoshida *et al* (1976). Nitrate reductase and IAA oxidase activity measured following Klepper *et al* (1971) and Mahadevan and Sridhar (1982) respectively.

Key morphological characters of 6 indigenous okra germplasm from Bay Islands are summerised in Table 1 alongwith standard check **Pusa Sawani** for comparison. It reveals that most of the local collections were having vigorous growth habit and lax plant type. ANC-3 and ANC-6 were characterised with

Table 1. Key morphological characters of a few okra germplasm in Andamans

Character	Germplasm							
	ANC -1	ANC -2	ANC -3	ANC -4	ANC -5	ANC -6	Pusa (check)	Sawani
Plant Vigour	V	V	Mo	V	Mo	V	Mo	
Type	L	L	L	Me	Me	L	C	
Stem colour	Gl	G	Gl	Dp	Gl	Pg	G	
Leaf								
Shape	Ov	Ov	Ps	Ps	Ov	Ov	Ps	
Lobe	Sl	Sl	Dl	Dl	Sl	Sl	Dl	
Colour	Lg	Lg	G	G	G	Dg	G	
Angle	>45°	>45°	>45°	– 45°	– 45°	>45o	<45°	
Blade length	M	M	S	S	M	L	L	
Petiole								
Colour	Gl	G	G	Pi	G	Pi	G	
Length	B	B	M	S	S	B	S	
Stipule size	B	S	B	S	S	M	S	
Corolla colour	Ly	Ly	Ly	Lybv	Lybv	Lybv	By	
Gynoecium	5c	5c	5c	5c	5c	7c	5c	
Fruit size	Sb	Sb	M	M	M	Sb	Nl	
Colour	Lg	Dg	G	Dp	G	Dg	G	
Ridges	8	7-8	5	5	5m	7, 8, 9	5	

1a. V = Vigorous, Mo = Moderate. 1b. L = Lax, Me=medium, c=Compact. 2. Gl = Light green, G = green, Dp = Deep pink, Pg = Pinkish green. 3a. Ov = ovate, PS = Pusa Sawani type. 3b. Sl = Slightly lobed, Dl = Deeply lobed 3c. Lg = Light green, G = green, Dg = deep green. 3e. L = Long > 24.33 cm, M = medium, = 21.67-24.33cm, S = small < 21.66 cm. 4a. Gl = Light Green, G = green, Pi = Pinkish. 4b. B= Big > 26.1 cm, M = medium = 23.6-26. 1 cm, S = small < 23.5 cm.5. B = Big > 1.74 cm, M = Medium = 1.24-1.47 cm, S = Small < 1.23cm. 6. Lybv = Light yellow coloured with violet base, By = Bright yellow, LKy = Light yellow. 7. C = Chambered 8a. Sb = Short bold, M = Medium, Nl = Narrow long. 8b. Lg = Light green, G = Green, Dg = Dark green, Dp = Deep purple.

deep pink and pinkish green coloured stem respectively while others were green or light green. Except ANC-3 and 4, all the accessions were having slightly lobed ovate type of leaves while others had typical **Pusa Sawani** type leaf with deep lobes. Regarding leaf colour, ANC-1 and ANC-4 bore light green leaves while ANC-6 had deep green and the rests were having green coloured leaves. Leaf angle to stem in the local varieties were mostly more than 45 except ANC 4 and 5 where the angle was about 45. Leaf blade·length were small to moderate in the local collections. ANC-4 and ANC-6 had pink coloured petiole while remaining strains had green or light green. Regarding petiole length and stipule size, notable variability observed as they ranged from small to big size in the local strains.

Coralla colour were mostly light yellow. ANC-4 and ANC-6 had light yellow coloured corolla with pink base. Except ANC-6 ANC1, 2 and 6 had short bold type of fruits and ANC-3, 4 and 5 were found to bear medium type of fruits in comparison to narrow long fruits of **Pusa Sawani**. Deep purple coloured fruit was found to be a diagonastic character of ANC-4 whereas in ANC-1, fruits were light green shabby looking. ANC-3 and 4 had green and ANC-2 and 6 had deep green fruits. Remarkable variability for number of ridges (5-9) within these germplasm ANC-1, 2 and 6 had more than 5 number of ridges as shown by the rests.

During the dry season, much differences were not observed for days to flower initiation among the local strains (Table 1) but all of them took more days from initial flowering to attain 50 per cent flowering than the check Pusa Sawani. In the rainy season, days to initial and 50 per cent flowering shown tremendous variation due to photosensitive nature of ANC -1, 2, 5 and 6. ANC - 3 and 4 took 5-6 days moe for initial flowering in comparison to dry season. Anc-1 and 6 were found dwarf while the others were much more taller across seasons. Stem girth and number of primary branches per plant were much more taller across seasons. Stem girth and number of primary branches per ploant were much more in local grmplasm than **Pusa Sawani**. Regarding average internode length ANC-1 and ANC 6 had very short internodes (2.8-4.5 cm). ANC-1, 3 and 5 gave the first branch at a distance more closure to the ground. Number of fruiting nodes and fruits per plant found maximum in ANC-1. Long fruits were found to be the characteristic of ANC 3, 4 and 5 while thick fruits were characteristics of ANC-1, 2 and 6 as evidenced from width of fruit data. Fruit yield found maximum in ANC 1, lowest in ANC-6. The yield of ANC-1 found as good as check **Pusa Sawani**.

To have a successful crop, heat tolerance is an essential character under the rainfed cultural condition of Bay Islands during the dry season. ANC-1 was found to be not affected due to excessive heat generated during mid day with clean sky. Thick leaves of ANC-1 articulated with strong veins probably attributed to the tolerance norms. Regarding photosensitivity among the local

Table 2. Agronomical traits of a few okra germplasm in Andamans

Character	Scason	Germplasm designation						
		ANC-1	ANC-2	ANC-3	ANC-4	ANC-5	ANC-6	Pusa Sawani (Check)
Days to initial	D*	41.2	43.0	42.2	46.0	41.2	43.0	41.0
flowering	R	110.0	92.3	50.0	51.0	99.8	100.0	44.3
Days to 50% flowering	D	53.2	49.0	48.0	51.0	45.3	49.0	46.0
	R	117.0	99.0	56.8	55.0	106.3	106.0	49.0
Plant height (cm)	D	61.4	89.5	155.2	166.6	165.4	91.4	147.8
	R	71.7	164.0	167.1	171.5	168.1	114.3	164.7
Plant Spread (cm)	D	95.1	89.4	56.0	70.0	72.0	75.0	51.4
	R	108.7	103.8	62.8	77.8	84.8	89.2	53.6
Stem girth (cm)	D	3.2	2.5	3.0	2.0	3.0	4.3	1.8
	R	3.0	2.8	3.3	2.30	3.1	4.1	2.0
No. of primary branches/Plant	D	5.7	2.2	2.0	1.2	4.2	3.0	1.0
	R	5.8	2.0	2.0	1.1	4.5	3.3	1.2
Average internode length (cm)	D	2.8	6.0	12.0	11.7	6.0	3.3	10.9
	R	3.2	8.3	14.2	12.5	8.5	4.5	13.2
Height of first branch from ground level (cm)	D	3.1	5.0	3.5	8.0	4.2	10.0	13.2
	R	2.6	6.3	4.6	8.9	6.2	13.6	11.6
No. of fruiting nodes/plant	D	11.2	10.2	9.8	10.2	8.9	10.5	12.2
	R	13.8	11.6	10.0	12.3	9.8	12.3	13.0
No. of fruits/Plant	D	10.9	7.4	8.0	8.1	8.1	6.3	10.3
	R	12.6	8.5	8.2	8.9	7.8	5.9	9.7
Length of fruit (cm)	D	13.6	12.7	19.7	15.4	18.0	9.1	17.8
	R	2.5	2.3	2.0	1.8	2.0	3.0	1.8
Fruit Yield /Plant (g)	D	201.2	170.9	135.7	149.0	156.6	87.6	206.2
	R	179.7	195.5	187.7	133.5	154.5	75.3	190.0

*D = Dry, R = Rainy

strains ANC-1, 2, 5 and 6 were found photosensitive (Table 3). While computing fruit harvest indice in comparism to check **Pusa Sawani** all the local collections were having lower values, amongst which ANC-4 scored maximum and ANC-6 scored minimum values. It also indicates inefficient translocation of nutrients from vegetative parts to the fruits among the local strains.

Table 3. Important physiological traits in okra collections from Bay islands

Designation	Heat tolerance (0-9 Scale)*	Photosensitivity	Fruit Harvest index (%)
ANC -1	0*	+**	32.93
ANC -2	5		33.05
ANC -3	9	–	30.95
ANC -4	3	–	41.96
ANC -5	3		36.87
ANC -6	5		23.46
Pusa Sawani (Check)	3	–	53.41

* Value scored on the basis of leaf wilting at mid day.

0 = Not affected, 3 = Mild affected 5 = Moderately affected, 9 = Severly affected.

**, + Photosensitive , – Not photosensitive

Studies made with a few representatives of local germplasm and check **Pusa Sawani** with special reference to some specific physiological and biochemical parameters (Table 4). It reveals that largest leaf area encountered in ANC-1. But it possessed low chlorophyll content. Nitrate reductase activity, IAA oxidase activity, nitrogen harvest index and phosphorus harvest index were found highest in ANC-4 among the local accessions. To the contrary of the above mentioned characters iron harvest index was found more in the local accessions than check Pusa Sawani.

Table 4. Specific physiological and biochemical parameters of a few Okra

Germplasm designation	leaf area/ plant (cm)	Total chlloroph yll content (mg/g)	Nitrate reducta se activity (n. moles nos/g/ hr)	IAA oxidase activity (mg IAA oxid/ g/hr)	Nitrog en harvest index (%)	Phosphor us harvest index (%)	Iron harvest index (%)
ANC-1	2270	1.32	3455	39.5	60.6	48.8	31.3
ANC-2	1838	1.32	2385	32.0	63.6	49.4	33.9
ANC-4	1815	1.50	4742	43.5	67.7	57.0	33.2
Pusa Sawani (Check)	1754	1.55	4393	43.5	76.1	60.6	29.4

In nutshell, it may be concluded that significant variation was observed in respect of morphological agronomical, physiological and biochemical parameters amongst the indigenous collections of okra in Bay Islands. ANC-1 bears enormous potentiality in vegetable production in Andamans as it is high yielding heat tolrant and with dwarf plant type though bottlenecked with strong photosensitivity, short bold light green shabby fruits, sreaded plant type and with lower harvest index. It will be more logical to launch a massive breeding programme to eliminate such unwanted traits for improvement of this local variety which seemed to gave progressed under many years selection pressure under this humid tropics of climate. Another germplasm ANC-6 was found to have multitolerance to alternaria leaf spot, powdery mildew and cercospora leaf spot which offers an opportunity in its exploitation in disease resistance breeding programme.

REFERENCES

Creech, J.L. and L.P. Reitz. 1971. Plant germplasm now and for tomorrow. *Adv. Agron.* **23**: 1-49.

Frankel, O.H. 1970. Evaluation and utilization-introductory remarks. *In* : Genetic Resources in Plants -their Exploraton and conservation. Frankel, O.H. Bennet, E. (Eds), p. 395-401 Oxford:Blackwell Sci.Publ.

Frankel, O.H and E. Bennett. 1970. Genetic Resources introduction. ibid, 7-17

Krull, C.F. and N.E. Borlaug. 1970. The utilization of collections in Plant Breeding and Production. ibid. 427-439.

Klepper, L.A Flasher D, and R.H. Hageman. 1971. Generation of reduced nicontinamide adenine dinucleotide for nitrate reduction in green leaves. *Plant Physiol.* **29**: 580-590.

Mahadevan, A. and R. Sridhar. 1982. Methods in Physiological PLant Pathology. II Edn. Sivakamani Publication, Madras. 326 p.

Yoshida, S; D.A Forno, J.H. Cock and K.A. Gomez. 1976. Laboratory manual for physiological studies of rice. International Rice Res. Inst. Philippines. 83 p.

Indian J. Pl. Genet. Resources 7(2): 223-226, 1994; Special Issue
Short Communication

PHYTOGEOGRAPHICAL STUDIES IN THE GENUS *MORUS* L. I. GEOGRAPHICAL DISTRIBUTION AND NATURAL VARIATION OF *MORUS SERRATA* ROXB.

S.B. Dandin[1], Basavaiah[1], R. Kumar and H.V. Venkateshaiah[1]

Central Sericultural Research and Training Institute,
Mysore 570 008 (Karnataka)

Key words : *Morus serrata*, geographical distribution, variation

Morus L. is an important genus of the family Moraceae and is distributed in temperature and subtropical regions of both the hemispheres. The genus is beleived to be originated in the temperate mountain regions of South east Asia. Vavilov has recognised 'China-Japan' gene centre as the centre of origin of this genus. Of the 68 species recognised from different parts of the world, 38 species are found in Asia and 14 in continental America (Sanjappa, 1989). The genus is also represented in middle east, Europe, and South Africa. Owing to the fast spread of sericulture to more than 60 countries in the recent past, numerous varieties belonging to different species have been introduced to all these countries. In India, *Morus* is represented by four species namely *M.alba, M. indica, M. laevigata* and *M. serrata* (Hooker, 1885), which are distributed in north-west, central and north-east Himalayas. The importance of wild species in mulberry improvement programmes has been realised in recent years. A systematic approach to study and collect the mulberry germplasm from Himalayas was taken on priority by C.S.R. & T.I., Mysore.

Three explorations were conducted covering the major growth seasons (spring and autumn) during 1985-89. The geographical areas covered include northwest Himalayan regions in Jammu and Kashmir and Himachal Pradesh; central Himalayas of Uttar Pradesh and north-east states, viz., Assam, Manipur, Meghalaya, Nagaland and West Bengal. For all the populations of *M.serrata* came across during the survey, details of habitat, population density, size of individual trees and other morphological characters which are important from sericulture point of view were recorded. Information was also collected on its

[1]Present address : Karnataka State Sericulture Development Institute, Thalaghattapura, Bangalore-560 062 (Karnataka)

use from the local inhabitants. Harbarium specimens were prepared which are preserved in institute's repository. Live specimens were collected in the form of stem cuttings and multiplied as bud grafts. In total 7 accessions which are found distinctly different from each other are included in the germplasm of the institute for further study. Preliminary cytological studies were made and their chromosome numbers are confirmed.

Morus serrata, is native of India and is known as Himalayan mulberry (Roxburg, 1832). Hooker (1885), Brandis (1906) and Osmoston (1927) have reported this species from north-western and central Himalayas. It has been recognised as a valuable timber species (Wlth. India, 1962). Its leaves are used as fodder and also rarely for feeding silkworm (Kanjilal, 1940). During the present survery, *Morus serrata* was found distributed in Himalayan regions of Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh. In Jammu region

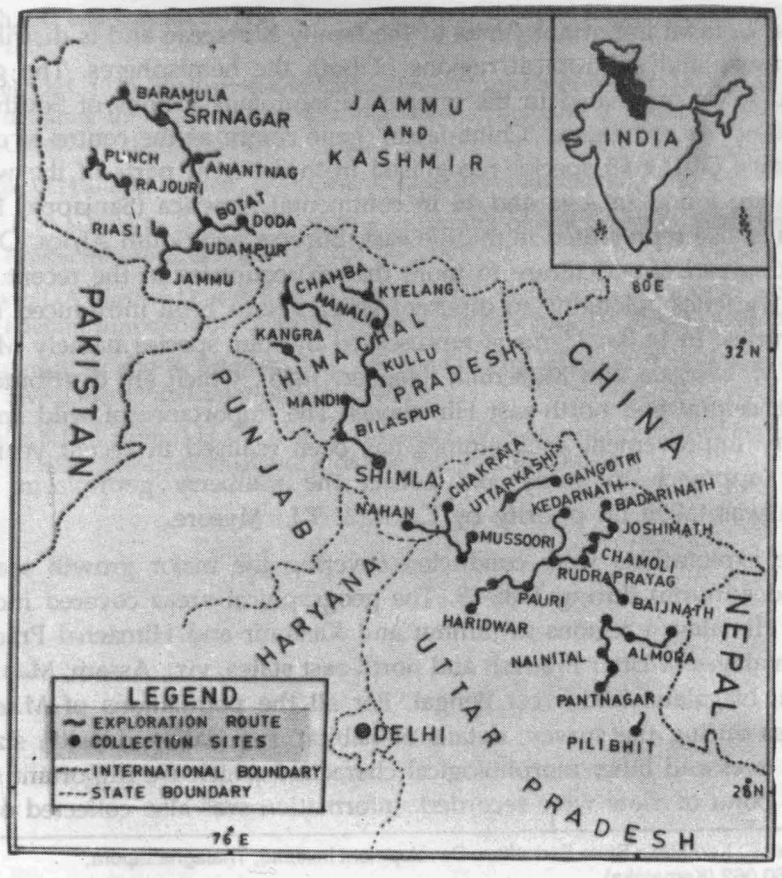


Fig. 1. Distribution of *Morus serrata* and sites of collection in north-west and central Himalayas

large trees measuring an height of 10-15 m were found as forest component in Rajouri, Punch and Botat at an elevation of 1300-2200 m. They showed broad, 3-5 lobed, dull-green leaves sharply pointed uneven serrations. Majority of the trees were males with 3-6 cm long catkins. Leaves are the common source of fodder and the wood is commonly used for the preparation fo agricultural appliances. Large trees of 100-200 years age were also found in Kangra, Chamba, Kullu and Nahan districts of Himachal Pradesh. They grow along roadsides, hillsides and river beds. Most of them were stunted due to continuous lopping of branches for fodder. Striking variations were observed in the size. lobation, texture and greenness of the leaves of different trees within the same population.

In Garhwal Himalayas of Uttar pradesh, this species constitutes a major floristic component alongwith oak. Large populations were recorded around Korawa, Astar, Dakyarna, Magralli, Larloo and Kwara villages in Chakrata tahsil of Dehradun district at an elevation of 1900 m. They were large trees of 20-30 m height and are mainly used as timber. They showed large unlobed to trilobed leaves with deep serration and sharp teeth. In some areas due to large scale denudation, trees were confined mostly to bunds of encroached areas. Tall trees measuring an height of 10-12 m are concentrated in Badrinath, Gopeshwar, Chamoli, Pauri, Urghum and Haridwar. They showed large trilobed leaves measuring 20-30 cm length and 20-25 cm width. In village like Salna, Lyari, Badiginda, Devagram etc., these trees were conserved on bunds of terraces for fodder purposes and also for feeding silkworms occasionally. In Kumaon region, large trees of *M. serrata* were distributed in Nainital, Pithoragarh and Almora at an elevation of 1100-2200 m. Both male and female plants were found in this region. In Pilibhit area, only isolated trees were found as sporadic occurance. This species was not observed in north-eastern regions during the present exploration. However, Kanjilal (1940) has reported it from the Khasi hills of Meghalaya.

Morphological variability in different populations of *M.serrata* has been described taxonomically. It is a large decidious tree, 20-45 m tall and 3-4 m girth; dark greyish brown as rough, branches lenticellate, young shoots pubescent, leaves 5-25 × 5.5-15 cm size, dull green, membranous to thick, ovate/cordate, unlobed or variously lobed or heterophyllous, acuminate, serrate, densely tomentose dorsally; dioeious, predominantly male, male catkins 2-6 cm. long, flowers sparse on catkins, female catkins 1-3 cm long and fruit 1-1.5 cm long, sweet and purple. It flowers during March-May and is locally called as 'Ki mu'.

Of the seven collections which are being maintained as important from sericultural value in the germplasm, two are triploids and five are hexaploids. The sacred tree of Joshimath (Rau, 1970) is found as a natural hexaploid with

2n=6x=84 (Basavaiah *et al.*, 1990). The stem cuttings of all the collections showed poor rooting capacity. Root grafts made on root stocks of local variety showed 30-40 per cent survival. However bud grafting technique is proved more successful witn 70-80 per cent survival. Silkworm feeding trials showed that the leaves are acceptable to worms. This species may not be of much use for sericulture purpose as the leaves are coarse. It may be exploited in higher altitudes of temperate regions. The diploid ancestor of presently available triploids and hexaploids may be of some use, which should be explored. This wild species may also find a place in disease/pest resistance breeding programmes of mulberry.

REFERENCES

Brandis, D. 1906. Indian trees. London.

Hooker, J.D. 1885. Flora of British India V : 491-493. L. Reeve and Co. Ashford, Kent

Kanjilal, 1940. Flora of Assam. L : 272-274.

Osmoston, A.E. 1927. A forest flora of Kumaon. Govt. Press. Allahabad.

Roxburgh, W. 1832. Flora Indica, Vol. 3. Serampore.

Sanjappa, M. 1989. Geographical distribution and exploration of the genus *Morus* L. (Moraceae). *In*: Genetic resources of mulberry and utilization. K. Sengupta and S.B. Dandin (Eds.) C.S.R. & T.I., Mysore. p 4-7.

Basavaiah, S.B. Dandin and Mala V. Rajan. 1989. Microsporogenesis in Hexaploid *Morus serrata* Roxb. *Cytologia* 54 : 747-751

Rau, M.A. 1967. The sacred mulberry tree of Joshimath, U.P. *Indian Forester* 93 (8) : 330-335.

Wlth. India. 1962. The Wealth of India - Raw Materials. A dictionary of Indian Raw materials Vol. VI Publications and Information Directorate CSIR, New Delhi. p. 438-439.

Indian J. Pl. Genet. Resources 7(2): 227-230, 1994; Special Issue
Short Communication

GERMPLASM EXPLORATIONS WITHIN INDIA AND CONTRIBUTION TO GENETIC DIVERSITY IN COTTON

S. S. Narayanan and V.V. Singh

Central Institute for Cotton Research,
Post Bag No. 225, GPO,
Nagpur 440 001 (Maharashtra State)

Key words : Cotton, germplasm, exploration, genetic diversity

India is the ancient home of the cultivated Asiatic species of *Gossypium* L. particularly representing the origin, and domestication of three geographical races of *G. arboreum* L. namely *bengalense, cernuum* and *indicum* and also the race *wightianum* of *G. herbaceum* (Hutchinson *et al.*, 1947). India grows the diploid desi cottons from earlier than 3000 BC and both perennial and annual forms are found widely distributed. In addition, several *G. hirsutum* and *G. barbadense* genotypes were introduced by the British East India Company and other agencies from the latter half of the 18th century and during the last two centuries, introduced and acclimatised materials have been spread in localised pockets all over the Indian sub-continent. Some of these have also undergone isolation, introgresion and continuous localised selection in various regions and are often grown by the tribals etc., in smaller pockets besides the large scale commercial cultivation of improved cultivars evolved during the recent decades. In the germplasm bank of cotton maintained at Central Institute for Cotton Research, Nagpur, though some such forms are available from the earlier acquisitions, there is scope and need for recollecting additional and fresh diversity for enriching the national cotton gene pool. In this paper, the utility of material collected under CICR-NBPGR joint explorations during 1979-1992 is presented and discussed.

The NBPGR in collaboration with CICR, Nagpur has a joint mandate to collect genetic diversity in cotton from India and exotic sources by explorations and exchange. During 1979-1992, seven explorations were conducted in various regions of Indian sub- continent as indicated in Fig. 1 and Table 1. The material collected from these explorations were systematically evaluated at CICR, Nagpur (Singh *et al.*, 1992) and the new gene sources available for crop

improvement programmes were recorded and documented. These accessions were added to the National Cotton Gene Bank at CICR, Nagpur.

The regions explored, type of material and number of accessions collected and useful characters identified are presented in Table 1. From the table, it may be seen that during 7 explorations, the total quantitative addition to the gene pool was to the extent of 315 *G. arboreum* race collections, 72 *G. herbaceum* and 40 *G. hirsutum* types. This included about 50 perennial forms also.

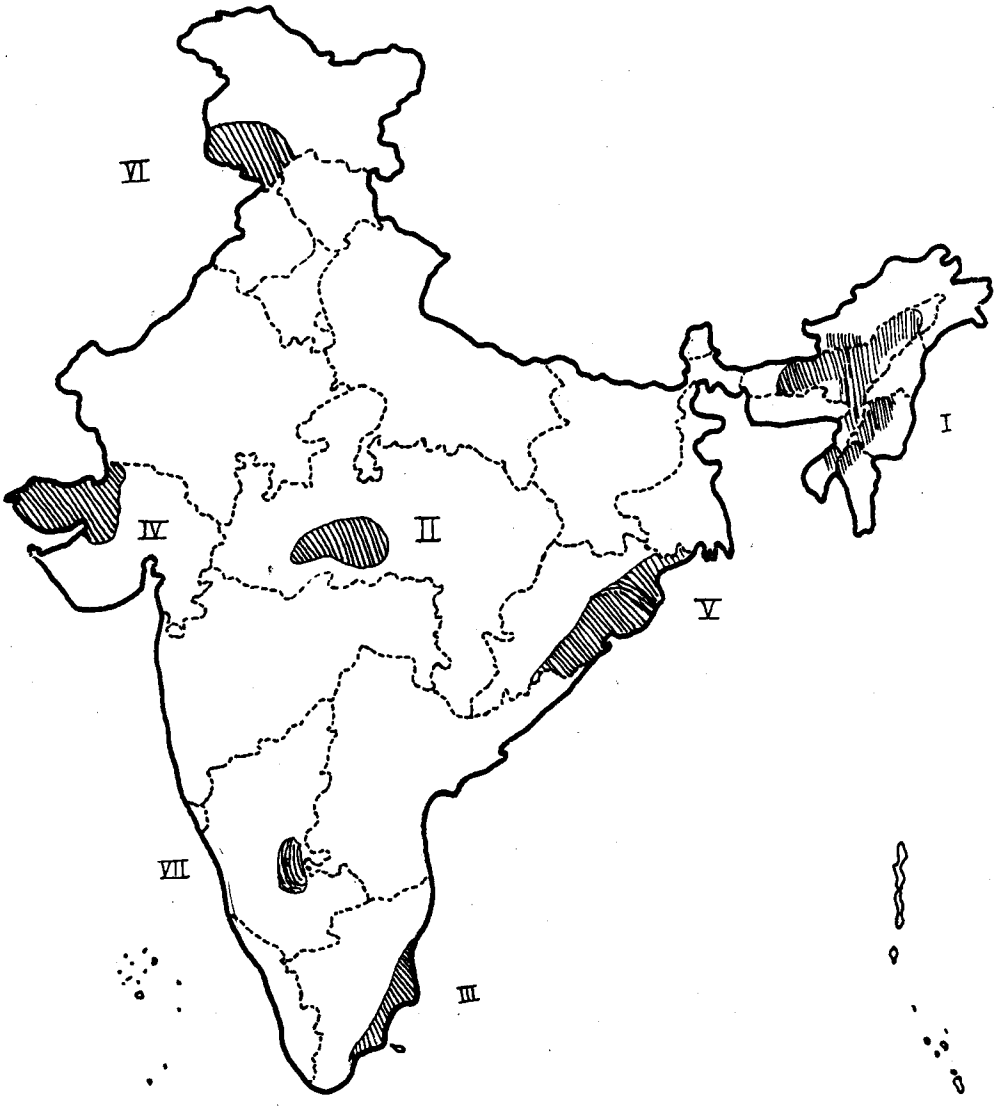


Fig. 1. Cotton Germplasm exploration regions explored I-VII

Table 1. Regions explored, material collected, characters identified (CICR-NBPGR)

No.	Region explored	Year	Species	No. of Accs.	Characters
1.	Neh region- mainly Assam, Meghalaya, Nagaland, Manipur, Tripura	1979 1984 1990	*arboreum* race-*cernuum* & perennials	190	Big long bolls, high boll weight, high got, high seed number, coarse fibre, short staple and high locule retentivity
II	Malwa plateau region	1980-81	*hirsutum* (upland types)	34	Hairy types, big boll, high boll weight and salt tolerant types.
III.	South coastal region	1979 1981	*arboreum* introgressed *indicum* and *hirsutum* types	32	Small bolls, medium staple, salt and drought resistant/tolerant types, bourbon types (*G.hirsutum*) drought tolerant
IV.	Gujarat Kutch Saurashtra region	1979	*herbaceum*	50	Round and closed bolls, high got and drought tolerant.
V.	East coast tract (Orissa)	1989	Mostly *arboreum*, some *hirsutum*, perennials and introgressed types	54	Small bolls, high got.
VI.	Jammu region (J&K)	1991-92	*arboreum*	45	High elevation and cold tolerant types.
VII.	Karnataka (raichur)	1979	*aerbaceum*	22	High boll number and high got

The major achievements of these efforts are represented by the acquisition of new/additional variability such as for increased boll size, boll shape differences, drought resistance, cold tolerance, high boll number, high ginning outturn, high locule retentive capacity after boll bursting and high seed number per boll in the *G. arboreum* collections. These have added considerably to the diversity in national gene pool of the diploid **desi** cottons. The additional variability collected in the tetraploid species from such remote locations falling

mostly outside the predominantly cultivated pockets was comparatively of a lower magnitude. The desi cottons are again regaining special importance compared to the trtraploid cottons because of the higher level of resistance of the desi cottons to abiotic and biotic stresses and the future scope for their yield and quality improvement (Singh and Narayanan, 1990; Narayanan *et al.*, 1990). Already CICR has used some of these new germplasm accessions especially the *cernuum* and *indicum* types for improving the productivity potential and developed advanced cultures which have been tested under All India Co-ordinated Cotton trials (Singh and Narayanan, 1987). These efforts thus have brought out the importance of collecting within the country from selected areas of origin, diversification and distribution of old cotton forms for enlarging and enriching the national gene pool of cotton.

REFERENCES

Hutchinson, J.B., R. A. Silow and S.G. Stephens, 1947. The evolution of *Gossypium* and differentiation of the cultivated cottons. Oxford Uni. Press, London.

Narayanan, S.S., V.V. Singh and R. Kothandaraman. 1990. Cotton Genetic Resources in India. *In*: Cotton Scenario in India, A Souvenir, ICAR, New Delhi, p. 9-20.

Singh, P. and S.S. Narayanan. 1987. Inter-racial introgression for some economic characters in *G. arboreum* L. *Indian J. agric. Sci* 57 (9) : 628-30.

Singh, V.V., and S.S. Narayanan. 1990. Studies on Cotton Genetic Resources in Relation to the Current Breeding Needs and for the 21st Century, *J. Cotton Res. & Devel.* 4 (1) : 1- 9.

Singh, V.V., S.S. Narayanan and G.S. Chauhan, (1992). Semiquantitative Analysis of Cotton Genetic Resources of Desi Cotton (*G. arboreum* L.). *Indian J. Pl. Genet. Resources.* 3 (2) : 37-46.

Indian J. Pl. Genet. Resources 7(2): 231-234, 1994; Special Issue
Short Communication

COMPARISON OF VARIABILITY PARAMETERS BETWEEN YELLOW vs BROWN SEEDED *BRASSICA TOURNEFORTII* GOUAN

P. Joshi and B.R. Choudhary

Agricultural Research Station,
Rajasthan Agricultural University,
Mandor, Jodhpur 342 304 (Rajasthan)

Key words : Chitti sarson, *B. tournefortii*, seed colour, heritability

Different species of *Brassicas* are cultivated in different parts of India but wild turnip *(Brassica tournefortii* Gouan)- locally known as **Chitti sarson** is sporadically grown in few pockets in northern parts of Rajasthan State. Its small, rounded seed had yellow and brown colour which normally contains oil up to 40 per cent. The seed colour is a established potent factor for genetic diversity in *Brassica.* The yellow seed has high oil and protein content due to thinner seed coat as compared to brown or black seed forms (Stringam *et al.*, 1974). Therefore, an attempt has been made here in present investigation to assess seed colour influence on different variability parameters in this species.

Thirty five yellow and sixty five brown seeded genotypes of *B. tournefortii* were grown in randomized block design with three replications at Agricultural Research Station, Mandor, Jodhpur during rabi 1991-92. Each of these entries were planted in two rows of 3 m length with crop geometry of 30 × 10 cm. Observations were recorded on five competitive plants from each plot on ten attributes. The mean data were subjected to compute the coefficients of variability (Burton, 1955), heritability in broad sense and expected genetic advance (Johnson *et al.*, 1955). Analysis of variance indicated highly significant difference among the genotypes for all the ten traits studied (Table 1). Analysis also indicated significant differences between yellow and brown seeded group (except recemes/plant) revealing predominant role of seed colour in expression of the most of the traits. Sufficient variation were also obtained within group for all the characters, indicating the opportunities for manipulation and improvement within each groups.

Table 1. Anova for different characters in *B. tournefortii*

Characters	Mean sum of squares				
	Total genotypes	Yellow seeded genotypes	Brown seeded genotypes	Yellow v/s brown seeded genotypes	Error
(df)	(99)	(34)	(64)	(1)	(198)
Vegetative phase (days)	154.76**	30.22**	50.56**	11057.92**	1.24
Reproductive phase (days)	59.95**	40.06**	29.33**	2695.89**	4.58
Maturity period (days)	59.63**	26.98**	33.79**	2823.49	1.98
Plant height (cm)	366.05**	241.27**	339.16**	6329.53**	14.62
Primary branches/plant	3.63**	2.77**	4.01**	8.55**	0.58
Racemes/plant	33.59**	41.88**	29.71**	0.05	8.70
Main raceme length (cm)	107.18**	43.01**	113.76**	1867.84**	4.99
Siliquae/main raceme	25.91**	17.10**	28.81**	139.85**	3.32
Siliqua intensity x 10^{-3}	11.60**	8.93**	11.81**	176.24**	1.28
Seed yield/plant (9)	16.27	6.07**	14.75**	460.35**	1.49

** p = 0.01%

Variability parameters computed for individual group indicated that traits like vegetative phase, maturity period, plant height, primary branches per plant and siliqua intensity had recorded higher mean values for yellow seeded genotypes as compared to brown seeded genotypes (Table 2), while the magnitude fo mean values of the characters viz., reproductive phase, main receme length, siliquae per main raceme and seed yield per plant were higher for brown cultures than yellow cultures group. All most all the attributes recorded higher magnitude of genotypic coeffcient of variation (except reproductive phase and racemes per lant) for brown seed strains in comparison to yellow seed cultures. Seed yield per plant had recorded maximum value of GCV in both seed colour groups. Joshi *et al.* (1993) had also recorded the highest GCV for this trait. High value of GCV was also observed in characters recemes per plant and primary bracnhes per plant for yellow seeded genotypes; while traits like primary branches per plant, main receme length and recemes per plant were exhibited high estimates of GCV in brown seeded genotypes. Heritability estimates (in broad sense) was high for the traits plant height (87.0%), vegetative phase (83.5%), main raceme length (78.7%), moderate for maturity period (71.7%), siliquae per main raceme (69.5%), siliqua intensity (68.7%), reproductive phase (64.8%), racemes per plant (64.6%), primary branches per plant (53.2%) and it was lowest for seed yield per plant (38.7%) in yellow seeded group. In brown seeded group, heritability estimate was highest for

Table 2. Comparison of variability parameters between yellow vs brown seeded *B. tournefortii*

Characters	YS* BS	Mean ± SEm	Range	Genotypic coefficient of variation (%)	Herita-bility (in broad sense) (%)	Expected genetic advance as percent of mean
Vegetative phase (days)	YS	13 ± 1.11	67.80	4.2	83.5	7.9
	BS	61 ± 0.78	54-73	6.7	94.8	13.4
Reproductive phase (Days)	YS	50 ± 2.02	43.56	6.7	64.8	11.2
	BS	56 ± 1.57	50-62	5.2	69.6	8.9
Maturity period (days)	YS	123 ± 1.45	116.128	2.3	71.7	4.0
	BS	117 ± 0.93	108-124	2.8	89.3	5.5
Plant height (cm)	YS	121.1 ± 2.76	101.7-138.7	7.2	87.0	13.8
	BS	112.4 ± 3.30	87.7-135.0	9.2	86.8	17.7
Primary branches/plant	YS	8.0 ± 0.65	5.7-9.9	10.5	53.2	16.2
	BS	7.7 ± 0.61	5.8-11.4	14.0	67.1	23.4
Racemes/plant	YS	22 ± 2.08	13-29	15.9	64.6	25.9
	BS	22 ±2.58	16-29	11.4	39.7	14.8
Main raceme length (cm)	YS	42.3 ± 1.54	34.3-47.0	8.6	78.7	15.6
	BS	47.5 ± 1.90	33.0-63.0	12.6	86.9	24.2
Siliquae/main raceme	YS	26 ± 1.21	19-29	8.6	69.5	14.6
	BS	27 ± 1.63	20-33	10.5	67.5	18.1
Siliqua intensity	YS	0.61±0.03	0.48-0.80	8.2	68.7	16.4
	BS	0.58 ± 0.03	0.42-0.72	10.2	72.9	17.4
Seed yield/plant (g)	YS	5.1 ± 1.18	2.2-8.8	22.3	38.7	29.4
	BS	7.7 ± 0.88	3.4-12.9	27.4	79.7	50.6

*YS = yellow seeded genotypes (35)

BS = brown seeded genotypes (65)

vegetative phase (94.8%) followed by maturity period (89.3%), main raceme length (86.9%), plant height (86.8%), seed yield per plant (79.7%), moderate for siliqua intensity (72.9%), reproductive phase (69.6%), siliqua per main raceme (67.5%), primary branches per plant (67.1%) and it was lowest for racemes per plant (39.7%). In general, most of the attributes in brown seeded group recorded higher estimates of heritability in comparison to yellow seeded group. Heritability estimates or seed yield per plant and racemes per plant

were influeced drastically by seed color effect. In yellow seeded group, high estimates of expected genetic advance as percentage of mean was obtained for seed yield per plant (29.4%) followed by racemes/plant (25.9%), siliqua intensity (16.4%), primary branches per plant (16.2%), main raceme length (15.6%). While the traits : seed yield per plant (50.6%), main raceme length (18.1%), plant height (17.7%) and siliqua intensity (17.4%) were recorded comparatively high estimates of expected genetic advance (Ad%) in brown seeded group. Reproductive phase and racemes per plant were only the traits recorded high magnitude of expected genetic gain in yellow seed group than the brown seed group.

As heritability in broad sense includes both additive and epistative gene effects, therefore, it will be reliable only if it accompanied by high genetic advance. As measured by this yardstick the characters, racemes per plant, siliqua intensity, main raceme length and siliqua per main raceme had moderate to high estimate of heritability as well as expected genetic advance, can be improved by direct selection of these traits, which consequently will contribute in improvement of yellow seeded genotyopes. The characters seed yield per plant, main raceme length, primary branches per plant, siliquae per main raceme and siliqua intensity were recorded moderate to high magnitude of both the above parameters in brown seeded cultures, indicating that these attributes might be have preponderance of additive gene action in their expression, therefore, selection for these characters, may be effective and fruitful in breeding programme in improvement of brown seeded genotypes of *B. tournefortii.*

REFERENCES

Burton, G.W. 1952. Quantitative inheritance in grasses. Proc. 6th Intern. Grassland Congress 1: 227-283.

Johnson, H.W., H.F. Robinson and R.E. Comstock. 1955. Estimate of genetic and environmental variability in soybean. *Agron. J.* 46: 314-318.

Joshi, P., B.R. Choudhary and R.P. Sarda. 1993. Variabilty of metric traits in wild turnip (*Brassica tournefortii* Gouan.) in two environment. *Geobios new Reports* 12 (2): 173-176.

Stringam, G.R., D.I. Mcgregor and S.H. Pawlowski. 1974. Chemical and morphological characteristics associated with seed coat color in rapeseed. Proc. 4th Intern. Rapeseed Congress. Giessen, p. 99-108.

Indian J. Pl. Genet. Resources 7(2): 235-238, 1994; Special Issue
Short Communication

INDUCED MORPHOLOGICAL VARIANTS IN KABULI CHICKPEA

S.M. Bhatnagar, S.N. Sharma, D.Singh and V.K. Bhatnagar

Department of Genetics and Plant Breeding,
Rajasthan Agricultural University, Agricultural Research Station,
Durgapura, Jaipur 302 018 (Rajasthan)

Key words: Kabuli chickpea, induced mutant, variability selection, mutagens

The mutation breeding technique has been used as an important supplement to other conventional methods of plant breeding for improvement of crops by developing new plant type with superior biochemical composition and better adaptation. Unlike other crops, such as wheat, barley, rice and peas, where much work as been done to understand the mutation process *per se* and the use of mutation breeding for yield improvement, very limited work has been carried out in Kabuli chickpea, which is of recent introduction in India and its cultivation has been increasing day by day in the irrigated areas due to good economic return per ha. as compared to *desi* type gram cultivation. However, this crop has limited to desi type gram cultivation. However, this crop has limited range of variability, which was not sufficient to ensure high potential and adaptible variety for wide range of cultivation. The present study therefore, aimed to know the quantum and direction of mutational variability (1) for most of morphological characters of economic importance, which could be useful to accelerate the pace of its genetic improvement.

Air dried seeds of kabuli chickpea cultivars, namely L-550 and Baroda Dhakeri local (BDL) were treated with 3 doses each of gamma rays, neutron, EMS and 2 doses of MMS individually and in combinations. In all, 11 individual and 30 combination treatments alongwith control were grown to raise M_1 at ARS Durgapura Station. M_2 generation was raised from individual M_1 plant. In M_2, morphological variants showing wide range of variation for various characters were isolated from each cultivar (2-7). Finally fertile plants from M_2 were grown in M_3 generation in RBD with two replications in 45 × 15 cm spacing. The data on morphological characters were recorded on 5 randomly

selected plants from each replication in only lines which bred true to the type. The extreme type of variations in morphological characters were catagorised in terms of frequency in the present communication.

The present study showed that the frequency of mutations was the highest in EMS among individual treatment and gamma rays + EMS is combined treatments. Neutrons and MMS combinations resulted in higher number of morphological mutants in both the cultivars and are in accordance with the earlier reports (Chaudhary and Singh, 1980; Bhatnagar *et al.*, 1982 and Bhatnagar, 1984). The results of morphological mutants isolated in M_2 generation (Table 1) revealed that in all, 532 mutants were isolated, of which 230 (153 in L-550 and 77 in BDL) were fertile and could be carried to M_3 generation. Of the 153 and 77 fertile mutants, 99 and 59 in L-550 and BDL, respectively bred true to their major characters whereas the remaining mutants showd segregation which continued to next generation. The number and frequency of stable mutants for fourteen morphological characters (Table 2) indicated that the frequency of mutants for economically important characters like early flowering and maturity (8.28 and 7.01%), more primary and secondary branches (7.64 and 12.10%) and high number of pods (11.46%) was fairly high among induced mutants. The behaviour of the cultivars was almost similar in producing stable mutants for different morphological characters. A close parallelism was recorded in the frequency of mutants for majority of the characters studied except the pod length and width in both the cultivars. Among morphological mutants, tall, dwarf and normal looking types were isolated which differed in habit, branching pattern, leaf type, leaflets, flower, pod and seed characters. The frequency of stable mutants for extreme range of characters was similar in both the cultivars. New mutant types isolated in kabuli type were extra early flowering and maturity, reduced number of leaflet per leaf type, twisted leaf, fasciated secondary branches and floral mutants with long style and exposed style type.

Table 1. Morphological mutants isolated in M_2 generation

Mutant type	Cultivars		Total
	L-550	BDL	
Total mutants/variant	355	177	532
Viable mutant/variant	153	77	230
Non viable mutant/variant	202	100	302
Stable mutant	99	58	157
Unstable mutant/variant	54	19	73

Table 2. Number and percentage of stable extreme type mutants in M_3 generation for various morphological characters

Character	Range	L-550 Total		BDL Total		L-550+BDL Total	
Flowering	- Early	9	0.09	4	6.90	13	8.80
	- Late	5	5.05	3	5.17	8	5.10
Maturity	- Early	9	9.09	2	3.45	11	7.01
	- Late	3	3.03	2	3.45	5	3.18
Plant hight	- Tall	7	7.07	5	8.62	12	7.64
	- Dwarf	8	8.08	6	10.34	14	8.92
Primary branches	- Many	9	9.09	3	5.17	12	7.64
	- Few	4	4.04	1	1.72	5	3.18
Secondary branches	- Many	11	1.11	8	13.79	19	12.10
	- Few	4	4.04	2	3.45	6	3.82
Pods/plant	- High	11	11.11	7	12.07	18	11.46
	- Low	3	3.03	4	6.90	7	4.46
Seess/pod	- High	2	2.02	3	5.17	5	3.18
	- Low	20	20.20	9	15.52	29	18.47
Seed Size	- Bold	4	4.04	2	3.45	6	3.82
	- Small	16	16.16	3	5.17	19	12.10
Internodal length	- Long	8	8.08	4	6.91	12	7.64
	- Short	2	2.02	2	3.45	4	2.55
Leaflet length	- Long.	8	8.08	4	6.0	12	7.64
	- Short	2	2.02	2	3.45	4	2.55
Leaflet length	- Long	4	4.04	1	1.72	5	3.18
	- SHort	4	4.04	2	3.45	6	3.82
Leaflet width	- Narrow	7	7.07	6	10.34	13	8.28
	- Broad	5	5.05	4	6.90	9	5.73
Pod length	- Long	3	3.03	4	6.90	7	4.46
	- Short	8	8.08	4	6.90	12	7.64
Pod width	- Narrow	5	5.05	4	6.90	9	5.73
	- Broad	5	5.05	1	1.72	6	3.82

It is, therefore apparent that considerable amount of genetic variability was induced in both the cultivars by mutagenic treatments. A large number of mutants isolated were economically important. However, a mutant having

positive variation in all the yield components could not be isolated. It is likely as the characters deviated in both plus as well as in minus directions in one or other character. However, desired mutant having increase in a particular component can easily be selected and used successfully in crop improvement.

Various micro-mutants isolated, can directly be used after careful testing for yield potential for general cultivation which will result in positive shift in present yield levels of kabuli gram.

REFERENCES

M.C. Kharkwal. 1983. Promising performance of chickpea mutants. *Mutation Breeding Newsletter* 22: 2-5.

R.D. Brock and B.D.H. Latter. 1961. Radiation induced quantitative variation in subterranean clover. Proc. Austr. Conf. on Radiation. Butterworths. London: 205-215.

R.D. Brock and W.D. Andrew. 1965. X-ray induced variation in *Medicago polymorpha* var. *vulgaris. Austr. J. Biol. Sci.* 18: 1119-1128.

A.K. Gupta and M.S. Swaminathan. 1967. Induced variability and selection advance for branching in autotetraploids of *Brassica campestis* var. *toria. Radiation Bot.* 7: 521-527.

H.C. Bansal. 1969. Studies on the induction of mutation with special reference to biochemical traits in chilli and polygenic characters in wheat and barley. Ph.D. Thesis. Sardar Patel University, Vallabh Vidyanagar.

M.K. Jana and K. Roy. 1973. Induced quantitative mutations in rice. *Radiation Bot.* 13: 245-257.

S.K. Bhadra. 1982. Studies on the genetic improvement of black gram (*Vigna mungo* (L.) Hepper), through induced mutation. Ph.D. Thesis, IARI, New Delhi.

R.K. Chowdhary and V.P. Singh. 1980. Effact of gamma irradiation on germination in pulse crops. *Tropical grain langume Bulletiin* 21:3-5.

C.P. Bhatnagar, J.P. Luthra and A.K. Awasthi. 1982. Effects of ethyl and methyl mathanesulphonates in gram (*Cicer arietinum* L.). *Sci. and Cult.* 48: 293-295.

C.P. Bhatnagar. 1984. Mutagenesis in Bengal gram (*Cicer arietinum* L.) Ph.D. Thesis, Rajasthan Univ. Jaipur.

Indian J. Pl. Genet. Resources 7(2): 239-241, 1994; Special Issue
Short Communication

EVALUATION AND UTILIZATION OF TOMATO (*LYCOPERSICON ESCULENTUM* Mill.) GENOTYPES FOR IMPROVING DISEASE RESISTANCE TO EARLY BLIGHT

D.S. Cheema, Surjan Singh and S.Kaur

Department of Vegetable Crops, Landscaping and Floriculture,
Punjab Agricultural University, Ludhiana 141 004 (Punjab)

Key words : Tomato, evaluation, utilization, disease resistance

Early blight disease of tomato caused by *Alternaria solani* Ellis and Martin (Jones and Grout) is one of the major diseases of tomato. Recently this disease has attracted much attention because of the considerable loss in yield inflicted by it (Kaur *et al.*, 1993; Datar and Mayee, 1981). This is a three phased disease which causes damping off/collar rot, leaf blight and fruit rot symptoms. The disease appears on foliage normally at fruiting stage of the crop as circular to angular, dark brown to black spots with concentric rings. On the stem, dark elongated spots, often target boarded, occur at any point, but are especially injurious when engirdle the juncture of stem. Fruits are infected usually at ripe stage, at the stem end. The pathogen remains viable on dry infected leaves and seeds. Most of the commercial varieties grown presently in the region are susceptible to early blight disease. The studies, were therefore, taken up to screen the germplasm against this disease to identify resistant /tolerant genotypes under field conditions during the year 1990, 1992 and 1993 when the disease appeared in a severe form, which could be used either as commercial varieties or as a source of resistance in the acceptable varieties.

The screening programme was carried out at the Vegetable Farm, PAU, Ludhiana, during the years 1990, 1992 and 1993. Three hundred and fifty genotypes tested, comprised varieties, hybrids and advance generation lines. All the genotypes were grown in the month of October and transplanted in the first fortnight of December in a randomized block design with three replications. The plot size was 1 × 5 mt. The data for the early blight disease were taken when the disease appeared in a severe form on the susceptible checks, Punjab Kesri and Punjab Chhuhara. The disease was recorded on a 0-4 scale. The plants with mean disease index (MDI) upto 1-5 were recorded as resistant and M.D.I. upto 2.0 as moderately resistant and above 2.0 as

susceptible. The observations were also recorded on the fruit characters (fruit shape, size and weight).

The tomato genotypes screened represented a wide range of responses to early blight disease in the three growing seasons. Four genotypes viz, Ottawa 32, Ottawa 33, Ottawa 46, and Cornell 6131 were recorded as resistant and nine genotypes, viz., Ottawa 30, Ottawa 31, Ottawa 55, PI 112835, PI 207407, PI 204587, OARDC 230, AC 142 and PP-4 were recorded as moderately resistant, some of these were also reported by Datar and Mayee (1981). The fruits of resistant and moderately resistant varieties were small with fruit weight of 3-4 g and 15-20 g, respectively. The plant yield was 1-2 kg per plant (Table 1) as compared to susceptible genotypes, where the fruit weight ranged fro, 45-60 gm per fruit with the yield of 2.5-3.5 kg. per plant. Earlier workers (Walter and Canover, 1952; Kaur *et al.*, 1988) also observed that small fruited varieties in tomato possess high resistance to diseases.

Table 1. Performance of resistant, moderate resistant and susceptible genotypes for early blight disease and fruit yield

Genotype	Disease reaction	Fruit weight (g)	Yield per plant(kg)
Ottawa-32	R	3-4	1.0-1.5
Ottawa-55	MR	15-20	1.5-2.0
Punjab Kesri	S	50-60	2.5-3.0
Punjab Chhuhara	S	45-50	3.0-3.5

The resistant or moderately resistant varieties identified in the present studies could not be exploited as commercial varieties due to their small size fruits, however, these were used as donors for incorporating resistance in the susceptible commercial varieties which lead to the development of moderately resistant genotypes No. 48 with pear shape fruit, identified from the cross cornell 6131 × Punjab. Chhuhara and No. 21 with round fruits, from the cross PI 345559 × Punjab Chhuhara, in addition to desirable horticultural characters (Table 2). Besides this, four introductions viz. WIR 4329 and IPA-3 (oval fruits) and I-979 and WIR 4285 (round fruits) showed field tolerance in addition to good yield potential. These genotypes may be exploited for the integrated disease management programme with the limited use of fungicides.

All the commercial F_1 hybrids viz., **Vaishali, Rupali, Rajni, Rashmi, Nema** 1401, Nema 1435. Peto 343, MHUF 789 from various seed companies and TH 2312 (PAU) were found to be susceptible to this disease. However, a few F_1 hybrids developed at PAU, Ludhiana, sustained a fair amount of early blight disease but had higher yield potential, thus exhibiting field tolerance and such a resistance can be helpful as the variety 'Manaluchie' has been cultivated for many years with excellent disease tolerance (Allen Stevens and Rick, 1986).

Table 2. Performance of tolerant genotypes

Genotype	D.I.	Yield/plant (kg)	Fruit wt.(g)	Fruit shape
No. 48	1.50	2.30	35.0	Pear
No. 21	1.90	2.50	47.5	Round
WIR-4329	2.20	3.45	75.4	Oval
I-979	2.40	3.54	81.2	Round
WIR-4285	2.43	3.45	79.4	Round
IPA-3	2.66	3.74	79.7	Oval
Punjab Chhuhara	3.40	3.50	50.0	Pear
Punjab Kesri	3.70	2.75	55.0	Oval

REFERENCES

Allen Stevens, M. and C.M. Rick. 1986. The tomato crop- A scientific basis for improvement (Ed. J.G. Atherton and J. Rudich, 1986).

Datar, V.V. and C.D. Mayee. 1981. Screening for early blight resistance in tomato. *Veg. Sci.* 39(1): 51-58.

Datar V.V. and C.D. Mayee 1981. Assessment of losses in tomato yield due to early blight. *Indian Phytopath.* 34: 191-195.

Kaur, S., Surjan Singh, J.S. Kanwar and D.S. Cheema. 1988. Variability in tomato for resistance to late blight under field conditions. *Indian Phytopath.* 41: 486-487.

Kaur, S., D.S. Cheema and Surjan Singh, 1993. Management of *Alternaria* blight disease of tomato (*Lycopersicon esculentum* Mill). (Abs. No. 229). Natn. Symp on Innovative Approaches in Plant Disease Management held at PAU, Ludhiana (Nov. 25-27, 1993).

Walter, J.M. and R.A. Canover. 1952. *Phytopathology* 42: 197-199.

Indian J. Pl. Genet. Resources 7(2): 243-245, 1994; Special Issue
Short Communication

SEARCH FOR FIELD TOLERANCE TO FUNGAL AND VIRUS DISEASES IN CHILLIES

S. Kaur, J.S. Hundal and D.S. Khurana

Department of Vegetables, Landscaping and Floriculture
Punjab Agricultural University,
Ludhiana 141 004 (Punjab)

Key words : Chillies, *Capsicum* sp., germplasm, fungal/viral tolerance

Various plant protection schedules for the control of diseases in chilli have been advocated, however, the increased cost of chemicals and their hazards have become limiting factors in the use of these control measures. Most of the resistant varieties have been found associated with undesirable horticultural characters (Kaur *et al.*, 1986). Therefore, studies were conducted to identify field tolerant genotypes to potentially important diseases (Table 1) with acceptable horticultural characters which could be used in preventing yield losses.

Table 1. Disease of Chilli/*Capsicum* prevalent under Punjab conditions

Disease	Pathogens
Fruit rot	*Colletotrichum capsici, Alternaria* Sp.
Wet Rot	*Choanephora/Cucurbitarum*
Die back	*C. capsici*
Viruses	Leaf curl, mosaic

The screening programme was carried out at the vegetable Farm, P.A.U. during the years 1988-1993. One hundred and fifty genotypes, comprising varieties, hybrids and segregating lines were sown in the month of October and were transplanted in the month of February in a randomised block design with three replications on ridges made 60 cm apart. The plant to plant distance was 30 cm apart. The data were recorded on viral (leaf curl and mosaic) and fungal diseases (fruit rot, die back and wet-rot) during July to September when the respective disease appeared in a severe form on the susceptible varieties. The scoring of fungal diseases was done on -4 scale (Kaur *et al.*,

1989) and the plants were grouped as immune (D.I = 0, resistant (D.I. 0.1-1.5) and moderately resistant (D.I. 1.6 2.0) and susceptible (D.I. 2.0-4.0). The viral symptoms were grouped as immune (no symptoms), resistant (mild symptom), moderately resistant (moderate symptoms) and susceptible (severe symptoms). The data on horticultural traits like fruit yield, fruit number, fruit weight and fruit size were recorded on five selected plants in each replication.

The chilli genotypes screened represented a wide range of responses to various diseases. No genotype could be identified which is resistance to all the diseases. The varieties, Perennual and Lorai were recorded resistant to fruit rot and viral diseases, however, they were highly susceptible to dieback and wet rot diseases (Kaur *et al.*, 1985, 1989). Varieties like BG-1 and Suryamani were resistant/moderately resistant to various diseases but they could not be exploited as commercial varieties due to either poor yield or small size fruit. (Table 2).

Table 2. Performance of multiple resistant genotypes for fruit characters

Genotypes	Disease reaction					Fruit characters			
	Fruit rot	Die back (%)	Wet rot	Mosaic	Leaf curl	Fruit yield gm (plant)	Fruit no/ plant	Mean fruit wt. (gm)	Mean fruit length (cms)
BG-1	1.4	2-5	1.33	R	R	200.40	163.27	1.23	5.60
Suryamani	1.6	10-20	2.76	R	R	192.08	150.45	1.28	2.57
Loral	1.0	40-50	2.86	R	R	98.33	116.30	0.85	3.75
Perennial	1.2	30-50	3.00	R	R	302.98	400.20	0.75	3.18
S 20-1	1.00	5-10	2.20	R	R	256.68	262.07	0.98	4.04

On the basis of excellent performance with respect to resistance/tolerance and yield attributes, the genotypes (Table 3) i.e., Punjab Lal, ELS-2, Indonesia Selection, LLS and F_1 hybrid (CH-1) were identified as having tolerance to various diseases in addition to acceptable horticultural characters. The highest fruit number was recorded in Punjab Lal followed by Indonesia selection and F_1 hybrid; whereas the maximum fruit weight was recorded in LLS followed by ELS-2 and CH-1. The fruit length was more in ELS-2 followed by Pusa Jwala and LLS. These factors ultimately affected the fruit yield which was maximum in CH-1 followed by ELS-2 and Indonesia Selection, whereas the yield of a commercial variety **Pusa Jwala** was lower than the above mentioned varieties Table 4. The use of these tolerant genotypes is a hopeful approach in stabilizing chilli production.

Table 3. Performance of promising genotypes for various diseases

Varieties	Fruit rot	Die back	Wet rot	Mosaic	Leaf curl
CH-1	2.30	5-10	1.25	R	R
Punjab Lal	1.90	5-10	2.50	R	R
ELS-2	2.36	5-10	2.01	R	MS
Indonesia Sel.	2.40	5-10	2.40	R	R
LLS	2.20	2-5	2.80	S	S
Pusa Jwala	3.10	5-10	2.40	R	MR

Table 4. Fruit characters and yield of promising genotypes

Genotypes	Fruit no. per plant	Fruit weight (gm) per plant	Fruit length (cm)	Mean yield Q/ha
Punjab Lal	628.70	0.89	4.30	60.56
Ch-1	334.10	2.72	6.62	100.78
ELS-2	227.50	3.20	9.16	95.48
Indonesia Selection	450.20	1.32	5.80	77.14
LLS	220.00	3.39	8.17	52.95
Pusa Jwala	269.20	1.64	8.32	65.41

REFERENCES

Chowdhury, S. 1957. Studies on development and control of fruit rot of chillies. *Indian Phytopath.* **10** (1) 55-62.

Jarnail Singh and S. Kaur. 1986. Present status of hot pepper breeding for multiple disease resistance in Punjab 21-24 Proc. VI. meeting on "Genetics and breeding on *Capsicum* and *Egg plant* - held at Zaragoza (Spain), Oct. 21-24., 1986

Kaur, S and J. Singh. 1985. Resistance to fruit rot diseases under field conditions in pepper (*Capsicum annum* L.). *Capsicum Newsletter* 4. 67.

Kaur, S., J. Singh and D.S. Khurana. 1990. Identification of sources of resistance in *Choanephora cucurbitarum*. *Pl. Dis. Res.* **5** : 123-125.

Indian J. Pl. Genet. Resources 7(2): 247-250, 1994; Special Issue
Short Communication

EVALUATION OF MUSKMELON GERMPLASM

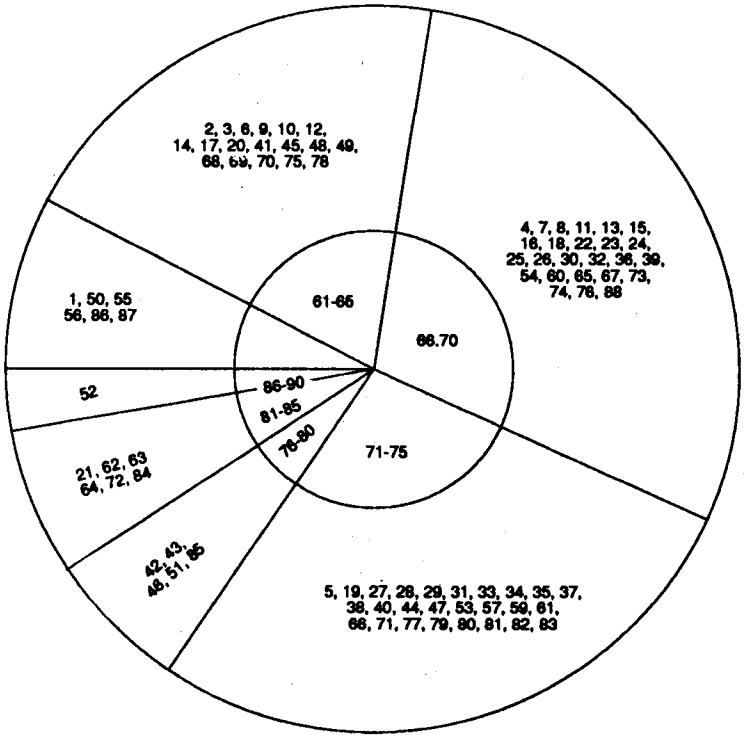
Tarsem Lal and M.S. Dhaliwal

Department of Vegetable Crops, Landscaping and Floriculture
Punjab Agricultural University,
Ludhiana 141 004 (Punjab)

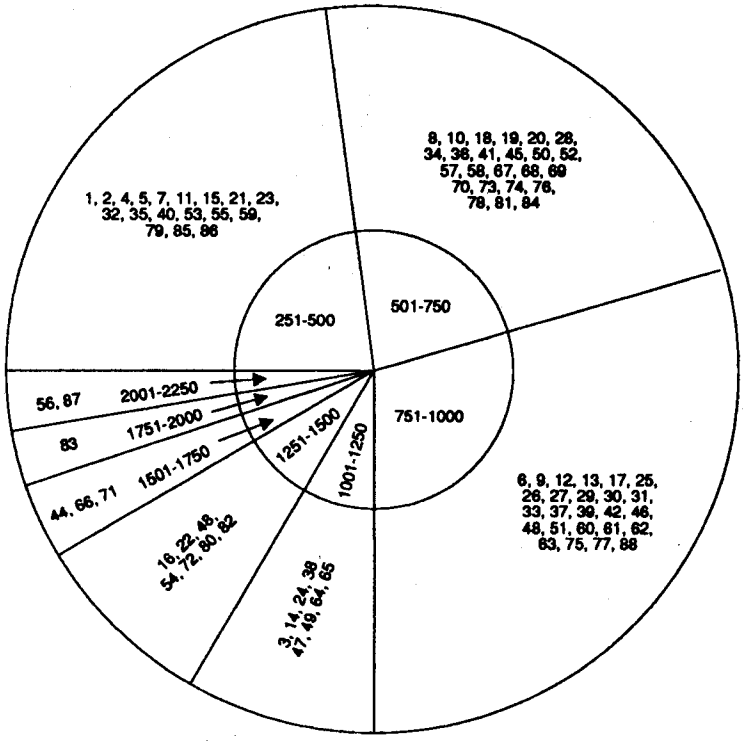
Key words : Muskmelon, *Cucumis melo* L., germplasm, evaluation

Muskmelon (*Cucumis melo* L.) germplasm available at Punjab Agricultural University is large and diverse, which represents many geographical regions. However, before embarking upon an effective breeding programme, it is of immense importance to characterise the germplasm in hand for various economic traits. Parrini (1965), Brar and Nandpuri (1968) and Nandpuri *et al.*, (1975) had made such studies from the aspect of geometical improvement of muskmelon. With this aim, the present investigations were undertaken for assessing the magnitude of genetic diversity for the important horticultural traits.

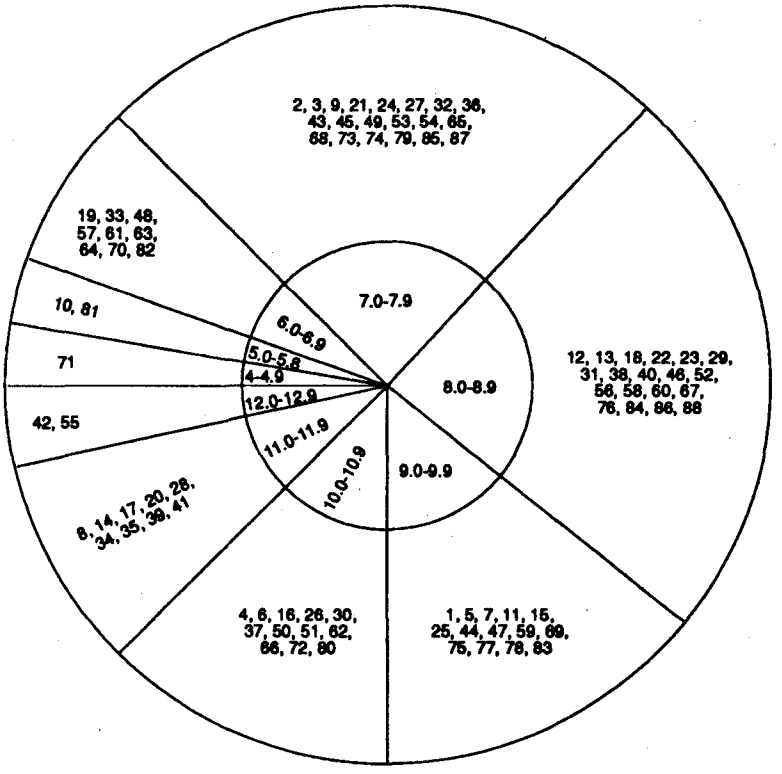
Eighty eight muskmelon genotypes obtained from both indigenous and exotic sources were evaluated for days to picking, fruit weight (g) and total soluble solids (TSS%). Means and their standard deviations were calculated from five representative fruits in each genotype. Genotypes studied included (1) Lucknow, (2) Improved Bush, (3) Janne Canari, (4) Dulce, (5) Pusa Sharbati, (6) MM 12-4-4-11, (7) Ameri, (8) Punjab Rasila, (9) Hales Best, (10) Cairo 90-3, (11) Dissected Leaf Mutant, (12) FM-1, (13) T-4, (14) Annamalai, (15) NDM-1, (16) MM 89-5, (17) PH 26-2-3-81, (18) MM (USSR) 88-3, (19) UP-12, (20) G-1, (21) RM-43, (22) Gulfstream, (23) T-4, (24) LED 1-9-1-15-8, (25) NDM-2, (26) Shakurpur 91-5, (27) Sutton Melon, (28) EHA 3-1-2-1, (29) MM 12-4-4-4, (30) Seminole, (31) MM 22-1-4-8, (32) Hari Dhari, (33) Kanganwal 87-1, (34) LED 1-9-1-15-2-4, (35) No. 11, (36) Verma's Best, (37) Edisto-47, (38) Market Collection 88-6, (39) Supermarket, (40) MH-5, (41) Durgapura Madhu, (42) Hara Madhu, (43) Sarda Melon, (44) Afganistan Coll. 88-6, (45) WI 998, (46) M-3 Var., (47) MS-1, (48) MS-5, (49) GM-6E-7, (50) Punjab Sunehri, (51) Pusa Madhuras, (52) MH-13, (53) NDM-5, (54) EC 163888, (55) EC 166534, (56) Silver World, (57) MR-1, (58) MM (USSR) 88-2, (59) Liria, (60) Perlita, (61) Bush, (62) Jacumba, (63) PI 124112, (64) Spain Melon 93-1, (65) B-17, (66) B-5, (67) B-29, (68) B-27,



MEAN = 70 ± 7.1; RANGE = 58-90



MEAN = 841 ± 341; RANGE = 250-2125



(69) B-7, (70) B-8, (71) Shakurpur 91-3, (75) Shakurpur 91-2, (76) Shakurpur 91-1, (77) Planters Jumbo, (78) PMR-45, (79) Novogibirsk, (80) T-7, (81) Monoecious-3, (82) UP-8, (83) USA Melon 90-2, (84) Cinco, (85) WMR-29, (86) France 89-2, (87) Casaba and (88) Golden Perfection.

Results pertaining to days to picking, fruit weight, (g), and TSS (%) are presented in figures 1, 2 and 3 respectively. Frequency distribution in each classs is reprsented by the size of sector, and figures in each sector represent genotype number. As is evident from the figures, there was wide variation reported for all the three characters studied. Genotypes, France 89-2 (57.5 ± 0.7) and Silver World (57.7 ± 0.58) took less number of days for picking. Genotypes MH-13 took the highest number of days (90.0 ± 4.36). Overall mean number of days to picking was calculated to be 69.9 ± 7.06. Silver World also produced the heaviest fruits (2125 ± 106 g) whereas Improved Bush produced the smallest fruits (280 ± 67 g). Overall mean fruit weight was recorded to be 841 ± 381 g. Amongst all the genotypes tested, Hara Madhu was the most sweet variety as adjudged from the highest TSS (%) content of 12.6 ± 1.72 per cent whereas Arka Rajhans had the lowest TSS content (4.2 ± 0.5%). Overall means TSS content was worked out to be 8.7 ± 1.72%. Earlier studies

conducted by Nandpuri *et al.*, (1975) also revealed that genotypes Lucknow for days to picking, Arka Rajhans and Kabul Muskmelon for fruit weight, and Hara Madhu for TSS content were the top ranking ones. It is to be pinpointed that the three economic characters considered for assessing the magnitude of diversity in te germplasms in the present study, were also reported to be important for classification of muskmelon collections by Brar and Nandpuri (1968).

Five top ranking genotypes for each trait are listed in Table 1. Genotypes France 89-2, Silver World, Casaba, Lucknow and EC 166534 for days to picking; Silver World, Casaba, USA Melon 90-2, Afganistan Coll. 88-6 and Arka Rajhans for fruit weight; and Hara Madhu, EC 166534, PH 26-2-81, EHA 3-1-2-1 and No.11 for TSS content were found to be superior. As is evident, genotypes Silver World and Casaba were superior for day to picking and fruit weight, but none of the genotypes has been found to possess all the three desirable traits. It is suggested that these genotypes may be involved in hybridization programmes for selecting desirable segregants/cross combinations for the economic traits under study.

Table 1. Five top ranking genotypes for three economic traits in muskmelon

Trait	Genotypes
Days to picking	France 89-2 (57.5 ± 0.71), Silver World (57.7 ± 0.58), Casaba (58.5 ± 0.71), Lucknow (58.8 ± 0.45), EC 166534 (59.3 ± 2.50)
Fruit weight (g)	Silver World (2125 ± 106), Casaba (2050 ± 71), USA Melon 90-2 (1850 ± 212), Afganistan Coll. 88-6 (1690 ± 207), Arka Rajhans (1580 ± 115)
T.S.S. (%) content	Hara Madhu (12.6 ± 1.72), EC 166534 (12.2 ± 0.83), PH 26-2-3-81 (11. 8 ± 0.84, EHA 3-1-2-1 (11.8 ± 1.3), No. 11 (11.8 ± 1.1)

REFERENCES

Brar, J.S. and K.S. Nandpuri. 1968. Classification of muskmelon (*Cucumis melo* L.) grown in Punjab. *Agric. Univ. J. Res.* 5 : 40-45.

Nandpuri, K.S., S. Singh and Tarsem Lal. 1975. Germplasm scrutiny for the improvement of some economic characters in muskmelon (*Cucumis melo* L.). *Punjab agric. Univ. J. Res.* 12: 252-57.

Parrini, P. 1965. A study of foreign melon varieties from the aspect of genetical improvement. *Sementi ellete* 11: 270- 90.

Indian J. Pl. Genet. Resources 7(2): 251-256, 1994; Special Issue
Short Communication

EFFECT OF ULTRA-DESSICATION ON SEED LONGEVITY IN PEARL MILLET

B.B. Singh, Vivek Mitter and N.K. Chowdhary

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

Key words : Pearl millet, seed longevity, ultra-dessication

Seeds of the majority of crops and many other plant species show orthodox storage characteristics i.e., they can be dried to low moisture contents without causing decline in their viability. The longevity of such seeds increase with decrease in seed moisture content and storage temperature (Roberts, 1973). It has been shown that at a given temperature, there is a logarithmic relationship between the longevity of desiccation tolerant seeds and their moisture content (Ellis and Roberts, 1980; Ellis *et al.*, 1986). Ellis *et al.*, (1986) reported that the increase in seed longevity which resulted from reducing moisture content from 5 to 2 per cent in *Sesame* seed was about 40 folds. Reducing storage temperature from +20°C to –20°C also increased longevity by a factor of roughly 40. Considering these results, the usefulness of ultra-desiccation in the conservation of seed viability is being studied on a number of crops. The present study summarizes our results on pearl millet seeds.

The experimental material for the present study comprised of seed of pearl millet variety ICTP 8203 of varying moisture contents ranging from 3.5 per cent to 15 per cent. The seed lots with different moisture contents were prepared by either drying the seeds over regularly regenerated silica gel or by humidifying them over water in closed containers at 20°C. About 300 seeds each were placed in small (12 × 10 cm) labelled laminated aluminium foil pouches for various seed lots with different moisture contents. Two sets of seed lots representing all the moisture contents viz. 3.5, 6, 8, 10, 12 and 15 per cent were prepared to examine their viability under ambient temperature storage and artificial ageing environment (65° in oven).

For artificial ageing, the seed packets with different moisture contents were kept in oven maintaining temperature of 65°C. One packet each of

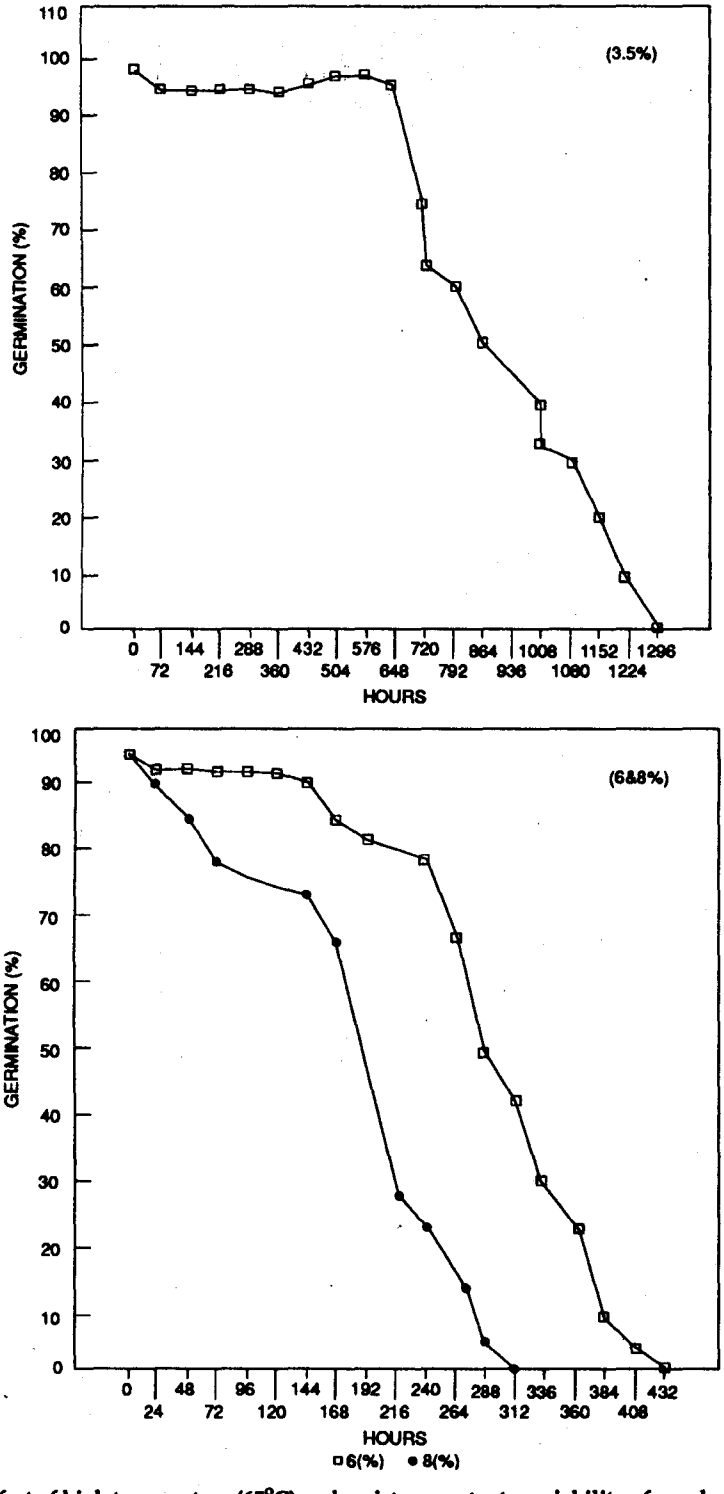
different moisture content was drawn regularly at fixed intervals. The seed packets stored under ambient storage condition were drawn at monthly interval for viability testing. The seeds with ultra low moisture content (3.5%) were humidified before their germination by placing them over a wiremesh in a closed disiccator having water in its bottom to avoid imbitional damage.

The germination tests were carried out on each seed packet drawn from oven or ambient storage. 24 hrs after their draw, the tests were carried out following the procedure prescribed by the International Seed Testing Association (ISTA, 1985 a) using 50 seeds replicated four times on moist filter papers in petriplates. The germination counts were taken after 7 days and number of normal, abnormal seedlings and dead seeds were recorded according to criterion of normal germination (ISTA 1985 a,b.)

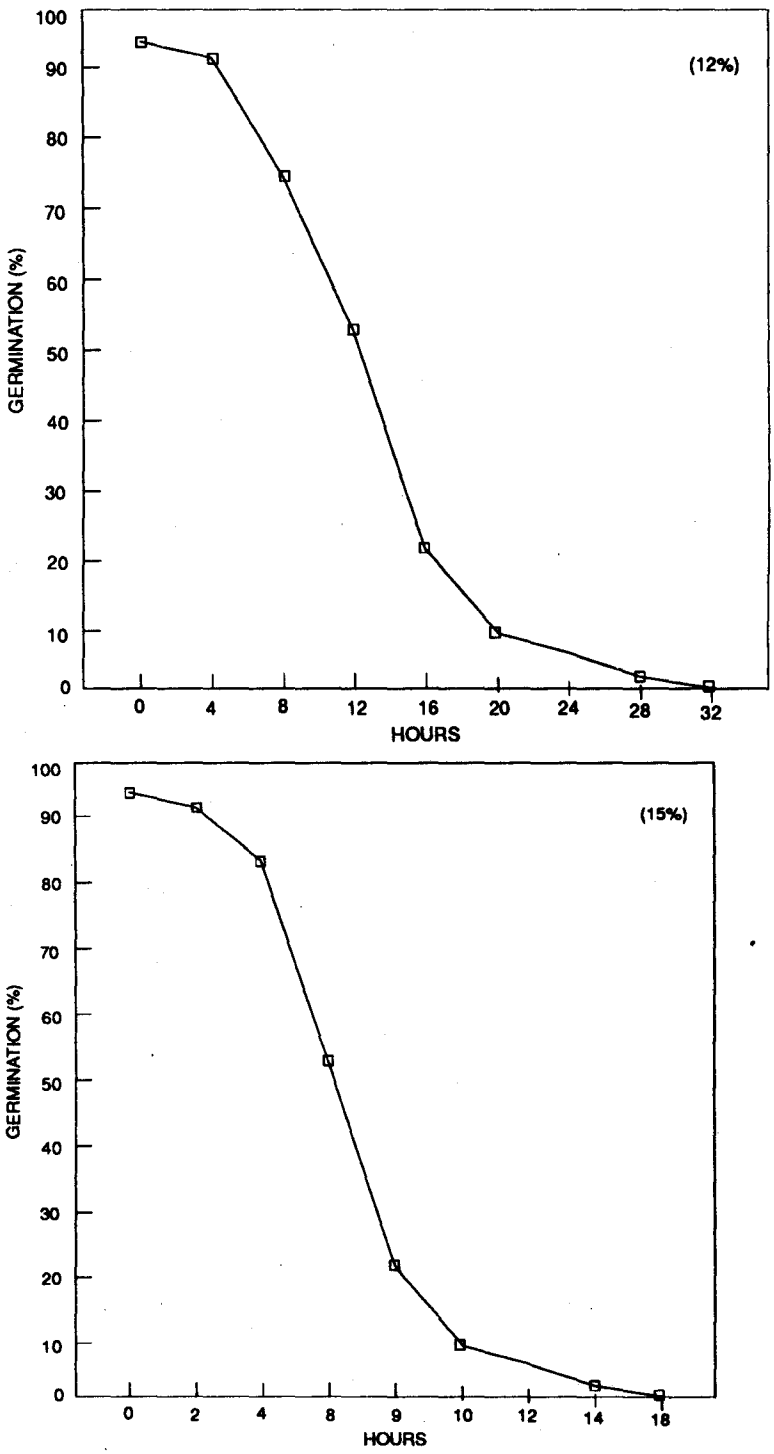
Storage of dry seeds in cooler environment is considered to be the safest and most reliable method of conserving genetic resources of seed propagated plant species. There are various technical standards which have been specified for long term storage of seeds of base collections of germplasm for their genetic conservation (Cromarty *et al.*, 1982). These standards require the seeds to be stored at –20°C in hermetically sealed containers at a seed moisture content of 5 ± 2 per cent (fresh weight basis). However, the maintenance of sub- zero storage temperatures especially in tropical countries indeed proves very expensive and difficult. Thus, there is a great need to look for other alternative methods aiming at the reduction in the cost of seed conservation of the germplasm.

Increasing seed longevity by lowering seed moisture content to less than 4 per cent (called ultra-desiccation) may be advantageous. Roberts (1989) mentioned that whereas drying cereal seeds from 9 to 8 per cent moisture content doubles storage life, further decreases are progressively even mor ebeneficial; so that decreasing the moisture content from 5 to 4 per cent increases the storage life by a factor of 3.7 per cent. On the contrary the advantage of descreasing temperature operates according to a law of diminishing returns, so that decreasing the storage temperature from 25 to 20°C would approximately double the seed longevity, whereas decreasing temperature from 5°C to 0°C increased the longevity by a factor of 1.5. The present work was undertaken to examine the merit of ultra-desiccation in conservation of seed longevity with reduced cost and non dependence on sub-zero temeprature for storage of seeds.

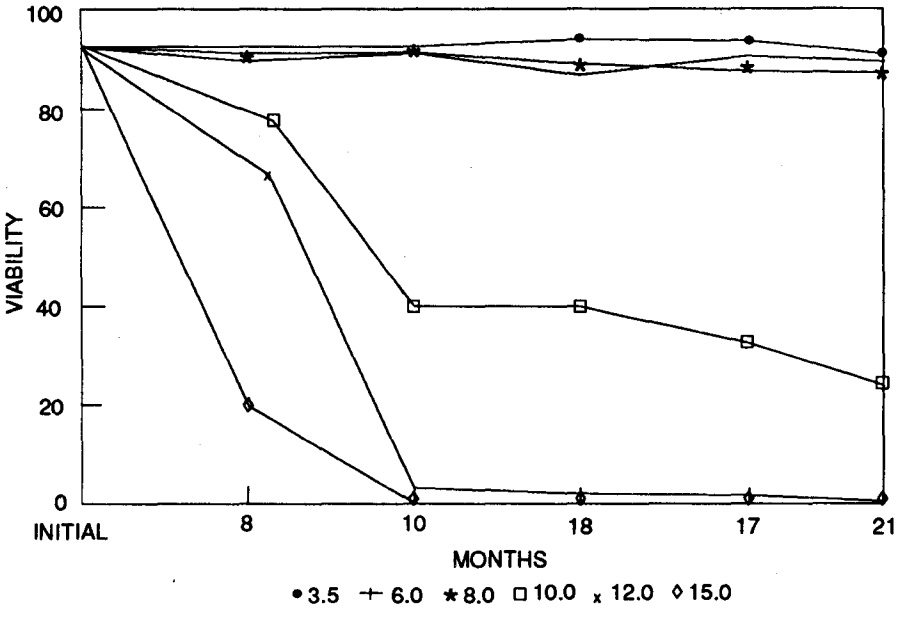
Under artificial ageing environment (Oven maintaining 65°C), seedw with 15 per cent and 12 per cent moisture content showed no germination after 14 and 28 hrs respectively. Seeds with 8 per cent moisture content were viable for 312 hrs (13 days) while those with 6 per cent moisture content remained



Graph 1a. Effect of high temperature (65°C) and moisture content on viability of pearl millet seeds



Graph 1b. Effect of high temperature (65°C) and moisture content on viability of pearl millet seeds



Graph 2. Storage of pearl millet seeds of different moistures at ambient temperature

viable upto 432 hrs (18 days). However, in the ultra-desicated seeds with 3.5 per cent moisture content the viability dropped down to zero only after 1296 hrs (54 days) (Graph No. 1a, 1b and 2).

No significant decline in germination was observed for the pearl millet seed with the moisture content of 3.5 per cent stored at ambient temperature during 21 months of storage. For seeds with 6 per cent moisture content the viability dropped from 95 per cent to 92 per cent. In seeds having 8 per cent moisture, it further declined from 94 to 89 per cent, whereas the viability of 10 per cent moisture seeds reduced from 94 per cent to 22 per cent during the same period. No germination, however, could be recorded after 17 months in 12 per cent moisture seed lot and after a period of 10 months in case of 15 per cent moisture content.

The present study thus clearly indicates the merit of ultra-low seed moisture content in prolonging the viability fo the pearl millet seeds as observed in both the viability tests in artificial ageing environment as well as under ambient temperature storage.

REFERENCES

Cromarty, A.S., R.H. Ellis and E.H. Roberts. 1982. The design of seed storage facilities for Genetic Conservation. IBPGR Publ. IBPGR Secretariat, Rome.

Ellis, R.H. and E.H. Roberts, 1980. Improved equation for the prediction of seed longevity. *Annals of Botany* **45**: 13-30.

Ellis, R.H., T.D. Hong and E.H. Roberts. 1986. Logarithmic relationship between moisture content and longevity in sesame seeds. *Annals of Botany* **57**: 499.503.

International Seed Testing Association. 1985 a. International rules for seed testing. *Seed Sci. & Technology* **13**: 307- 355.

International Seed Testing Association. 1985 b. International rules for seed testing. Annexes 1985. *Seed Sci. & Technology* **13**: 356-513.

Roberts, E.H. 1973 Predicting the storage life of seeds. *Seed Sci. & Technol* **1**: 499-514.

Roberts, E.H. 1989. Seed Storage for genetic conservation *Plants Today* **2**: 12-18.

Indian J.Pl. Genet. Resources 7(2): 257-259, 1994; Special Issue
Short Communication

COLLECTION OF *VANILLA WIGHTIANA* LINDL. — AN ENDANGERED WILD SPECIES FROM EASTERN GHATS OF ANDHRA PRADESH

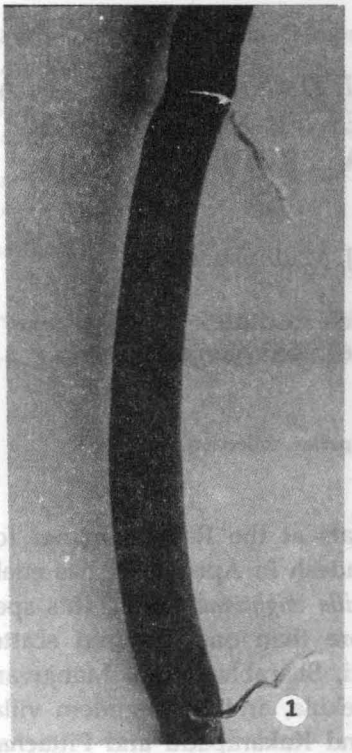
Y.S. Rao, K.M. Kuruvilla and K.J. Madhusoodanan

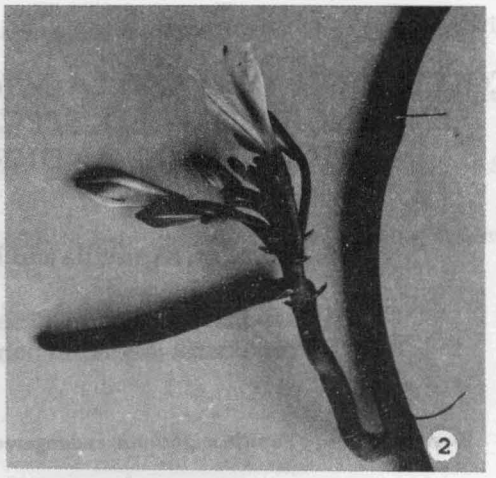
Indian Cardamon Research Institute,
Spices Board, Myladumpara 685 553 (Kerala)

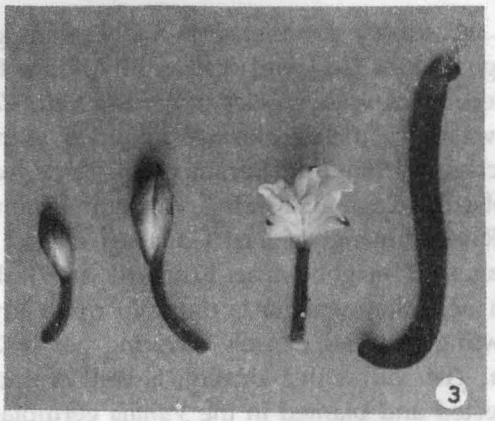
Key words : *Vanilla wightiana*, endangered species, collection

A survey conducted in the Eastern ghats at the Rajavommangi forest range of East Godavari district of Andhra Pradesh in April 1994, has enabled collection of wild species of *Vanilla* viz., *Vanilla wightiana* Lindl. This species grows in restricted elevated mounds at more than one hundred scattered patches surrounding Surampalem, Kondapalli, Sharabhavaram, Manjuvaram, Labbarthi, Lagarai, Kindra, Vayyedu, Ammirekula, and Bornegudem villages of Rajavommangi of East Godavari district and Kakarapadu and Pittachalam villages of neighbouring Kovvuru of Visakhapatnam district. Of these, one area near Surampalem is unusally quite large with thousands of these plants crawling on trees densely covering nearly 2 sq.km. in the unreserved forest area. The soil at this location is well drained, gravelly laterite. Cuttings were collected and planted in the *Vanilla* germplasm repository at Indian Cardamon Research Institute at Myladumpara in May 1994.

Vanilla wightiana Lindl. is a herbacious perennial vine climbing by means of adventious roots on trees. The roots are long, greenish to brownish in colour, aerial, about 2 mm diameter and are produced singly opposite to small leaves one at each node. The roots adhere firmly to the support as the plants climb. The stem is long cylindrical, vertically grooved and succulent (Fig. 1). It has monopodial growth or is rarely branched. The branches are 1 - 2 cm diameter with dark green colour. The internodes are 10 - 20 cm in length. At an early age of the plant, there are very small leaves one at each node opposite to aerial roots. The scaly leaves fall of quickly leaving a scar at each node. Flowering commences in February and it continues for a period of 3 - 4 months. The stout inflorescences (Fig. 2) are axillary, usually simple and rarely branched. They are usually borne towards the tip of the vine and are 10 - 30 cm long with 10 - 20 flowers. Generally 1-3 flowers open at a time







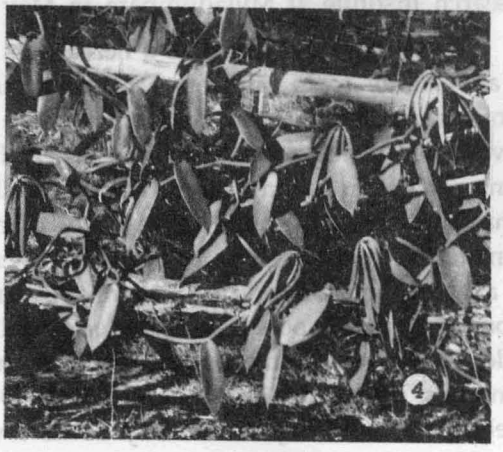


Fig. 1 Stem of *Vanilla wightiana* showing vertical grooves and serial roots.
Fig. 2. Inflorescence of *V. wightiana* showing axillary origin.
Fig. 3. Different stages of flowring from bud formation to fruit formation in *V. wightiana*.
Fig. 4. *V. planifolia* with beans and well developed leaves.

in an inflorescence and each lasts for a day. Flowers are large, fragrant, whitish in colour with light pinkish tinge at lip base (Fig. 3). The peduncle is very short. There are three oblong-lanceolate sepals. The upper two petals resemble the sepals in shape but are slightly smaller. The lower petal is modified as a trumpet shaped labellum or lip which is attached to the gynostemium. The tip of the lip is obscurely 3 lobed and is irregularly toothed on this revolute margin. There is a single stamen containing two pollen masses or pollinia covered by a cap and below is the concave sticky stigma which is seperted by a thin flap like rostellum. The overy is inferior, trilocular, cylindrical, often curved, 4-7 cm long and 3-5 mm diameter. The fruit known in the trade as a bean (Fig.3) is pendulous, narrowly cylindrical, 10-25 cm long and 5-15 mm in diameter with minute (0.3 mm diameter) globose seeds. It takes 8 to 10 months for the harvest after flowering and is aromatic after drying.

The wild species *V. wightiana* Lindl : is easily distiguished from the cultivated species (*V. planifolia* Andrews) by its vertical grooves on the stem which are absent in the latter (Fig.4). Another prominent character of the wild species is the absence of well developed leaves as these observed (Fig.4) in *V. planifolia* Andrews (Purseglove *et al.*, 1981). It was also observed that the wild species is free from pests and diseases, indicating the source of resistant / tolerant genes unlike in the commercially grown species. It is essential to conserve the species which is under the uneat extinction so that crop improvement programmes can be taken up in future.

REFERENCES

Purseglove, J.B. E.G. Brown, C.L. Green, and S.R.J. robbins. 1981. Spices Vol.2. Longman Scientific & Technical. p 644-735.

(*continued from first cover page*)

Vol. 7 **1994** **No. 2**

Typesetting & Printed by : **KAMALA COMPU COMPOSE**
O-96 New Mahavir Nagar, New Delhi 110 018 (India)
Phone 5103039