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Exploration and Genepool Sampling of Landrace Diversity in *Oryza* from Chhotanagpur Region

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Rich genetic diversity in Oryza *landraces occur in Indian gene centre. Chhotanagpur plateau and adjoining Orissa State possesses amazing variability in its landrace forms. Several wild species also continue to perpetuate in this region. Exploration and germplasm collection work was undertaken in Chhotanagpur region of Bihar comprising districts of Ranchi, Gumla, Lohardaga, parts of Palamau and Girdih and adjoining Keonjhar and Sundargarh districts of Orissa. Ecologically diverse regions and farming systems, representing varying soil and edàphic factors were explored for the collection of primitive diversity. The population samples from each site/micro-niche were obtained randomly, sampling 80-100 panicles/accession. Detailed observations were recorded on 10 randomly drawn panicles/accession. Detailed data were collected on different accessions for panicle and grain characters. The range, mean and standard error of means were calculated. The genepool sampling and its analysis showed occurrence of considerable genetic variability. The differences were prominent for varying degree of adaptation to different soil conditions. More than 150 distinct landraces of* Oryza sativa *var.* indica *were captured. Amazing genetic variability is exhibited in their forms, differing widely in plant height, foliage colour, internode length, stem thickness, stiffness of straw, maturity, grain size colour, aroma and glume colour etc. Several genetically unique forms and wild* Oryza *species were collected during the exploration trip. The analysis of diversity showed the efficiency of random genepool sampling.*

Rich genetic diversity in *Oryza* occurs in the tribal dominated tracts of Chhotanagpur plateau (Bihar) and adjoining Orissa State. The variability in landrace forms is prevalent in diverse agro-ecological conditions; from very high rainfall to very low rainfall areas, under transplanted and direct seeded conditions. Undulating topography of the terrain has diversified the nature of native variability tremendously. The paper highlights the richness of genetic diversity in landrace populations from this region.

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MATERIALS AND METHODS

Exploration and collection of rice germplasm was undertaken in the Chhotanagpur region of Bihar (Fig. 1) comprising Hazaribagh, Ranchi, Gumla, Lohardaga, parts of Palamau, Girdih districts and adjoining Keonjhar and Sundargarh districts of Orissa with varying soil, edaphic factors and farming practices. Population samples from each ecological region (site/micro-niche) were collected by random sampling of upto 80-100 panicles per accession. Passport data were recorded at the site. Comprehensive data on 10 randomly drawn panicles per accession were recorded for panicle length, panicle type, branching pattern, grains/panicle, 1000-grain weight (g), seed size, seed colour, epicule colour, kernel size and colour. For 80 landraces from Chotanagpur region, the range, mean and S.E. of means were calculated using appropriate statistical methods.

RESULTS AND DISCUSSION

The study of the *Oryza* landrace populations showed that Chhotanagpur plateau holds rich genetic variability in primitive cultivars of the *indica* types. The landra-

Fig. 1 Map showing the area/region explored, route followed and collection sites

ces vary in adaptation to rainfed upland/medium elevation areas and lowland catchment or water run-off areas. The emergence and the perpetuation of such unique genetic variability is the result of prolonged selection pressure reinforced by adaptation and socio-economic needs.

Variations in soils, other edaphic factors and rainfall patterns in this plateau region pose serious problem to rice crop in its sowing/planting as well as in adopting improved technology. This holds good for those landraces which are directly seeded. The seeding of rice depends on the adequacy of proper moisture and its retention by soil in a gradiant topography. Only those primitive cultivars continue to survive in this region which have polymorphic alleles for survival and adaptation. Further, since the soils are fairly acidic (pH 5.0-6.5), these landraces have also developed high tolerance to acidity.

The local types may be transplanted or directly sown and harvested accordingly. Depending on the local physiography, they are adapted to upland soils, medium soils and to lowland/catchment areas where water accumulates and drains out gradually. In the first case, water (soil moisture) is a limiting factor and thus only short duration landraces adapt well, while in case of second types, both direct seeding and transplanting is practised. In third case, soils are rich in humus and minerals and also possess high concentration of iron, aluminium and mica. The water is abundant that permits tall, long duration varieties to be grown and generally transplanting is practiced for such cultivars.

The diversity collected comprised more than 150 distinct landraces, mainly of tall types, maturing in 70-140 days. Variability encountered was considerable exhibiting mosaic pattern (Fig. 2 A, B) in attributes, such as plant height, foliage colour, internode length, stem thickness, stiffness of straw, leaf angle, leaf width and maturation period. Variability was pronounced for panicle size ranging from lax to moderately compact types showing distinct differences (Fig. 3) among accessions in shape, size, colour and branchlets; awn/awnless character; glume colour (black, brown, reddish, straw colour, golden); grain shape, size and colour, tiller number, stem thickness and leafiness. Medium coarse-grained/fine-grained types, short, bold/long slender and very bold grain types were found to occur.

Local types represented both directly seeded cultivars and transplanted one. Types adapted to lowland/catchment areas exhibited tall plant habit being vigorous, medium/long grained with variation in glume colour. The most predominent landraces were *Goradhan, Lalka, Chandragarhi, Askalma, Jhonga, Dhusaree, Nardha, Katkai, Sathi, Kalamdani, Ranikajar, Tilasar, Jhingasar, Shyamjeera, Rassi, Mehera, Patharia, Karhani, Dudhiraj, Bhedakaber, Kharkakhochi, Tulasi-manjari, Bhajani, Dahia, Aginsal, Garibasal, Karmusal* and *Jhonsar*. Several accessions of wild/semi-wild types were collected from different sites; one wild form called by tribals as *Jhadkadhan* (C-2021) collected from deep water ponds along Tamar-Parasi road (Ranchi district), appeared to be a perennial with tall plant type and long internodes, bearing straw coloured and awned grains borne on a small panicle

Fig. 2. A. Landrace diversity in Rice in Chhotanagpur Region

Fig. 2. B. Germplasm sampling in scented landrace of Rice.

with a brittle rachis. *O. nivara* (C-2022 and C-2934) also collected along the Tamar-Parasi road from roadside ditches possessed dwarf, bushy plant habit with small panicle, pinkish, convergent awns, highly brittle rachis, black grains and highly shattering habit. A semi-wild rice, '*Pasaradhan*' (C-2023), possessed tall, erect plant habit, black awns and highly shattering grain behaviour. This form mimics the cultivated landraces till it matures, but due to its brittle rachis, grains shatter and provide a natural mechanism for its survival and perpetuation.

Analysis of variation pattern

The distribution and variation pattern of landrace diversity showed occurrence of several distinct types in varying proportions. Genetic polymorphism prevailed for grain types. Out of the 109 landraces studied, medium types occured in much greater proportion (78), while other categories were represented by short, medium (6), long slender (6), long medium (8), extra long slender (3). Polycaryopsis was found in a collection with 2-3 fruits per spikelet, while extra long glumes with bold flattish grains was prominent in a landrace *Sugathur*. The variation for kernel colour varied from dull white (46), white (28), red (14), brown (7) and light brown (14). Kernel size varied from short bold (4.0-5.0 mm) occurring in very low frequency (8), medium long types (5.1-6.5 mm) were predominent (78), while long slender types (6.6-8.0 mm) were found in 20 landraces. Three landraces possessed kernels longer than 8.0 mm.

The epiculus colour showed occurrence of white colour only in one landrace, straw colour in 63, brown in 13, purple type in 27 and black only in 4 accessions. Light red epiculus was found only in one case. The glume exhibited significant colour variability ranging from light purple (1), deep purple (4), straw (34), light brown (1), brown (23), deep brown (6), golden brown (2), brown furrowed (20) and black (4). Besides, 12 accessions showed mottling, furrowing, etc, ranging from golden with brown furrows, brown with white lining and purple spots on straw colour in only few types. Gold furrows were found in two accessions, while base and apices only being straw coloured and entire surface being brown were observed in six landraces and golden apices in only single landrace in this region.

Among the landraces collected, predominant awned types were *Johondrashar, Kalamkatki, Jonga, Dudhkalma, Mehera, Katkai, Katika, Nawair* and *Gopal Bhog*.

Important variation among landraces collected

Interesting variability in rice landraces represented *Sathi* (early and drought tolerant), *Kanak Champa* (very attractive plant and seed type). *Sugathur*, a landrace with very tall plant type, bold, flattish grains and long extended glume (Fig. 4) was found to be well adapted to lowland areas of Urguttu/Thakurgaon region of Ranchi district. *Ambaghabada* (Fig. 5) collected from Maganpur Ramgarh (Hazaribagh district) possessed polycaryopsis (3 fruits per spikelet) and adapted to lowland terrain, matures late but produces high grain yield. A completely deep purple pigmented landrace, *Aginsar* (also called as *Singalbaba*), was collected from Chaibasa region (Fig. 6). This landrace is also late maturing and lowland type. Among scented types, *Laxmi Bhog*, *Rukmani Bhog*, *Shyamjeera* and *Ramdi* were prominent. *Kalamdani* and *Kalamkathi*, both are tall cultivars, possess long slender grains and have fairly high grain yield potential.

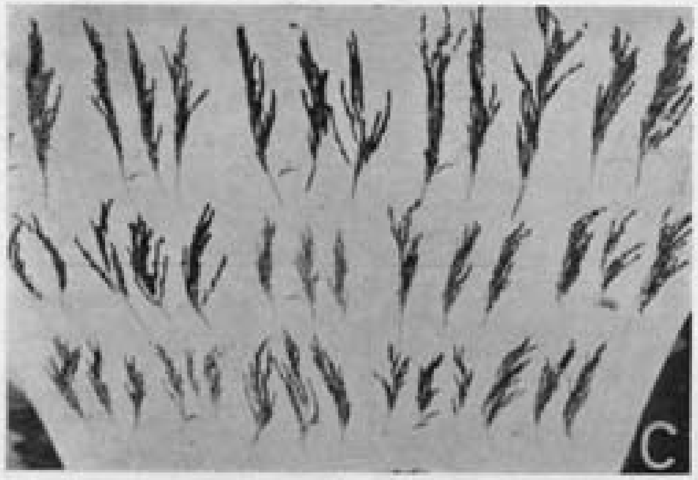

Fig. 3 Variability in panicle, shape, size, colour and grains in *Oryza* landraces.

Fig. 4 *Sugathpur*—A landrace with extra long gloom.

Collection of wild Oryza species

Indian Gene Centre is appreciably rich in the genetic wealth of wild rice, particularly *indica* types (Arora and Nayar, 1984). Wild *Oryza* species, such as *O. nivara* and *O. rufipogon* occur in ponds and ditches in Chhotanagpur region and adjoining tracts of Orissa State. Several accessions of wild rice were collected and it was observed that habitats where wild populations occur and survive are often distributed/encroached by man and his companion domesticates, consequently resulting in the genetic erosion of wild populations much faster than the landrace diversity in the cultivated forms. Thus, the collection, conservation of genepool of wild rice assumes special significance and demands much greater urgency and adequate attention.

Fig. 5 *Ambaghabada*—Unique landrace with polycaryopsis (3 fruits/spikelet).

Fig. 6 *Landrace*—Adapted to heavy metal soils.

CONCLUSIONS

Analysis of diversity clearly indicates that the enormous genetic diversity of gene complexes determining adaptation and productivity, assembled and incorporated over centuries of cultivation in different environments could perhaps be recognised as the most outstanding and unrivalled characteristics of primitive varietal populations (Frankel and Bennett, 1970). Although genetic diversity among landraces is well established from field study, yet there is very little knowledge of genetic structure and population dynamics in landrace populations other than observation on introgresssion from wild relatives. This paper represents studies on the variation pattern in landraces in their natural and social setting which would be of relevance for crop evolution, ethnobotany and for plant exploration as well as utilization of plant genetic resources for crop improvement (Frankel and Soule, 1981). The new possibilities have become apparent with emergent recombinant DNA technology. The tremendous genetic variability in *Oryza* continues in this tribal dominated tracts. The tribals of Chhotanagpur plateau, while practicing primitive agriculture system, selected only those landraces/types that fitted well in their dry land/ rainfed farming system. Thus, it is evident that this natural diversity can be of immense advantage to mankind.

REFERENCES

Arora, R. K. and E. R. Nayar. 1984. Wild relatives of crop plants in India. NBPGR Sci. Monogr. No. 7; 1–90.

Frankel, O. H. and M. E. Soule. 1981. Conservation and Evolution. Cambridge Univ. Press., Cambridge, London.

Frankel, O. H. and E. Bennett. 1970. Genetic Resource. In : Genetic Resources in Plants—Their exploration and conservation (O. H. Frankel and E. Bennett, Eds). Blackwell Scientific Publications, Oxford and Edinburgh.

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Cotton Germplasm Evaluation and Utilization in India

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Central Institute for Cotton Research, Nagpur has built up comprehensive collection in different Gossypium *species which have been evaluated, characterized and useful genetic stocks identified. Elite strains evolved through breeding are tested for performance.*

The last one decade has been very unique in the history of cotton germplasm collection, conservation and evaluation in India. With the establishment of the Central Institute for Cotton Research (CICR) at Nagpur in 1976, over 6,000 accessions of germplasm in all the four cultivated *Gossypium* species have been assembled. Systematic evaluation was carried out (1980 to 1986) for initial screening and grouping of elite accessions for various morpho-agronomical characters based on IBPGR list of descriptors, providing basis for their utilisation in relation to current agricultural and industrial requirements.

MATERIALS AND METHODS

The germplasm accessions available at various research centres in India were assembled and consolidated at CICR (1977 to 1980). Exotic accessions were added through the efforts of NBPGR, New Delhi particularly from USA, USSR, West Indies, China, Pakistan, Egypt, France, Sudan, Peru, Bangladesh, Turkey, etc. Some indigenous accessions were added through explorations within India mainly from North Eastern hill region, western and southern peninsular India. The total collections in the four cultivated species count to 6,056 accessions representing wide geographical diversity. Accessions evaluated upto 1986 included 3,700 in *G. hirsutum*, 289 in *G. barbadense*, 1455 in *G. arboreum* and 390 in *G. herbaceum*.

The germplasm collections were grown under rainfed conditions in single row plots of 20 plants per accession in augumented block design using local checks at regular intervals under recommended spacing of 75 × 30 cm and normal cultivation and plant protection practices. Based on preliminary evaluation, elite lines were grouped into working collections for important economic characters of immediate breeding value. The trials were carried out between 1981 to 1987 as per the CICR, Nagpur germplasm index card (Bhale and Narayanan, 1987). The data on range of variability in elite germplasm as compared with standard cultivar in each species for quantitative characters and other attributes like leaf and bolls were collected. The values for major economic attributes which are of immediate relevance, namely, number of bolls per plant, boll weight, seed cotton yield per plant, ginning out turn, spun length, uniformity ratio, micronaire value, fibre strength, fibre maturity and NMR value of oil in the seed, were recorded for elite working collection.

RESULTS AND DISCUSSION

Wide spectrum of variability for various morphological characters particularly leaf size and shape, petal and calyx pattern, boll size, locule angle and boll opening was observed. These are important for breeding especially for higher boll production, high yield, resistance to insect, pests and diseases, marker characters and picking qualities.

The data on variation in the elite accessions (working collections) in each of the four cultivated species and the respective standard cultivars are presented in Table 1. The values recorded in germplasm indicate that there is vast untapped

TABLE 1. HIGHEST VALUES FOR VARIOUS CHARACTERS IN ELITE GERMPLASM

Characters	G. hirsutum		G. barbadense		G. arboreum		G. herbaceum	
	Germ-plasm	Check SRT 1	Germ-plasm	Check Suvin	Germ-plasm	Check AKH 4	Germ-plasm	Check G. cot. 13
Bolls per plant	82	26	29	18	59	32	69	21
Boll weight (g)	6.9	3.9	3.5	3.0	5555	22.7	2.8	2.0
Yield of seed cotton (g/plant)	180	56	106	48	96	444	109	40
Ginning %	43	35	33	29	50	40	43	36
Spun length (mm)	36	26	40	34	28.0	22.5	26.9	23.0
Uniformity ratio %	54	46	52	45	55	47	52	49
Fineness (mv)*	3.0–5.6	4.1	2.5–4.2	3.2	2.5–8.2	4.9	2.4–6.2	3.4
Tensil strength (g/tex)	58.4	46.1	58	49	58.2	44.0	59	44
Fibre maturity (%)	97	71	88	79	93	84	95	69
NMR value of seed oil (%)	27.3	18.5	30	26	22.8	17.0	20.4	16.5

*lowest and highest values are required for breeding finer and coarse cottons used in textiles and hence indicated.

potential for improving the agronomic attributes like number of bolls per plant, boll weight and seed cotton yield per plant as compared to what has been achieved so far in cotton breeding. Similarly, the fibre quality and oil content of cotton seed which represent the important industrial attributes, could also be improved further for meeting the modern processing needs of the textile and oil crushing mills. By and large the collections evaluated represent wide genetic and geographical diversity.

As a result of the utilization of the elite accessions possessing the highest expression for ten characters mentioned in Table 1 in breeding programmes, over 2,000 cross combinations were produced. Out of these, 20 elite F_1 combinations, 40 segregating lines, 8 high yielding intra-*hirsutum* hybrids, 20 advanced cultures of *G. hirsutum* and 2 *G. arboreum* cultures combining superior attributes were identified. These are under multilocation testing in the All India Coordinated Research Project on Cotton at 15 centres all over the country. This is an instance of massive evaluation of the largest number of germplasm collections in all the four cultivated species of *Gossypium* under rainfed conditions using sophisticated instruments for technological attributes and their successful utilisation in cotton improvement programmes directed towards the changing commercial/industrial demands for cotton in India.

REFERENCE

Bhale, N. L. and S. S. Narayanan. 1987. Need for augmenting the genetic resources in cotton—Indian perspective. In R. S. Paroda, R. K. Arora and K. P. S. Chandel, eds., *Plant Genetic Resources—Indian Perspective* pp. 545

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North-Western Himalaya—A Centre of Maize Diversity

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Exploration and germplasm collection programme undertaken recently in the hilly region comprising interior pockets in the districts of Rajauri, Poonch, Udhampur and Doda/Kishtwar and adjoining Chamba district of Himachal Pradesh in the North-Western Himalaya (Pir Panjal and Shiwalik ranges) and also in the foothills of Himachal Pradesh with contiguous Ambala district of Haryana, showed the occurrence of rich landrace diversity in both flint and dent types. The analysis of diversity was made on natural populations comprising distinct types by grouping the collections in four categories based on their regional/agro-ecological adaptation. The mean, range and coefficient of variability estimates were obtained regionwise. The results showed existence of high genetic variability for most of the cobs and seed characters. Genetic variability was evident in attributes such as height (1-5m) and adaptation to varying altitudinal ranges (upto 3000 m elevations). Cob size, shape, number of grain rows/cob and colours exhibited considerable polymorphism and similar variations were observed for grain size, shape and colour. Both, dent and flint types are cultivated and landraces exhibited definite patterns of distribution. Several types possessed small cobs and irregular grain arrangements on the cobs. The shelled cobs also showed remarkable variability in shape, size, thickness and also in cupule shape and size. The maize landraces also showed considerable range for crude protein content as also the total grain yield, lodging, stiffness of straw and including that of rachilla. The study shows that the North Western Himalayas is potential centre of landrace diversity in maize.

Exploration and germplasm collection programme was undertaken intensively in the hilly region of North-Western Himalayas. The occurrence of rich diversity in maize in different zones comprising distinct ecological niches/microniches, suggested that North-Western Himalaya also constitutes a centre of diversity for maize. The paper highlights the richness of genetic variability and its distribution patterns.

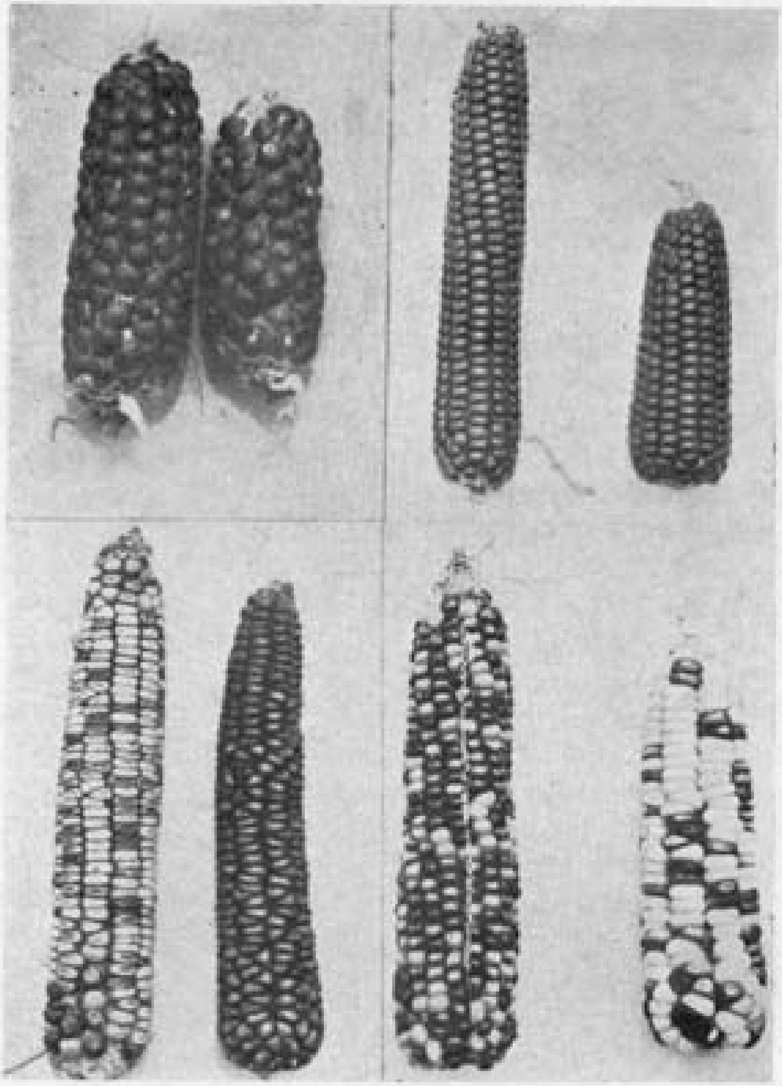
MATERIALS AND METHODS

Explorations were undertaken in the Jammu hills and ecologically diverse locations with varying altitudes (500-2000 m). Population samples from each ecological region/niche were obtained by randomly sampling 10-15 plants per accession/site. Detailed passport data on each accession were collected and studies were made on population samples. One hundred and ten germplasm accessions of maize were collected from five agro-ecologically distinct regions of North-Western Himalayas, namely, Poonch, Rajauri, Udhampur, Bhadarwah and Kishtwar in Jammu and Kashmir. These collections were studied for various morpho-agronomical traits, such as plant height, cob size, kernel number per cob, grain rows per cob, 100-kernel weight, endosperm colour and total protein percentage. The per cent protein was analysed using automatic protein analyser based on micro-Kjeldahl principle. Forty five of these accessions exhibited wide variation for per cent protein and were utilised for electrophoretic analysis. The polyacrylamide gel electrophoresis (PAGE) of total soluble protein, isozymes of peroxidase and esterase were conducted following Davis (1964). A random sample of 10 kernels was allowed to imbibe water overnight and the embryos were excised alongwith the scutellum and homogenised in 0.1 M Tris-HCl (pH 7.4). The homogenate was contrifuged at 10,000 rpm in Remi R-21 centrifuge and the supernatant was used for the electrophoresis. An equal volume of each extract containing an equal quantity of protein estimated following Lawry's method (Lawry *et al.*, 1951) was loaded on 4.5 per cent stacking gel. The protein fractions were resolved in polyacrylamide gel (7.5%). The total protein fractions on the gels were localized by staining with Coomasie brilliant blue. The peroxidase and esterase isozymes were visualized following the techniques described by Shaw and Koen (1968) and Scandalios (1969) respectively.

RESULTS AND DISCUSSION

Study of the natural populations and analysis of data showed that considerable genetic diversity in maize existed in North-Western Himalayan region of India, particularly in remote hilly pockets due to variation in ecology, microniches and spatial isolation imposed by different mountain ranges. Dwarf to very tall (1-5 m) landraces continue to occupy the landscape differing widely in adaptation to varying altitudes (500-2000 m) and soil conditions from valleys to hill tops. Early (70 days) to extremely late types (140 days) were still under cultivation. Variations were prominent for growth, vigour, leaf size and their placement on main shoot. Both narrow and broad leaf types were common.

Much variation occurred in cob size (8-30 cm) (Fig. 1a, 1b), prolificity of cobs (1-3 per plant), internode length, rachilla length (1-10 nodes), and stiffness of rachilla. Amazing diversity existed for cob girth, shell type, grain colour, size, shape and grain yield per cob. Earlier reports (Grant and Wellhausen, 1955; Wellhausen, 1965) suggested that Indian maize varieties seemed to be of two general types; an early yellow flint with a long slender ear somewhat enlarged at the butt with light yellow endosperm and shallow grains closely resembling the early yellow flint grown in the North-Eastern parts of United States of America. The other general type was a flint with short compact ears, deep yellow colour with orange endosperm and shallow grains. This type looked very much like some Cuban yellow flints found in the Caribbean region.

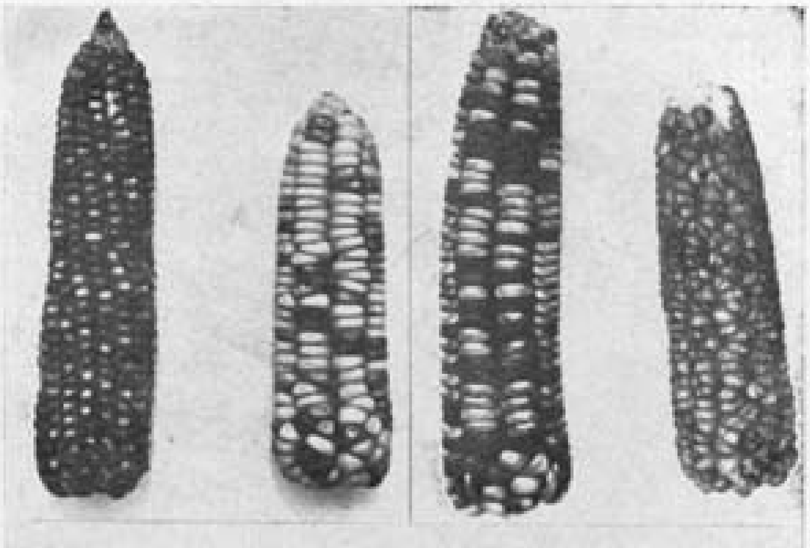


a

Fig. 1a. Diversity in land races of maize.

In contrast to the above observations, both flint and dent types alongwith their intergrades were found to be predominent under cultivation in North Western Himalayan region.

Variations were pronounced for ear (cob) shape (conical, cylindrical or slender-tapering types). Number of rows per cob varied from 8-18. The weight of individual cob ranged between 43.67 and 282.00 g. The grain yield per cob varied between 35.67 and 234.00 g. Grain shape and size was variable and 100 grain weight varied between 10.44-56.86 g. The Rajauri/Poonch region exhibited high coefficient of variability for most of the ear and grain characters. The analysis of data



b

Fig. 1b. Diversity in landraces of maize.

(details being presented elsewhere) showed that remarkable variability existed in the landrace populations for weight of cob, grain yield per cob, 100-grain weight, grain size and colour. Flint and dent types both occurred in varying proportions, flint types with white, yellow or purple grain types had high coefficient of variability in Jammu hills. Besides, purple grained types in flint corn were restricted only to a few accessions. Variation for kernel rows per cob showed interesting features as majority of the landraces had regular kernel rows, though in some, irregular rows occurred suggesting primitiveness of these landraces. The inter-regional comparison showed that variability was high in Rajauri/Poonch region, closely followed by Gull hills and also in Mantalai hills (Udhampur district). The diversity compared well with genetic variability reported earlier from North-Eastern region of India (Anderson, 1945; Stonor and Anderson, 1949; Dhawan, 1964; Singh, 1974, 1977; Sachan and Sarkar, 1982; Sachan, 1985).

The per cent protein in assorted population samples indicated that the variation was higher among the collections from Gull hills in Udhampur region. Wide variation observed for morphological characters, viz, cobs and seed traits and protein content was further confirmed by the differences in the electrophoretic mobility of soluble protein fractions (Plate I. e, f.) and isozymes peroxidaze (Plate I, a, b) and estrases (Plate I, c, d). However, a strong similarity of 5 out of the total of 15 fractions resolved through electrophoresis was indicative of local build up of diversity in ppulations of maize. The variation in the electrophoretic mobility of protein fractions was maximum for lines from Gull hills (Udhampur area) and moderate for collections from Rajauri/Poonch and the least for populations from Bhadarwah/Kishtwar region. This was further substantiated by thepresence of

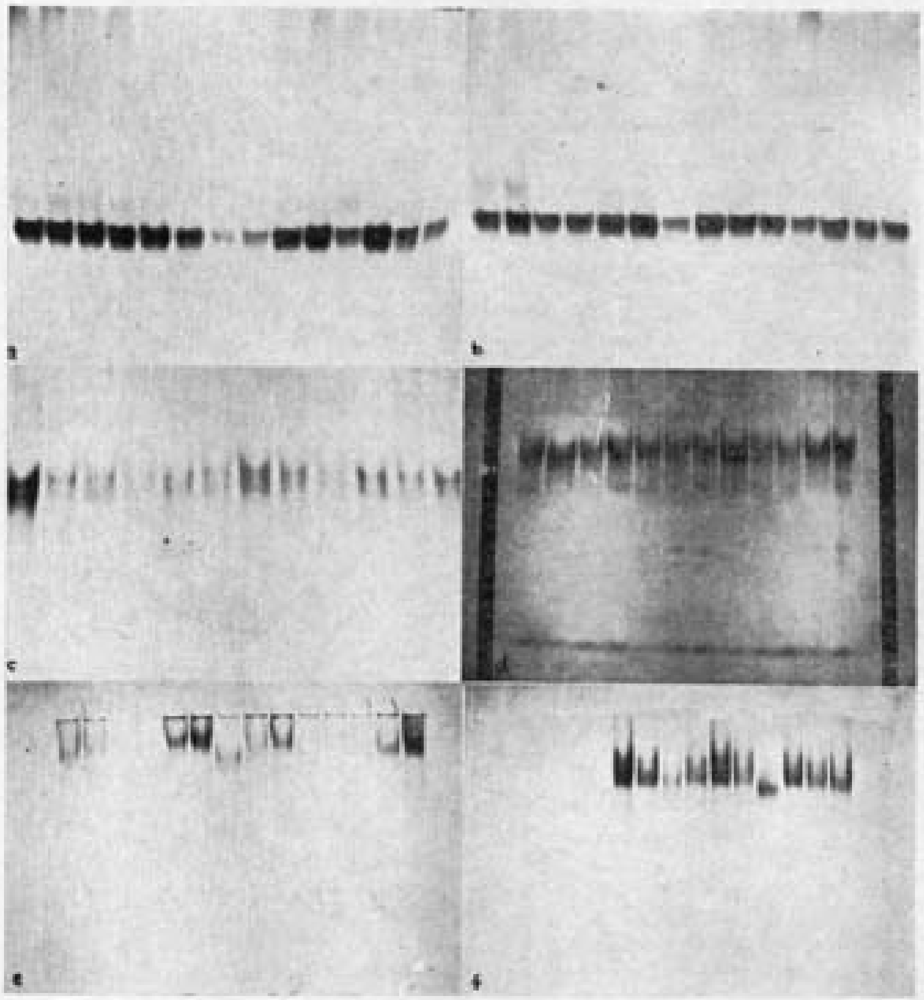


Plate 1. Electrophorograms of per oxidases (a, b), esterases (c, d) and soluble protein (e, f) from North-Western Himalayan maize land races.

a fast moving fraction of peroxidase in these populations. The esterase zymogram (Plate 1c to d) also confirmed the prevalence of variations between the maize populations under cultivation in the regions explored.

REFERENCES

Anderson, E. 1945. What is *Zea mays* ? A report of Progress. Chron. Bot. 9 : 88–92.

Davis, B. J. 1964. Disc electrophoresis II. Method and application to human serum proteins. Ann. N. Y. Aca. Sci. 121 : 404–427.

Dhawan, N. L. 1964. Primitive maize in Sikkim. Maize Genet. Co-op. Newsletter. 38: 104–106.

Grant, U. J. and E. J. Wellhausen. 1955. A Study of Corn Breeding and Production in India. Ministry of Food and Agriculture. Government of India p. 1-27.

Lawry, O. H., N. J. Roseburgh, A. L. Farr and R. J. Randal. 1951. Protein measurement with the folin phenol reagent. J. Biol. Chem. 193 : 265-275.

Sachan, J. K. S. 1985. Characterisation of North Eastern Himalayan maize. National Seminar on Integrated Management Approach for Maximising Crop Production in Rainfed and Problem Areas (Abstract) p. 49.

Sachan, J. K. S. and K. R. Sarkar. 1982. Plant type of Sikkim primitives. Maize Genet. Co-op. Newsletter, 56 : 122–124.

Scandalios, J. G. (1969) Genetic Control of multiple molecular forms of enzymes in plants. A review. *Bioch. Genet.* 3 : 37–79.

Shaw, C. R., Koen, A. L. (1968) Zone electrophoresis of enzymes. In Smith I (ed.), Chromatography and Electrophoresis, 2nd ed., Interscience Publishers, New York.

Singh, B. 1974. The Eastern Himalayan region as a centre of diversity of maize. SABRAO J. 34A : 22–25.

Singh, B. 1977. Races of Maize in India. Indian Council of Agricultural Research, New Delhi. pp 106.

Stonor, C. R. and E. Anderson. 1949. Maize among the hill peoples of Assam. Ann. Mo. Bo.-Gard., 36 : 355–404.

Wellhausen, E. J. 1965. The origin and breeding of maize. Indian J. Genet., Proc. 3rd Intern. Symp. Spl. Vol. : 45–59.

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Effect of Lancing on Alkaloids Profile of Capsules in Opium Poppy

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The commercially important crop of opium poppy is grown for production of alkaloids. These alkaloids are now favoured to be extracted from dry capsules due to constraint of manual labour rather than from latex as practised earlier. However, due to presence of bound form of alkaloids in capsules, the process of extraction complicates. Hence, a method has been developed for the extraction of alkaloids from the poppy straw and analysed over HPLC. The lanced and unlanced dried capsules of four promising varieties alongwith two control varieties, were analysed for the spectrum of five major alkaloids by the method developed by us. It was observed that unlanced capsules have greater proportion of alkaloid contents in comparison to lanced capsules. Hence, unlanced capsules of opium poppy can be used for better production of alkaloids.

The opium alkaloids are obtained from poppy plants in two ways : (a) from the latex which on drying is called opium-gum, and (b) from the plant organs specially capsules.

In India, mainly the latex is used for the production of opium alkaloids. However, due to presence of bound form of alkaloids in capsules, the process of extraction is complicated. Hence, an attempt has been made to develop a method for releasing the bound alkaloids in capsules and their analysis on HPLC. The major alkaloids in both lanced and unlanced capsules of the promising varieties and controls were also studied.

MATERIALS AND METHODS

In this study, promising varieties of opium poppy (IC-30, IC-42, IC-88 and IC-128) collected from different agro-climatic zones alongwith two established varieties as controls were grown at NBPGR Research Farm at Issapur, New Delhi, in 1985-86. The composite samples of fully matured lanced and unlanced capsules were collected from the plants of each variety for analysing five major alkaloids.

The dried, mature, terminal and lateral capsules with 2-3 cm stem attached, collected from ten plants of each variety were powdered and used as composite samples for analysis. The dried powder (1 g) was shaken with 25 ml of 5% glacial acetic acid for 20 minutes using a mechanical shaker. The extract was filtered and residue was extracted similarly three times. Residue was rejected and the pH of the total extract was adjusted to 9.0–9.5 with concentrated ammonia solution (25% NH_3). The liberated alkaloids were repeatedly extracted

(4 × 15 ml) with chloroform; isopropanol (3 : 1) solvent system. The extract was dried over anhydrous sodium sulphate and evaporated to dryness under vacuo at 50°C. The residue was redissolved in 5 ml of methanol (HPLC grade) and injected into HPLC after making it free of any particulate matter by passing through sample clarification kit. Peak heights obtained on the plotter were compared with those of standard compounds and the percentage of each alkaloid in the sample calculated.

RESULTS AND DISCUSSION

Unlike in latex, opium alkaloids are present in bound forms in capsules of *Papaver somniferum*. The complexity and molecular weight of these bound alkaloids seem to increase during ripening of capsules and these substances represent transitional forms in the metabolism and translocation of morphine from latex to seed (Fairbairn and Steele, 1980). To overcome this practical difficulty, a new method was developed in which finely powdered poppy capsules (without seeds) were repeatedly extracted with 5% acetic acid. Four extractions of 5% acetic acid were enough to extract optimal amount of alkaloids. The total extract was adjusted to different pH for the liberation of alkaloids and optimum pH was 9.0 to 9.5. The free alkaloids were extracted from the aqueous solution by chloroform; isopropanol (3 : 1) solvent system. The residue left after removal of solvent was subjected to 'High Pressure Liquid Chromatographic' analysis for five major alkaloids under conditions developed earlier (Srivastava and Maheshwari, 1985).

The comparison of alkaloids of the poppy capsules of different varieties tested showed that the percentage of each alkaloid varied greatly between lanced and unlanced capsules (Table 1). Unlanced capsules possessed more morphinane and

TABLE 1. ALKALOIDS PROFILE OF THE POPPY CAPSULE OF PROMISING VARIETIES

Varieties	Percentage of Morphinane alkaloids				Percentage of Isoquinoline alkaloids		
	Morphine	Codeine	Thebaine	Total	Narcotine	Papaverine	Total
In lanced capsules							
IC–30	0.32	0.14	0.02	0.48	0.06	0.01	0.07
IC–42	0.12	0.24	0.12	0.48	0.01	0.06	0.07
IC–88	0.12	0.14	0.02	0.28	0.01	0.03	0.04
IC–128	0.12	0.16	0.02	0.30	0.02	0.02	0.04
Ranjhatak (control)	0.14	0.24	0.04	0.44	0.02	0.02	0.04
Jawahar afeem (control)	0.08	0.26	0.10	0.44	0.02	0.16	0.18
In unlanced capsules							
IC–30	0.40	0.20	0.06	0.66	0.14	0.01	0.15
IC–42	0.30	0.14	0.03	0.47	0.22	0.07	0.29
IC–88	0.32	0.12	0.03	0.47	0.10	0.08	0.18
IC–128	0.72	0.10	0.03	0.85	0.18	0.16	0.34
Ranjhatak (control)	0.44	0.20	0.12	0.76	0.14	0.08	0.22
Jawahar afem (control)	0.38	0.12	0.04	0.54	0.24	0.36	0.60

isoquinoline alkaloids as compared to the lanced capsules. Amongst morphinane alkaloids, morphine content was greatly reduced by lancing. Similarly, thebaine, narcotine and papaverine contents also reduced in lanced capsules. The only exception was codeine content which was found to be unaffected in lanced capsules. It rather increased in some cases.

The opium alkaloids are biosynthesised in the opium poppy through shikimate pathway (Jindra *et al.*, 1966). Synthesis of morphine takes place by successive demethylation process, i.e. from thebaine to codeine and then to morphine. In lanced capsules, all the alkaloids except codeine were reduced in quantity. It has been noticed earlier that in contrast to the alkaloids distribution found in the plant of *papaver somniferum*, callus-cultures accumulated a predominance of codeine and in some cases also thebaine (Hodges and Rapoport, 1982).

Similarly, in cell suspension culture, codeine was not metabolised to morphine whereas codeinone (a precursor of codeine) was transformed to codeine indicating that cell line lacks the ability to demethylate codeine to morphine (Tam *et al.*, 1982). On the other hand, it was observed that latex is capable of synthesising morphine in *in vitro* conditions (Fairbairn and Djote, 1970). This indicates that the metabolic system(s) necessary for biosynthesis of morphine, were mainly present in the latex. Hence, it could be inferred that whenever latex was drawn from the capsules, the conversion of codeine to morphine was inhibited due to inhibition of specific metabolic system(s). This may probably create the situation where codeine accumulates at the cost of morphine. It further suggests the possible application of lanced capsules for tapping the codeine alkaloid. However, if only capsules are to be used for the production of alkaloids, then unlanced capsules will be preferable due to higher content of alkaloids present in them. This can overcome the constraint of skilled labour required for collection of latex and also help in preventing clandestine activities in opium-gum trade.

REFERENCES

Fairbairn, J. W. and M. Djote. 1970. Alkaloid biosynthesis and metabolism in an organelle fraction in *Papaver somniferum*. Phytochemistry, 9 : 739–742.

Fairbairn, J. W. and M. J. Steele. 1980. Bound forms of alkaloids in *Papaver somniferum* and *P. bracteatum*. Phytochemistry, 19 : 2317–2321.

Jindra, A., P. Kovacs, Z. Pitnerova and M. Psenk. 1966. Biochemical aspects of the biosynthesis of opium alkaloids. Phytochemistry, 5 : 1303–1315.

Hodges, C. C. and H. Rapoport. 1982. Morphinane alkaloids in callus cultures of *Papaver somniferum*. J. Nat. Prod., 45 (4) : 481–485.

Srivastava, V. K. and M. L. Maheshwari. 1985. Liquid chromatographic determination of major alkaloids in gum opium. J. Assoc. Off. Anal. Chem., 68 : 801–803.

Tam, W. H. J., W. G. W. Kurz, F. Constable and K. W. Chatson. 1982. Biotransformation of thebaine by cell suspension cultures of *Papaver somniferum* CV Marianne. Phytochemistry, 21 : 253–255.

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Genetic Divergence in Flue-Cured Tobacco (*Nicotiana tabacum* L.)

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Twenty four promising varieties of flue-cured tobacco were studied for their genetic divergence by D^2 statistics with a set of seven characters related to yield and quality of the leaf. The study revealed that genetic divergence has little relevance to geographical origin of the varieties. The maximum divergence was observed for quality of leaf, bright leaf and TBLE followed by number of leaves per kg. The varieties, MC 1 and Speight G 33, when crossed with McNair 14 and Jayasree are likely to yield segregants with high yield coupled with better quality in subsequent generations.

Several flue-cured tobacco (FCT) producing countries, have been evolving new varieties to meet their requirements and acquisition of these varieties has become easier now than ever before due to increased international co-operation. The CTRI has been acquiring the germplasm of *N. tabacum* (L.) through NBPGR, New Delhi. In majority of cases, the germplasm obtained from different countries is used as donor parents. Therefore, the study of genetic diversity in the material is of paramount importance so as to select suitable parents in the hybridization programme.

Various methods are in vogue for classifying the material, for example, morphological characters, key diagnostic characters and semigraphical method Metroglyph analysis outlined by Anderson (1957). Mahalanobis D^2 was used to study the divergence in flue-cured tobacco and white-burley tobacco (Lakshminarayana *et al.*, 1970). The present paper reports the result of genetic divergence among 24 high yielding varieties of flue-cured tobacco.

MATERIALS AND METHODS

The experimental material comprised 24 varieties selected from amongst 56 varieties evaluated during 1979-80 under dryland conditions. These included Coker 213, Coker 411, Florida 22, McNair 135, Oxford 1-181, Va 45, NC 13, Speight G41, V71 Meadows Giant, Speight G33, and Speight G41 (USA), F 207, F 210, Hicks 104, and MC1 (Japan), Kazimerski 640 (Poland), Kauka 427 (New Zealand), M 43-strain 94 (Rhodesia), Rila 9 (Bulgaria), EC 11083 (Yemen Arab Republic) and CTRI Special, Jayasree, Line 2178 and Cock Tobacco (India). The net plot had 28 plants and the rows and plants were spaced at 80 cm and 60 cm respectively. The data were recorded on cured leaf yield (CLY), bright leaf yield (BLY) and total bright leaf equivalent (TBLE) as well as plant height (HT), number of economic leaves (EL), flowering time (FT) and number of leaves per kg (LW). Cured leaf was graded into three broad categories as bright, medium and low grades. Medium grades are priced, on an average, 0.465 of bright grades as such the medium grades are converted to bright leaf equivalents by multiplying them with 0.465, the resultant figure being added to bright leaf to yield TBLE. (Anon., 1957-58). The genetic divergence as measured by D^2 statistics was calculated following standard methods using variance and co-variance matrix obtained from the error component.

RESULTS AND DISCUSSION

The varieties differed significantly among themselves for all the characters (Table 1). The 24 varieties were grouped into eleven clusters; the intra and inter cluster D^2 values are presented in Table 2. The inter cluster values of D^2 for

TABLE 1. SIGNIFICANT OF VARIABILITY IN CHARACTERS FOR DIFFERENT VARIETIES OF FLUE CURED TOBACCO

Variety	CL	BL	TBLE	EL	HT	FT	LW
G.M.	62.9	13.6	29.9	18.6	133.3	77.7	230.1
C.V. (%)	9.6	31.9	15.6	7.1	6.9	3.9	14.9
C.D. 5%	9.9	7.2	7.7	2.1	15.2	5.0	56.6
C.D. 1%	13.2	9.6	10.2	2.9	20.3	6.7	75.6

TABLE 2. INTRA AND INTER-CLUSTER D^2 VALUES FOR 24 VARIETIES OF FCT

Clusters	Varieties	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
I	8, 9, 10, 18, 22	5.9	26.0	15.7	25.4	19.7	18.0	35.4	27.5	13.0	48.9	25.7
II	6, 7, 12, 16, 21, 23		7.0	26.9	16.7	24.8	42.4	17.3	15.9	54.5	15.9	14.5
III	13, 17			5.5	20.6	27.0	13.4	17.6	43.2	18.8	40.3	15.8
IV	1, 2				7.6	37.4	21.0	29.9	25.5	48.3	19.5	23.1
V	5, 15, 20					7.2	49.3	34.3	19.4	26.6	50.9	11.8
VI	3,							42.2	55.5	20.2	55.2	41.4
VII	11,								46.8	54.3	31.0	12.2
VIII	14,									53.3	22.0	21.4
IX	19,										83.8	35.6
X	24,											26.69
XI	4,											

Varieties included; 1. Cock tobacco; 2. Coker 213; 3. Coker 411; 4. EC 11083; 5. Florida 22; 6. F 206; 7. 207; 8. Hicks-104; 9. Kasimierski-640; 10. Kwaka 427; 11. McNair 14; 12. McNair 135; 13. MCl 14; 14. M 43 Strain 94; 15. Oxford-1-181; 16. Rila-9; 17. Speight G-33: 18. Speight G-41; 19. V 71 Meadows Giant; 20. Va 45; 21. L. 2178; 22. NC-13; 23. CTRI Special; 24. GSH 3.

clusters II, IV and V were about 7.0, while the same for clusters I and III were low (5.88 and 5.52 respectively). The inter-cluster distance between IX and X was the maximum (83.80). The distances were higher between cluster I and

X, I and VII than between I and IX, I and III, I and VI. Cluster II had greater distance from Cluster IX as compared to others. Similar was the case with respect to cluster III and X, III and VIII. Cluster VI, was farther apart from Cluster VII, VIII, IX and X.

Marked differences between different clusters in respect of bright leaf, total bright leaf equivalent (TBLE) and number of leaves per kg were observed. Cluster VII had the highest means of 27.261 and 41.904 for bright leaf and TBLE yields respectively, while the least values were recorded by cluster IX for both these characters. The clusters VII and IX had the least number of leaves per kg.

The material utilised in the present study originated from eight countries of different geographical regions. The majority of the varieties (11) were from USA, the major tobacco producing country in the world. The varieties in cluster I originated from USA, Newzealand, Japan and Poland. The varieties in cluster II also originated from USA, Japan and Bulgaria. Varieties McNair 135, Coker 213, Florida 22, Coker 411 although from USA were grouped in different clusters. Similar observations were made by Murty and Pavate (1962) with their limited material of 13 genotypes and genetic divergence estimated only on four characters. The studies showed that there was no relationship between geographical origin and genetic diversity (Arunachalam and Ram, 1977; Narasinghani *et al.*, 1978; Singh *et al.*, 1979).

TABLE 3. GROUPING OF 24 VARIETIES OF TOBACCO IN DIFFERENT CLUSTERS

Cluster No.	No. of Varieties	Name of the Varieties	
1	5	Kwaka-427	New Zealand
		Speight G-41	USA
		NC-13	USA
		Kazimierski 640	Poland
		Hicks 104	Japan
5	6	F 207	Japan
		McNair 135	USA
		Rila-9	Bulgaria
		F 210	Japan
		L-2178	India
		CTRI Special	India
3	2	MC1	Japan
		Speight G-33	USA
4	2	Cock Tobacco	India
		Coker 213	USA
5	3	Florida-22	USA
		Oxford-1-181	USA
		Va-45	USA
6	1	Coker-411	USA
7	1	McNair-14	USA
8	1	M 43 Strain 94	Rhodesia
9	I	V 71 Meadows Giant	USA
10	1	GSH 3	India
11	1	EC 11083	Yemen Arab Republic

In FCT, the leaf is valued on the basis of colour. Bright coloured tobacco always fetches more price per kg than other shades like brown, etc. Varieties giving higher quantities of bright leaf and TBLE are preferable. The varieties Jayasree (Cluster X) and McNair 14 (Cluster VII) were similar in bright leaf and TBLE yields while MC1 and Speight G. 33 (III) were high cured leaf yielders. Hybridization between the varieties of Cluster X and VII with those of III are likely to yield segregants with higher yield and better quality. The other character of importance was the number of leaves per kg. It is considered that number of leaves was advantageous as the production costs of tobacco could than be reduced, while realising higher yields. The varieties in Cluster IX, VII, III and I satisfied this criterian. However, the varieties of cluster III, being common for high yeild and less number of leaves per kg, may be chosen for hybridization with those of cluster VII for beneficial results.

The diagnostic characters in tobacco are plant habit, internodal length and leaf characters. When these characters are considered for grouping the varieties, the variety Speight G-41 stands distinct from the others as its leaves are highly puckered compared to the other four varieties of the same group (Cluster I). Similarly the varieties F-207, F-210 and McNair 135 are distinct from CTRI Special and line 2178 of cluster II, the latter two varieties have light green leaves and are early maturing.

Thus, the D^2 analysis proved to be an effective tool for measuring divergence among various genotypes.

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REFERENCES

Anderson, E. 1957. A semigraphical method for the analysis of complex problems. Proc. Nat. Acad. Sci., Wash. 43 : 923-927.

Anonymous. 1950. Annual Report. Central Tobacco Research Institute, Rajahmundry, India. p. 234.

Anonymous. 1957. Annual Report. Central Tobacco Research Institute, Rajahmundry, India.

Arunachalam, V. and J. Ram. 1967. Geographical diversity in relation to genetic diversity in cultivated sorghum. Indian J. Genet. 27 : 369-380.

Lakshminarayana, R., D. M. Gopinath and K. V. Krishna Murty. 1970. Varietal classification and selection in burley tobacco. Indian J. Genet. 30 : 424-438.

Murty, G. S. and M. V. Pavate. 1962. Studies on quantitative inheritance in *Nicotiana tabacum* L., Varietal classification and selection by multivariate analysis. Indian J. Genet. 22: 60-80.

Narsinghani, V. G., K. S. Kanwal and S. P. Singh. 1978. Genetic divergence in peas. Indian J. Genet. 38 : 375-379

Singh, V. P., M. S. Swaminathan, R. B. Mehra and E. A. Siddiq. 1979. Divergence among dwarfs of cultivated rice. Indian J. Genet. 39: 315-322.

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Genetic Resources in Tomato and Their Evaluation

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Tomato is one of the most popular and widely grown vegetable in the world ranking second in importance to potato in many countries. The centre of origin of genus Lycopersicon *is a narrow belt of South-American west coast and the Andes. The greatest variability occurs outside this area in Mexico, Central America and coastal Peru. Because of its climatic tolerance, tomato has been proved to be one of the most versatile cultivated plants. The erstwhile Plant Introduction Division (IARI) under the leadership of late Dr. H. B. Singh, started genetic resources activities long back and over the years, the NBPGR has assembled a total of 2, 659 collections in tomato from diverse agro-climatic zones of the world (from over 40 countries) and from within India. These were tested/evaluated in phased manner but during past two years, data were recorded systematically on 39 different agro-botanical and economic characters. Donor types were indentified for different traits. High yielding, paste types, heat tolerant lines, and collections suitable for good/excellent transportation were sorted out for their utilization as direct selections or exploitation as parental material in hybridization programme.*

The tomato is relatively a recent addition to the world's important food crops. Within the past century, it has become one of the most popular and widely consumed vegetable crops with an annual world's production of *ca* 50 million metric tons. In India, tomato can be grown nearly throughout the year since favourable climatic conditions are available in one part of the country or the other. It is cultivated in *ca* 80,000 hectares in different parts and is well adapted to all the regions. On an average, a normal crop of tomato yields 16,000 to 24,000 kg per hectare. Considerable variability has been generated through introductions from several countries of the world from time to time as well as through breeding efforts in the past three decades. Germplasm collections have been further augmented by Germplasm Exchange division of the NBPGR. The present paper highlights the efforts in evaluation and identification of world genetic resources in tomato.

MATERIALS AND METHODS

The NBPGR and erstwhile Plant Introduction Division of the Indian Agricultural Research Institute through introductions from various parts of the world assembled 2,659 germplasm accessions from over 40 countries (Table 1). In

TABLE 1. TOMATO GERMPLASM IN INDIA

Sources of germplasm collection/introduction	Accessions
(i) Exotic germplasm	2,229
USA, Philippines, UK, Canada, Australia, Protugal, Italy, Argentina, Cyprus, Mauririus, Israel, Netherlands, Nepal, Tanzania, Turkey, Japan, Iraq, Chile, Yugoslavia, Denmark, Switzerland, China, Trinidad, S. Africa, Czechoslovakia, Ghana, Germany, Hungary, Taiwan, Poland, Iraq, Bulgaria, South America, Columbia, Hongkong, Spain, United Arab Republic, Burma, Nigeria, Newzealand and Brazil.	
(ii) Indigenous germplasm	430
West Bengal, Tamil Nadu, Madhya Pradesh, Maharashtra, Uttar Pradesh, Himachal Pradesh, Karnataka, Bihar, Jammu & Kashmir, Andhra Pradesh, Haryana, Gujarat, Mizoram, Sikkim and Manipur.	
Total Germplasm Assembled	2,659

India, several pockets in Madhya Pradesh, Maharashtra, Uttar Pradesh, Bihar, West Bengal, Andhra Pradesh, Himachal Pradesh, Karnataka, Tamil Nadu, Jammu & Kashmir, Mizoram, Sikkim and Manipur were explored and fairly rich variability was collected. The entire tomato germplasm is maintained at New Delhi centre of NBPGR. The germplasm collections were grown in augmented design at NBPGR Experimental Farm, Issapur and were evaluated systematically over the years for 39 different agro-botanical and economic characters. Several wild species, introduced in the last decade or so are also being maintained such as *L. pimpinellifolium*, *L. hirsutum*, *L. peruvianum*, *L. glandulosum*, *L. cheesmanii*, *L. chilense*, *L. esculentum* var *cerasiforme* and *L. pissisi*.

RESULTS AND DISCUSSION

The collections varied in plant height (25-167 cm), number of branches per plant (3-19), number of clusters per plant (4-201), number of flowers per cluster (2-26), number of fruits per cluster (1-22), number of fruits per plant (8-790 including wild material) and average weight of 10 marketable fruits (30-167 g). Several high yielding, paste types, heat tolerant lines and collections with excellent transportation quality (Table 2) were identified for their utilisation either as direct selection or exploitation as parental material in hybridisation programme (Thomas and Umesh Chandra, 1988). Table 3 lists such genetic resources identified for different agro-ecological zones of India.

The screening of tomato germplasm has helped in the identification of many donors of which only a few have been used in the breeding programme. Several cultivars particularly from exotic sources such as Sioux (ex USA), Best of All,

TABLE 2. DONOR TYPES IDENTIFIED FOR BREEDERS USE

Traits	Donor germplasm
High yield	EC Numbers : 1127, 1153, 3069, 4708, 6049, 6053, 7291, 9016, 9149, 11238, 10309, 27412, 16920, 17960, 27918, 42662, 35395, 54645, 66504, 101652, 110176, 125754, 126776, 128524, 126776, 128524, 128693, 128969, 129600, 129699—p^2, 129081, 129353, 129354, 129081, 129353, 129757, 129171—p^{1-2}, 130035, 130163, 130163—p^{2-1}, 141854-1, 145515, 161251, and DM 83-12, DM 83-21 and Bulgarian.
Heat tolerant	EC Numbers : 41824, 7764, 9149, 9149, 35211, 54315-1, 122963, 129666—p^1, 32611, 126955, 159979, 141832, 14073—p^2, 27936, 27929, 128964, 2599, 35220, 27251, 37264, 43225, 54027, 61691, 103595, 111085, 1139, 41025; PI Numbers : 126453, 126923, 130/47, MH/81-3, 78/81-13, IC 23571.
Processing type	Bulgarian, EC 942, 1193, 2790, 480, 1132, 1154, 8822, 4229/p^2, 54627, 35461, 52062, 89258, 110578, 161252, 160187, 145623, 141814, Ont 717; IC 15212; M 28/81; 12 etc.
Suitable for transportation	EC 4229/p^2, 19/18-6, 7167, 7352, 8822, 100845, 110268, 99184, DM Sel 3-1; EC 130049, 168541, 171072.
Resistant to Fusarium wilt and fruit rot	EC Numbers 160195, 1149, 1184, 1151, 1136, 6589, 26108, 35401, 16163, 122527, 21626, 103598, 116874, 117008, 115947, 37192, 117671, 117103, 119116, 5962, 4764, 54716, 455, 119187, 35488/p^{2-1}, 110116, 109181-2. 54716, 54628A, 54628B, 50366-1-1-1. 104162/p^2—1, 106261, 66504, 11662, 12659, 12957, 129380 and EC 128769.
Resistant to fruit borer	EC Numbers : 262, 2669, 490, 491, 6200, 7764, 6987, 16787-1, 23528, 110264, 101552, 1747, 57289, 65077, 59621, 129354, 11520-1, 124406, 129599, 129597, 129698, 129699/p^{2-1}, 129469, 128016, 119791, 43264, 66005, 65984, 2630, 121443, 86526, 20685, 121451, 2792, 85622, 160191, 21318, 161254, 9227, 18223, 118266. 119121; IC 59067; 51/81-3, 14/81-6, 78/81-8, 100/81—A, M 3/81-3, DM/81-14, DM—3, DM 83-7, 51/81-2, 28/81-3, 95/81-2, 51/81-3 and 14/81-6.

EC Numbers represent exotic collections obtained from other countries and maintained at the National Bureau of Plant Genetics, New Delhi-110012, India.

Fireball (ex Canada), Rutgers, Early Lethbridge, King Humbert, Roma (ex USA), la Bonita (ex USA), Dwarf Money Maker (ex Israel), Pan America, Early Chatham have been found to perform well. Other varieties like Marglobe, Best of All, Italian Red Pear and Roma performed well in different parts of India.

Selections have also played important role in tomato improvement in India. Improved Meeruti was evolved at the IARI through selection from an Indian cultivar from Meerut in Uttar Pradesh (Singh and Sikka, 1955), Other selected indigenous material are Meeruti, HS-101, HS-102, KS-1, KS-2, S-11, CO-1 and

TABLE 3. IMPORTANT VARIETIES IDENTIFIED IN TOMATO FOR DIFFERENT AGRO-ECOLOGICAL ZONES IN INDIA

Variety, source and year of identification 1	Suitable zones* 2	Varietal characteristics 3
Pusa Ruby, IARI/NBPGR, (1975)	II, IV, VI VII and VIII	Plant height 80-85 cm, indeterminate growth habit, spreading, less branched and hardy. Fruits flat, round, small to medium, uniform deep red, slightly lobed (4-5 locules). slightly acidic, 25-30 fruits per plant, early variety, maturity 60-65 days, suitable for autumn, winter & spring summer seasons in plains. Good for juice & Ketchup. It is an old variety derived from the cross 1mproved Meeruti × Sioux.
HS-101, Hisar (1975)	I, II, IV, VI and VIII	Plant height 50 cm, dwarf multi-branched sturdy and determinate in growth habit. Fruits bearing in cluster of 2-3, round small to medium in size, 3-4 locules, Fruits ripe uniformely, 40-50 fruits per plant. Suitable for winter senson.
S-12 Ludhiana (1975)	I, II, IV VII and VIII	Plants are dwarf, bushy, vigourous, fruits are medium sized, compressed round. Uniformly coloured, red at maturity, juicy highly acidic. Average yield 175-230q/ha. Suitable for marketing, fresh for table.
Sel 120 IARI/NBPGR (1975)	I, IV, VI, VII and VIII	Semi-determinate, spreading type, foliage dark green good covarage, fruits attractive, round to flattish round, medium to large in size, smooth, uniform, red in colour, less acidic & less seeded. Resistant to nematodes. suitable for summer & winter.
T-1 Pantnagar (1975)	I, II, IV, VII and VIII	Plant height 100-120 cm, tall, erect and indeterminate in growth habit, foliage, green in colour, Fruits round, slightly, pointed at the stigmatic end, 4-5 locules, 4-5 fruits per plant, non-cracking, red on ripening, susceptible to TMV.
Sweet-72 Gwalior (1975)	I, II, IV and VII	Plants determinate type, fruit flattish round green stem end, slightly furrowed. Uniform maturity. Heavy yielder.
Puss Early Dwarf, NBPGR (1975)	I, II, IV and VIII	Plant typical dwarf 50-55 cm in height with determinate growth habit. Fruit set closely roundish slightly flattish, medium large, uniform red, ribbed, obscurs furrow, 5-6 locules 30-40 fruits

Contd..

TABLE 3. (*Continued*)

1	2	3
		per plant. Maturity in 55-60 days after transplanting, suitable for *rabi* season in plains and March in hills.
Sioux, IARI (1977)	II, IV, VI and VII	Plants with indeterminate growth habit, fruits round, smooth, medium to large, attractive red on ripening, less seeded, Maturity 60-70 days after transplating Suitable for summer & Spring in plains & hills both.
Pusa Gaurav (Sel-152) IARI (1983)	I, II, IV, VI, VII and VIII	Determinate growth habit, leaves with light green foliage, fruits yellow, smooth, oblong, two locules, uniform ripening, matutity 80-85 days after sowing, Excellent for processing and suitable for long transportation.
Punjab Chhuhara, Ludhiana (1981)	I, II, IV, VI, VII and VIII	Plants dwarf, bushy and determinate growth habit with dense and luxurient foliage, Fruits are medium sized, pear shaped, firm, fleshy, usually bilocular, less seedy, less sour, thick walled, uniformly coloured, red at maturity, ratain marketable quality for a week after harvesting under ordinary condition during summer. Most suitable for long transportation. Average yield 300-320 q/ha.
MS-22 Kalianpur (1985)	I, II, IV and VI	Plants determinate, foliage light green, fruit flattish round, slightly furrowed. Moderate yield. Stem end and leaves are slightly rolly, number of locules 4-5.
Pant Bahar (AC-238) Pantnagar (1985)	I, II IV and V	Plant height 90 cm, bushy indeterminate in growth habit and branched. Light green foliage, stem relatively thin, leaflets small in size. First ripening in 78 days. Fruits flattish round, medium in size, 5-6 locules, slightly ridged, red on maturity. Resistant of Verticillium wilt and Fusarium wilt under field conditions. Good storage and processing qualities.

*Zones :

I = Humid Western Himalayan Region
II = Humid Bengal-Assam Basin
III = Humid Eastern Himalayan Zone and Bay Islands
IV = Sub-humid Satluj-Ganga Alluiral Plains
V = Sub-humid to Humid Eastern and South-Western Uplands
VI = Arid Western Plains
VII = Semi-arid Lava Plateau and Central Highlands.
VIII = Humid to semi-arid Western Ghate and Karnataka Plateau.

CO-2 (a pure line selection from Kalianpur cultivar) for Tamil Nadu. Selection-120 was selected from breeding material (Helani numbers) received from Dr. Gilbert of Hawaii. This cultivar has been found to be promising for nematode resistance and is a high yielder with large, round and attractive fruits. Hybridization programme utilising exotic cultivars as one of the parents, has been successful in evolving cultivars like Pusa Ruby (Sioux × Improved Meeruti), Pusa Early Dwaf (Improved Meeruti × Red Cloud), Pusa Red Plum (*L. esculentum* × *L. pimpinellifolium*) — the material of *S. pimpinellifolium* was received from Dr. B. B. Mundkar, Punjab Chhuhara (Israel Introduction EC 55055 × Punjab Tropic) and Sweet 72 (Pusa Red Plum × Sioux). Mutation breeding was also exploited in developing cultivars like S-12 and CO-3. Heterosis has been exploited in F_1 hybrids in tomato to a great extent in the last 50 years in developed countries like USA, Japan, etc. In India, heterosis in tomato resulted in an increased yield of 20 to 50 per cent (Pal and Singh, 1943; Chaudhary *et al.*, 1965). Two very promising combinations were Red Jacket × Meeruti using closed anther mutant (Mital *et al.*, 1962) and Pusa Ruby × Best of All (Chaudhary *et al.*, 1965). It has been reported that superior hybrid yield was obtained in a cross between Pusa Early Dwarf and Selection 120, when selection 120 was used as pollen parent.

Studies on inter-specific hybridisation in tomato (*L. asculentum* × *L. pimpinelifolium*) in India resulted in Pusa Red Plum-an early, cultivar rich in Vitamin C and sugar (Pal and Singh, 1943) from interspecific hybridisation between *L. esculentum* and *L. pimpinellifolium*. Similarly in USA, Porte and Waker (1943) evolved Pan America cultivar resistant to Fusarium wilt.

Wild relatives have been evaluated for high tolerance to poor soils, the ability to withstand droughts, to resist insects and to be tolerant to excessive moisture. Without question, the greatest contribution to tomato improvement has been through the development of cultivars resistant to common pathogens. The wealth of genetic diversity from germplasm holdings in Indian gene bank has yielded a few sources of resistance. Sel 673 and EC 37192 have been found to be highly resistant to Fusarium wilt whereas Dwarf Money Maker, Marglobe are moderately resistant to this disease. The cultivated tomato suffers from numerous viral diseases also. Chaudhary *et al.*, (1973) have reported that breeding lines B 2247 and Holmes PI showed high degree of resistance to TMV. Among allied species, *L. peruvianum* and *L. hirsutum* were characterised as resistant to TMV. *L. peruvianum*, *L. hirsutum* and *L. esculentum* lines, P-13, XXXII—354—A—Silvestra, B 2247 and Sel. 498 and two lines each of *L. peruvianum* (Lp-6, Lp-8) and *L. chilense* were identified as resistant to leaf curl virus. In addition, *L. peruvianum* has been reported as highly resistant to *Meloidogyne incognita* but susceptible to *M. arenaria* and *M. javanica*. Resistant cultivars available with Southern Tomato Exchange Programme are Anahu, Florida, Hawaii Cross, Hawaii 55, Nemered, Atkinson and VHF-8. In India, Singh and Chaudhary (1972) reported Nematex as immune, Atkinson, VHF 8, 65N-215-1 and 65N-255-1 as resistant and Selection 120 as highly tolerant to root-knot nematode.

REFERENCES

Chaudhary, B., R. S. Punia and K. S. Sangha· 1965. Manifestation of hybrid vigour in F_1 and its retention in F_2 generation of tomato (*Lycopersicon esculentum* Mill.). Indian J. Hort. 22 : 52-59.

Chaudhary, B., R. Tiwari, P. J. Mathai, G. C. Joshi, V. Kesavan, A. K. Chakravarty, T. S. Kalda and S. Sivakami. 1973. Breeding for disease resistance in some tropical and sub-tropical vegetable crops. In : Breeding Research in Asia & Oceania (S. Ramanujam and R. D. Iyer, Eds) 22-28 February 1973. Indian J. Genet. 34A : 1-1328, 1974.

Mital, S. P., H. B. Singh and T. A. Thomas. 1962. Pusa Early dwarf tomatoes. Indian Fmg, 12(3) : 7.

Pal, B. P. and H. B. Singh. 1943. A note on the economic possibilities of the cross *Lycopersion esculentum* × *L. pimpinellifolium*. Indian J. Genet. 3 : 115-116.

Porte, W. S. and H. B. Waker. 1943. The Pan America, a new red variety highly resistant to Fusarium wilt. Circ. U. S. Dept. Agri. 611 : 6pp (Plant Breed. Abstr. 12: 283).

Singh, B. and B. Chaudhary. 1972. Resistance in tomatoes to root-knot nematodes. Haryana J. Hort. Sci 1: 63-68.

Singh, H. B. and S. M. Sikka. 1955. Pusa has some outstanding tomatoes. Indian Fmg. 5 : 18-25.

Thomas, T. A. and Umesh Chandra 1988. Genetic Resources of Tomato in India. Their build up, evaluation, maintenance and utilization. Proc. Intl. Symp. on Integrated Management Practices for Tomato and Pepper production in the Tropics, AVRDC, Shanhua, Tainan, Taiwan, 22-25 March, 1988, pt 28.1—28.6.

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Evaluation and Utilization of Genetic Resources of Minor Millets

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The National Bureau of Plant Genetic Resources, during the past 7-8 years, has been engaged actively in the exploration (collection), evaluation, conservation and utilization/exploitation of genetic resources of various species, namely, Setaria italica, Eleusine coracana, Panicum miliaceum, Panicum sumatrense, Echinochloa frumentacea, Echinochloa crus-galli *and* Paspalum scrobiculatum *under minor millet group of crops. A total of 3,123 diverse genetic resources (905 collections in* Setaria, *601 in* Panicum, *983 in* Eleusine *sp., 386 in* Echinochloa *sp. and 248 in* Paspalum scrobiculatum) *assembled from diverse agro-climatic zones from within India and abroad, were evaluated thoroughly from 1980 to 1984 at Akola and Shimla locations for various agro-botanical and economic characters. The variability occurring in above crops for most of the agronomic attributes (including fodder characters), is of immense significance to the breeder. Crop catalogues for Foxtail and Kodo millet were published and on other species are under preparation. Donor types were identified for their use as direct introductions or as parents for evolving better varieties in these crops for both in the hills and plains. An account of the variability and promoising germplasm identified in each crop is presented in this paper.*

In India, seven species of lesser millets are cultivated from time immemorial and used as grain and fodder in different parts of the country. Paradoxically, these crops have been always grown on marginal lands with poor soil nutrients. Since, these crops have constituted the main diets of the poor tribal and ethnic population, rich genetic diversity has evolved and perpetuated until recently. However, this genetic diversity is now under constant threats. Thus, their collection and conservation is of vital importance. The efforts made in this direction are presented here.

MATERIALS AND METHODS

Germplasm collection comprising landraces in finger millet (*Eleusine coracana*), italian or foxtail millet (*Setaria italica*), common or proso millet (*Panicum miliaceum*), little millet (*P. sumatrense*), kodo millet (*Paspalum scrobiculatum*), barnyard millet (*Echinochloa crus-galli*) and Japanese barnyard millet *E. frumentacea*) were built up through exploration surveys using random collection strategies. Out of total germplasm diversity comprising 3,123 accessions assembled from different agro-climatic regions of India and introduced from abroad; 2,739 accessions (737 diverse germplasm in *Setaria italica*, 404 in *Panicum miliaceum*, 197 in *P. sumatrense*, 767 in *Eleusine coracana*, 386 in *Echinochloa* spp and 248 in *Paspalum scrobiculatum*) were evaluated (1980-1984) at NBPGR Regional stations, Akola and Shimla for various agro-botanical and economic characters and crop catalogues developed. Useful genotypes were identified for their use as direct introduction or as parents for evolving better varieties for marginal land in both hills and plains.

RESULTS AND DISCUSSION

(a) *Foxtail millet*

A total of 737 collections in Foxtail millet (*Setaria italica*) were studied for 45 qualitative and quantitative characters at Shimla and a wide range of variability observed in plant height (44.8-203.5 cm), internode length (6.3-24.2 cm), number of internodes (4-16), tillering capacity (2-16), leaf length (28.2-74.4 cm), leaf width (1.1-3.5 cm), spike length (7.3-40.2 cm), green fodder yield (0.2-1.8 kg) per plot (1.0 m × 0.5 m), days to flowering (53-96), days to maturity (93-147), seed yield per plant (0.9-52.0 g) and 1000 grain weight (2.0-5.92 g). Promosing genotypes identified are :

High yielding grain types	:	ISe-720, IC-11241, Manikaran-2 Shai Local-1, Kasol-3-92, IC-41900
Bold seeded types	:	ISe-897, ISe-952, ISe-62
Longr panicle types	:	ISe-720, Manikaran-2, ISe-82, IC-17336
Early maturing types	:	EC 24091 (93 days), EC 24086 (95 days) and Kasol-3-92 (96 days)

The promising varieties were tested at 3 locations at Shimla, Palampur and Sangla valley and it was found that ISe-720, IC 11241 and ISe-83 are the best yielders at these locations. A Catalogue on Foxtail millet has been published (Umesh Chandra *et al.*, 1987a).

(b) *Finger millet*

A total number of 767 collections in finger millet (*Eleusine coracana*) were studied at Shimla for 44 characters and the germplasm varied in plant height (48.2-161.2mɔ), number of internodes (5-14), culm length (5.5-18.4 cm), tillering (2-9), leaf length (19.4-67.5 cm), leaf width (0.6-2.1 cm), number of fingers per spike (4-10), finger length (4.1-10.4 cm), green fodder yield (0.1-4.8 kg) per 1 m × 0.5 m plot, days to heading (57-116), days to maturity (93-191), seed yield per plant (0.6-50.0 g) and 1000 grain weight (2.2-6.98 g). Promosing genotypes identified include :

High yielding types	:	IC 41819, IE-168, IC 41822, IC 18007 and IE-240.
High green fodder yielding types	:	IE-240, IE-16, IE-168 and EC 130989.
Bold seeded types	:	Kandaghat local, EC 130889 and EC 13007
Early maturing types	:	IE-8 (93 days) and IE-11 (95 days)
High tillering types	:	IE-512, IE-510 and EC 131041
Long panicle types	:	E-KEP-540, EC 131056 E-KEP-545.

Accession IE-168 and IE-240 were observed good both for grain and fodder. They can be used as direct introductions.

(c) *Proso millet and Little millet*

In India, *Panicums* are grown in Andra Pradesh, Maharashtra, Karnataka, Tamil Nadu and to a small extent in Bihar, Madhya Pradesh, Uttar Pradesh and Punjab. Four hundred and four accessions in proso millet (*Panicum miliaceum*) and 197 collections in little millet (*P. sumatrense*) were studied for 34 agro-botanical and economic characters at Shimla location and variability was observed in plant height (38.4-172.6 cm), internode length (4.1-16.7 cm), number of internodes (4-15), culm length (4.8-13.6 cm), tillering capacity (2-12), leaf length (21.5-61.4 cm), leaf width ((1.0-2.3 cm), panicle length (15.7-46.2 cm), green fodder yield (0.2-1.2 kg) per 1.0 m × 0.5 m plot, days to heading (47-67), days to maturity (78-92), seed yield per plant (2-40 g) and 1000 grain weight (3.0-8.44 g). Promising strains identified include :

High grain yielding types	:	HCC-20, HCC-112, EC 25096, EC 24114 & EC 24113
High fodder yielding types	:	IC 41854, HCC-20, HCC-12 EC 24124, EC 24114, Runa local & Shai local
Long panicle types	:	Shai local, EC 24114
Early maturing types	:	Jaried local (78 days) and IC 13358 (80 days)

(d) *Barnyard millet*

Three hundred and eighty six collections were evaluated for 37 characters in barnyard millet (*Echinochloa* sp) at Shimla location. Much variability was observed in plant height (76.7-153.1 cm), internode length (9.6-18.2 cm), number of internodes (4-12), tillering capacity (2-17), leaf length (14.1-48.1 cm), leaf width (1.1-1.8 cm), spike length (9.4-18.3 cm), green fodder yield (0.2-3.2 kg) per 1.0 m × 0.5 m plot, days to heading (55-83), days to maturity (127-160), grain yield per plant (3-12 g) and 1000 grain weight (2.4-4.86 g). Promising donors identified include :

High grain yielding types	:	IC 28431, IC 23428 and IC 41785
High fodder yielding types	:	IC 41785
Early maturing types	:	IC 28431 and Local Enzalu

(e) *Kodo millet*

Two hundred and forty eight collections in Kodo millet (*Paspalum scrobiculatum*) assembled from drier tracts of Madhya Pradesh and Andhra Pradesh were evaluated for 26 characters at two locations (Akola and Shimla). The collections varied in plant height (44.4-82.0 cm), days to heading (101-126), number of internodes (2-5), tillering capacity (2-7), number of spikelets per spike (2-3), spike length (4.5-7.4 cm), number of rows per spikelet (2-4), days to maturity (154-168 days), grain yield per plant (3-9.2 g) and 1000 grain weight (2.40-6.38 g). Promising donor genotypes identified are :

High grain yielding type	:	IC 76268, IC 76264 and IC 76267
Bold seeded types	:	IC 41865, IC 76262 and IC 76214
Early maturing types	:	IC 76169, IC 76213 and IC 41856.

A catalogue on Kodo millet has been published (Umesh Chandra *et al.*, 1987b).

Other two important millets grown in emergency/stress situation are *Digitaria cruciata* and *Coix lacryma jobi*. *Digitaria cruciata* var. *esculenta* is grown by the *khasi* tribals in Shillong plateau. It is cold tolerant grass for food and fodder (Singh and Arora, 1972). The soft shelled form of *Coix lacryma jobi*, easy hulling types with bigger kernel and heavy fruiting occur in North-Eastern region. In Garo hills (Meghalaya), variability has been reported (Arora, 1977).

Multilocation evaluation and documentation is very important for future utilization of minor millet germplasm (Thomas *et. al.* 1986). Much work in this direction is currently being carried out by the ICAR coordinated project on minor millets. Strengthening of genetic resources from untapped areas and documentation of existing evaluated material is pertinent. The NBPGR Gene Bank is currently storing about 2000 collections of diverse minor millets germplasm. Improvement in yield is the immediate need and easy access to diverse germplasm will be the first step in aiming at higher yield of lesser millet crop species.

REFERENCES

Arora, R. K. 1977. Job's tear (*Coix lacryma jobi*)—a minor food-*cum*-fodder crop of North-Eastern India. *Econ. Bot.*, 31(3) : 358-366.

Singh, H. B. and R. K. Arora. 1972. Raishan, *Digitaria* sp. minor millet of the khasi hills. India. *Econ. Bot.*, 26(4) : 376-380.

Thomas, T. A., B. D. Joshi, Umesh Chandra, D. P. Patel and N. K. Gautam. 1986. Evaluation and utilization of genetic resources of grain legumes, minor millets and other crops for the hills. Proc. Silver Jubilee Seminar on Role of Plant Genetic Resources in the Development of Hill Agriculture. NBPGR Regional Station, Shimla/ICAR, 29-30 September 1986; 199-216.

Umesh Chandra, T. A. Thomas, R. L. Sapra and R. S. Paroda. 1987a. Evaluation studies in Foxtail millet (*Setaria italica* (L) Beauv.) Germplasm. NBPGR publication, New Delhi : 84 p.

Umesh Chandra, T. A. Thomas, Ranjana Nagpal and R. S. Paroda. 1987b. Evaluation studies in Kodo millet (*Paspalum scrobiculatum* L) Germplasm. NBPGR Publication, New Delhi: 66 p.

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Studies Relating to Relationship of Weight-Volume of Various Agricultural Crops

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Information is evaluated on relationship between weight-volume and number of seeds per kg and per litre and volume per kg of seeds. The results from this investigation would be useful in standardizing the size of container for storing seeds. The information would be useful, particularly for long-term and medium-term storage where standard size of storage space is available. Employing the knowledge of weight and volume, number of seeds in any volume of container of specific crop can be known which will help in planning, distribution, germination test and regeneration strategy of genetic stock. Number of seed samples of priority crops consisting of small, medium and bold size were evaluated. Weight-volume relationship was studied for barley, maize, paddy and wheat among cereals; Italian millet, Japanese millet, finger millet, kodo millet, little millet and proso millet among minor millets; Brassica, *sesame, groundnut, safflower and sunflower among oilseeds; blackgram, greengram, cowpea, mothbean, peas, ricebean, adzuki bean, Frenchbean and clusterbean among leguminous crops and buckwheat and sunnhemp among others. A strong positive correlation had been observed for all the crops except finger millet and Italian millet indicating that any increase in weight of seeds is accompanied by corresponding increase in volume of seeds and vice-versa. In case of finger millet, the correlation co-efficient of weight and volume was not significant, whereas in case of Italian millet the correlation co-efficient was significant at 5% level.*

A wide range of variability exists with regard to weight and volume of seeds in agri-horticultural crops. Limited information is available on relationship between weight, volume and number of seeds per unit volume. Such information is essential for working out the size of container for long term and medium term storage and for efficient use of storage space. This information would provide an approximate guide to the storage space required for germplasm of important agri-horticultural crops to be conserved at the National Gene Bank at NBPGR, New Delhi.

MATERIALS AND METHODS

Seed samples of crops with small, medium and bold size were evaluated. The crops taken up for study were barley, maize, paddy and wheat among cereals;

Italian millet, Japanese millet, finger millet, kodo millet, little millet and proso millet among minor millets; *Brassicae*, sesame, groundnut, safflower and sunflower among oilseeds; blackgram, greengram, cowpea, mothbean, peas, ricebean, adzuki bean, Frenchbean and clusterbean among leguminous crops and among others sunnhemp and buckwheat. The seeds were randomly selected from seed lots for weight and volume determination. Weight and volume were recorded for 1000 seeds in *Brassicae* and sesame, 500 seeds in Japanese millet, Italian millet, proso millet and little millet and 100 seeds in all other crops except groundnut in which 50 seeds were taken. These seeds were weighed with the help of a semi-micro electronic pan balance. From weight and volume of seeds, number of seeds per kg and per litre and volume per kg seeds were calculated using following formulae :

$$\text{No. of seeds per kg} = \frac{100{,}000}{g} \times CF$$

$$\text{No. of seeds per litre} = \frac{100{,}000}{v} \times CF$$

$$\text{Volume per kg seeds} = \frac{v}{g} \times 1000$$

where

$$CF = \frac{N}{100},$$

g = weight of 100 seeds (grams),

v = Volume of 100 seeds (cm^3), and

N = Number of seeds per sample.

RESULTS AND DISCUSSION

Weight-volume relationship

A strong positive correlation was observed between the weight and volume in all the crops except finger millet and Italian millet indicating that any increase in weight of seeds was accompanied by corresponding increase in volume and *vice-versa*.

Among leguminous crops there was a large variation of the order of 40 per cent in case of Frenchbean.

Volume of seeds

In maize, variation both in seed size and seed weight was considerable. The largest seed was more than four times the size of the smallest seed.

Among millets, proso millet had a high coefficient of variation of the order of 41 per cent.

TABLE 1. NUMBER OF SEEDS PER KG AND PER LITRE AND VOLUME PER KG SEEDS OF IMPORTANT CROPS

Name of Crop		Approximate number of seeds		Approximate volume
		per kg.	per litre	per kg. seeds (cm^3)
1	2	3	4	5
Barley	Mean	25960	15370	1710.00
(*Hordeum vulgare*)	Range	15674-40989	9615-25000	1149.00-2857.00
	CV (%)	19.95	21.47	14.85
Maize	Mean	3880	2945	1442.00
(*Zea mays*)	Range	2298-9615	1612-6667	1310.00-1674.00
	CV (%)	43.40	46.93	5.55
Paddy	Mean	51220	23730	2146.00
(*Oryza sativa*)	Range	32258-100000	16667-41667	1391.00-2867.00
	CV (%)	23.39	21.62	11.95
Wheat	Mean	35960	24240	1467.00
(*Triticum aestivum*)	Range	20534-81300	14285-43454	1168.00-1938.00
	CV (%)	33.79	23.22	9.61
Italian millet	Mean	323814	209265	1564.13
(*Setaria italica*)	Range	250000-500000	156200-294117	1111.11-2300.00
	CV (%)	17.22	15.60	16.28
Japanese millet	Mean	374041	227235	1651.82
(*Echinochloa*	Range	246305-510204	142857-294117	1475.41-1925.93
frumantacea)	CV (%)	14.81	15.71	6.00
Finger millet	Mean	286871	151062	1916.24
(*Eleusine coracana*)	Range	125000-434783	111111-263457	955.17-2344.83
	CV (%)	21.79	16.14	19.46
Kodo millet	Mean	228734	116592	1964.21
(*Paspalum*	Range	140845-312500	74074-142857	1777.78-2400.00
scrobiculatum)	CV (%)	11.38	11.12	4.91
Little millet	Mean	385729	308903	801.13
(*Panicum sumatrense*)	Range	250000-555555	200000-500000	695.65-1085.71
	CV (%)	15.81	18.70	10.40
Proso millet	Mean	270129	202681	1432.92
(*Panicum miliaceum*)	Range	135135-568182	94339-357142	505.42-4431.82
	CV (%)	51.76	48.96	41.41
Oleiferous	Mean	335233	191881	1752.15
Brassicae	Range	217391-526315	125000-285714	1351.35-2142.86
	CV (%)	16.85	15.53	9.72
Groundnut	Mean	3232	1909	1694.09
(*Arachis hypogaea*)	Range	2000-5882	1250-2941	1437.50-2545.45
	CV (%)	16.34	14.46	7.68
Safflower	Mean	24721	11989	2073.32
(*Carthamus tinctorius*)	Range	13888-34246	6666-16665	1574.10-4629.60
	CV (%)	17.46	15.29	16.84

TABLE 1. (*Continued*)

(1)		(2)	(3)	(4)
Sunflower	Mean	15786	5610	2859.21
(*Helianthus annuus*)	Range	9242–31250	2777–11111	2343.75–4189.19
	CV (%)	26.59	29.82	11.85
Sesame	Mean	341030	205240	1675.15
(*Sesamum indicum*)	Range	147059–584795	153846–370370	735.29–2115.38
	CV (%)	21.62	22.24	12.63
Blackgram	Mean	31701	20444	1554.52
(*Vigna mungo*)	Range	18181–41666	14285-27777	1000.00–2205.32
	CV (%)	15.13	13.86	10.37
Greengram	Mean	34960	23538	1494.80
(*Vigna radiata*)	Range	16474–54347	100000–33333	1145.80–2039.80
	CV (%)	21.94	22.84	9.45
Cowpea	Mean	11500	8376	1380.74
(*Vigna sinensis*)	Range	6105–26666	4545–20000	1096.29–1584.91
	CV (%)	32.45	32.72	6.44
Mothbean	Mean	39767	31317	1273.67
(*Vigna aconitifolia*)	Range	30303–55555	23809–50000	1052.60–1388.90
	CV (%)	11.50	13.79	3.83
Peas	Mean	8414	5642	1491.73
(*Pisum sativum*)	Range	4347–20000	2857–12500	941:18–2209.30
	CV (%)	29.82	25.94	13.75
Rice bean	Mean	16205	12336	1324.20
(*Vigna umbellata*)	Range	8554–24630	6060–25881	744.00–1576.58
	CV (%)	22.62	25.34	7.71
Adzukiban	Mean	8535	6300	1355.03
(*Vigna angularis*)	Range	4842–15748	3546–10989	848.03–1495.73
	CV (%)	32.58	30.58	8.04
French bean	Mean	4388	3342	1344.91
(*Phaseolus vulgaris*)	Range	1759–8984	1190–8333	324.97–2296.21
	CV (%)	37.78	42.20	10.72
Clusterbean	Mean	29092	23096	1275.88
(*Cyamopsis tetragonoloba*)	Range	24875–38462	19230–33333	967.74–1615.30
	CV (%)	7.44	15.18	9.71
Sunnhemp	Mean	24578	17897	1377.44
(*Crotalaria juncea*)	Range	17331–32573	13333–22222	1116.63–1837.27
	CV (%)	11.39	10.65	9.49
Buckwheat	Mean	50037	28957	1742.58
(*Fagopyrum esculentum*)	Range	35971–70125	18519–500000	1292.13–2180.09
	CV (%)	16.74	19.54	8.54

Except for blackgram, mothbean and clusterbean, the variation in volume of seeds was high. The largest seed was three to four times the size of the smallest seed. In Frenchbean, the largest seed was seven times the size of the smallest seed. In case of Frenchbean, the volume of 100 seeds varied from 12 to 84 cm^3 with a coefficient of variation of 41 per cent and the mean volume 35.47 cm^3.

Number of seeds per kg and per litre

High variation of the order of 30-40 per cent was observed both in the number of seeds per kg as well as number of seeds per litre in case of cowpea, pea, Frenchbean and adzuki bean. It was also observed that there was comparatively larger variation, both in number of seeds per kg and per litre for bold seeded as compared to the small seeded ones.

Volume per kg seeds

There was little variation between the lowest and the highest values in the oilseed and leguminous crops as well as in sunnhemp and buckwheat.

The percentage of samples falling in low, medium and high ranges were worked out for each of the crops for all the characters. These ranges varied from crop to crop. This could be used to determine the number of seed samples which were likely to fall within a particular range and to have an idea of an approximate/average seed size of a specific crop.

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Effect of Storage Temperatures on Longevity of Onion Seeds

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Onion cv. Nasik Red seeds were stored at different temperatures, viz, −18°C, 5°C and room temperature. Seeds were viable for 12 months under ambient conditions, whereas seed longevity was extended to 48 months at 5°C or −18°C without affecting the seedling vigour.

Conservation of gemplasm variability has assumed considerable significance in the recent years. Various conservation strategies have been practised to avoid frequent regeneration of germplasm in the field as well as to cheek the genetic erosion. Gene bank for the conservation of seed crops has shown that germplasm can be stored for considerably long span of time. However, it is yet to be fully established as to what kind of containers would be most appropriate. The present studies relate to the effects of storage containers and temperatures on onion seed longevity.

MATERIALS AND METHODS

The experiment was conducted with the seeds of onion cv. Nasik Red. The seeds were extracted from fully matured umbels, dried to 6.5 per cent moisture content in shade, and stored in different packaging material, viz, glass bottle, polyethylene bags laminates, butter paper and kraft paper bags at ambient conditions (16-35°C, RH 25-90%), low temperature (5°C, RH 40%) and sub-zero temperature (−18°C, RH 85%). Seed viability and vigour were tested at regular intervals. Seed viability was assessed by the germination of seeds in seed germinator by paper top method at 25°C and seedling vigour was evaluated as per the ISTA standard (Anon., 1985). Shoot length was recorded on seven days old seedling to compare the seedling vigour. The moisture content of seeds was estimated by oven method at 105°C for 24 hours.

RESULTS AND DISCUSSION

Seed longevity differed significantly with the packaging material and storage temperatures. The high germination (90%) of seed was maintained for only six months in all the storage containers under ambient conditions. Further, seed viability declined to 30 per cent at twelve months of ambient storage, however; high seed germination was recorded in seeds stored in laminates and glass containers. It appears that seed moisture equilibrium attains faster in paper bags.

At low temperature (5°C) storage, percentage germination of seed was 89 in glass, 73 in polyethylene, 74 in laminate, 29 in kraft paper and 12 in butter papar bags after fifth year of storage.

Seed viability of 95 per cent was maintained for three years in glass bottle, polyethylene bags and laminate and the reduction was more in seeds stored in polyethylene bags than seeds stored in laminates or glass containers at fourth year of storage; whereas initial viability was maintained for two years in paper containers. It appears that none of the containers were completely moisture proof. However, high germination capacity of 89 per cent in glass bottle and 73 per cent in polyethylene bags or laminate was preserved for five years with low temperature (5°C) storage. The initial germinability of seed was maintained for four years at −18°C and subsequently, there was slight reduction during fifth year of storage which is still at par with low temperature (5°C) storage of seeds. At freezing temperature storage, seeds stored in laminates gave 90 per cent of germination followed by those stored in polyethylene bags (82%). There was significant reduction of viability to 10 per cent in seeds stored in paper bags at −18°C. For long-term storage, dried seeds are to be packed in laminates and stored at −18°C. Further, the laminate foils are relatively moisture proof, reusable and inexpensive. The loss of seed viability in paper container was due to increase in seed moisture content (Table 1).

TABLE 1. MOISTURE CONTENT OF ONION SEEDS STORED IN DIFFERENT CONTAINERS AT DIFFERENT TEMPERATURES AT 60TH MONTH OF STORAGE

Storage containers	Storage conditions		
	5°C	−18°C	Ambient
Glass bottle	6.7	7.7	6.5
Polyethylene bags	7.1	8.5	6.3
Laminate	6.8	7.5	6.0
Butter paper	8.2	15.1	5.7
Kraft paper	8.0	14.0	5.7

The seedling growth was significantly affected in seeds stored at ambient conditions. The shoot length was high during sixth month of storage and subsequently it declined, which also coincides with rapid decline in seed viability. Shoot length was maintained by storing the seeds at 5°C or −18°C.

Onion seeds are short-lived for only six months under room temperature while seed viability improves with cold storage. Fonseca *et al.* (1980) reported that seeds in ambient temperature began to deteriorate faster and exhibit lower germination and low seedling vigour. The decline of seed viability was slower at cooler temperature (Harrington, 1972), but at low temperature, seeds require moisture proof container especially when the relative humidity is high for preserving seed viability. Among many physiological manifestation of seed deterioration, reduced germinability has been widely accepted as major criterion (Abdul-Baki and Anderson, 1972) which could be minimised predominantly by conserving the seeds at low temperature and low moisture or relative humidity. The period of storage of seeds depends on the individual requirement and purpose for which seeds are stored. Accordingly, one can select economically viable temperature and container for storage. In this study, seed viability of 75 per cent was successfully preserved for five years at 5°C. Both polyethylene bags and low temperature are easily available and economically possible. According to Villareal *et al.* (1972), polyethylene bags are as good as laminated foil in dry conditions and the germination of seeds from paper bags was the poorest when stored at high relative humidity. High humidity or moisture of seed was more harmful when stored in small encloser than ambient storage (James, 1967). The laminates are relatively impermeable to moisture and thus retained high viability of seeds.

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REFERENCES

Abdul-Baki, A. A. and J. D. Anderson 1972. Physiological and biochemical deterioration of seeds. *In* Seed Biology, Vol. II, p 283-309. Academic Press, New York.

Anonymous 1985. International rules for seed testing. Seed Sci. Technol. 13 (2): 322-326.

Fonseca, J. R., A. De. Freire, B., M. S. Freire and F. J. P. Zimmerman. 1980. Conservation of bean seeds under three methods of storage. Revista Brasileira de Sementes. 2 (1): 19-27.

Harrington. J. F. 1972. Seed storage and longevity. *In* Seed Biology (Ed. T. T. Kozlowski), Vol. III, p 145-245. Academic Press, New York.

James, E. 1967. Preservation of seed stocks. Adv. Agron. 19 : 87-105.

Villareal, R. L., J. B. Balagedan and A. D. Castro. 1972. The effect of packing materials and storage conditions on the vigour and viability of squash (*Cucurbita maxima*), patola (*Luffa acutangula*) and upo (*Lagenaria siceraia*) seeds. Philippine Agriculturist. 56 : 59-76.

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Role of Plant Quarantine in Checking Dispersal of Nematodes with True Seed

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Unknowingly man has helped, to a great extent, in the worldwide geographical distribution of several economically important plant parasitic nematodes through the exchange of nematode infested/contaminated plant material. With the growing awareness of the role of nematodes as a limiting factor in agricultural production, testing of seed material for nematode infestation is now being undertaken by many seed health testing and quarantine laboratories. Nematodes could be transported with the true seeds, either as internally seed-borne or as a contaminant with seed in the form of nematode galls, infested plant debris, soil clods, soil entangled between corrugated seed surface etc. Important nematode interceptions made while quarantine processing of true seed material during 1976-1986 period included Aphelenchoids besseyi, Rhadinaphelenchus cocophilus, Ditylenchus dipsaci, D. angustus, Anguina tritiei, Heterodera schachtii, H. humuli. *Some of the nematode species intercepted are still not recorded from India and are known to cause extensive damage to crops in country of origin.*

Exchange of plant genetic resoures among different countries of the world is essential part of agricultural research for upgrading crops for yield, quality and developing resistant varieties against insects, nematodes, diseases and various stress conditions. However, indiscriminate exchange of plants/plant materials may result in introduction of new pests and diseases which may endanger our agri-horticultural and foresrty crops. Dissemination of plant parasitic nematodes through the movement of vegetatively propagated plant material and infested seed or its contaminants have been reported by several workers from time to time (Thorne, 1961; Southey and Aitkenhead, 1972; Bingefors, 1973; Sanwal and Mathur, 1975; Mathur *et al.*, 1981).

During the past 20 years, several nematode species have been reported as internally seed-borne or forming seed galls (Fortuner and Williams, 1975; Bos, 1977; Cuc, 1982; Green and Sime, 1979; Corbett, 1976). These reports further strengthen the necessity of careful examination of all kinds of imported seed material for nematode infestation. In this paper, nematodes intercepted from imported seed material meant for research purpose are reported. Detection techniques, salvaging methods and suggestions for preventing/minimising risks of introductions of exotic nematode species have also been highlighted.

MATERIALS AND METHODS

Nematode detection techniques

Well over 350 thousand samples of plant/plant material were introduced (1976-86) into India through National Bureau of Plant Genetic Resources, New Delhi and were examined for nematode infestation. Approximately 90 per cent of imported germplasm comprised true or botanical seed. Each sample was carefully examined for nematode infestation using the detection procedures of (i) direct visual examination of true seeds for the presence of soil clods, plant debris, seed galls and abnormalities (deformed/discoloured seeds); (ii) mechanical separation of abnormal seeds/soil clods/other contaminants and soaking them separately in water for 24-48 h at 25-30°C; (iii) extraction of nematodes by Cobb's decanting and sieving technique in combination with Baermann's funnel method and (iv) teasing water soaked seeds using forceps and needle under a dissecting microscope. Further recovery of nematodes from infested/infected seeds was made using Baermann's funnel technique. Nematode suspension was concentrated using a 400 mesh sieve. Nematodes were killed by gentle heat, fixed in formalin and processed to dehydrated glycerine for making permanent mounts. Specific identification was not possible in many cases due to lack of sufficient number of intact/adult specimens.

RESULTS AND DISCUSSION

Nematode interceptions

Species belonging to thirteen genera of plant parasitic nematodes were intercepted from imported seed and its contaminants. Important nematode species intercepted were *Aphelenchoides besseyi* from seeds of *Oryza sativa* and *Digitaria smutsii*; *Rhadinaphelenchus cocophilus** from husk of *Cocos nucifera* nuts; *Ditylenchus dipsaci** from seeds of *Medicago sativa*, *Trifolium* spp. and *Stylosanthes* spp., *Aphelenchoides arachidis** from *Arachis hypogaea*, *Heterodera schachtii* from soil clods mixed with seeds of *Beta vulgaris* (species marked with asterik are still not known from India). The details of various nematode interceptions are given in Table 1.

Maximum number or nematode species including viable cysts of some of the cyst forming nematode species have come along with true seeds as contaminant (Table 1), thus highlighting the point that any plant parasitic nematode species can get transported across the continents by this mode of dispersal irrespective of the fact whether the seeds are from a host or non-host crop. It may be mentioned here that on most occasions, soil clods weighing only 200 to 500 mg were found to carry the nematodes in a viable condition. This observation coupled with the fact that sufficient information on seed-borne nematodes is still lacking, strongly suggests the need to subject all the incoming seed material to quarantine examination.

Besides the plant parasitic nematodes, species of several free living and saprophagus genera, viz, *Rhabditis*, *Panagrolaimus*, *Diplogaster*, *Plectus*, *Dorylaimus*, and *Cephalobus* were also intercepted.

TABLE 1. NEMATODES INTERCEPTED FROM IMPORTED SEED MATERIAL DURING 1976-1986

Nematodes intercepted	Seed material	Country of origin
	A. From Seed	
Aphelenchoides besseyi	*Oryza sativa*	Philippines, UK, USA
	Digitaria sp.	Australia
Aphelenchoides spp.	*Cocos nucifera*	Ivory Coast, Guyana
	Artemisia annua	USA
	Guiciclina gosipes	Costa Rica
	Arachis hypogaea	Sri Lanka
	Pentstemon sp.	USA
	Stylosanthes sp.	Australia
	Terminalia chebula	USA
	Macadamia spp.	Australia
Aphelenchoides arachidis	*Arachis hypogaea*	Philippines, Thailand
Bursaphelenchus sp.	Red palm oil nuts	Indonesia
Ditylenchus dipsaci	*Stylosanthes* sp.,	Australia
	Medicago sativa	
	Trifolium sp.	
	B. Seed galls as contaminants of seed	
Anguina tritici	*Triticum aestivum*	Turkey, Italy, UK
Anguina sp.	*Stylosanthes* sp.	Australia
	C. From soil clods mixed with seed	
Aphelenchoides subtenuis	*Lablab purpureus*	Australia
Aphelenchus avenae	*Helianthus annuus*	Egypt
	Eucalyptus sp.	Australia
	Arachis hypogaea	Sri Lanka
	Triticum aestivum	Italy
	Medicago sativa	USA
Aphelenchus spp.	*Trifolium* spp.	Australia
Criconema sp.	*Arachis hypogaea*	Thailand
Criconemella lobata	*Hordeum vulgare*	Syria
	Arachis hypogaea	Thailand
Ditylenchus sp.	*Helianthus annuus*	Egypt
Filenchus filiformis	*Sesamum* spp.	Egypt
Helicotylenchus dihystera	*Triticum aestivum*	Mexico
	Eragrostis spp.	Ethiopia
	Arachis hypogaea	Bulgaria
Helicotylenchus spp.	*Sesamum* sp.	Egypt
	Arachis hypogaea	Sri Lanka
	Mrdicago sativa	USSR
	Medicinal plants	Hungary
	Brassica spp.	Thailand
Hemicriconemoides spp.	*Digitaria* spp.	Australia
Heterodera schachtii (Cysts)	*Beta vulgaris*	UK, Italy, West Germany
Heterodera spp. (Cysts)	*Pinus oocarpa*	Brazil
	Triticum aestivum	Turkey

Contd.

TABLE 1. (*Continued*)

Nematodes intercepted	Seed material	Country of origin
Hoplolaimus galeatus	*Medicinal plants*	USA
Hoplolaimus spp.	*Arachis hypogaea*	Thailand, Sri Lanka
	Eucalyptus spp.	Australia
	Lycopersicon spp.	Hungary
	Beta vulgaris	UK
Paratylenchus projectus	*Triticum aestivum*	Italy
Paratylenchus sp.	*T. aestivum*	UK
Pratylenchus neglectus	*T. aestivum*	Mexico
Pratylenchus sp.	*Arachis hypogaea*	Sri Lanka
Rotylenchulus sp.	*Eragrostis* spp.	Ethiopia
	Sesamum spp.	Egypt
Tylenchorhynchus claytoni	*Triticum aestivum*	Mexico, Italy, Turkey
Tylenchorhynchus spp.	*Eucalyptus* sp.	Australia
	Oryza sativa	USA
	Brassica spp.	Thiland
Tylenchus spp.	*Triticum aestivum*	Italy, Turkey
	Hordeum vulgare	Syria
	D. Plant debris/paking material	
Aphelenchoides myceliophagus	*Acrocomia sclerocarpa*	Brazil
	Euterpe oleracea	
Aphelenchoides spp.	*Citrus bergamia*	Italy
Ditylenchus anqustus	*Oryza sativa*	Philippines
Helicotylenchus spp.	*Carambola* spp.	USA
	Myrciaria sp.	

Salvaging of infested/contaminated seed samples

Wherever possible, standardised denematisation procedures such as hot water treatment, nematicidal dip, mechanical cleaning and thorough washing with water (to remove soil sticking to seeds with rough surface) were used. Before release of the seed samples, effectiveness of the denematisation method used to achieve 100 per cent kill was checked. Packing material was always replaced by fresh material.

SOME SUGGESTIONS FOR INDENTORS AND SUPPLIERS

Success of plant quarantine in any country largely depends upon crop growers' awareness and their cooperation with quarantine officials in effective implementation of quarantine rules and regulations. 'Prevention is better than cure' holds true with regard to quarantine measures against exotic nematode pests. Therefore, some suggestions are given hereunder which would greatly help in preventing introduction of exotic nematode pests.

— Quantity of seed material being imported is positively correlated with the degree of nematode risk. Therefore, only minimum possible seed quantity required should be indented. This would not only minimise nematode risk but would also reduce time for inspection, denematisation, if required, and release.

— Custom/Quarantine inspectors must chek passengers' baggage for seed/plant material and send it for plant quarantine inspection.

— Direct planting of any crop in open fields without quarantine clearance must be avoided.

— Request for import of seed material must be sent well in advance to allow sufficient time for quarantine examination and clearance.

— It is important that exporting country sends all seed material free from insects, nematodes, pathogens, weeds and all kinds of contaminants, and also information along with seed material on important pests/pathogens of the concerned crop in the country. This would help the quarantine officials of importing country to take special care against such hazards.

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REFERENCES

Bingefors, S. 1973. International dispersal of nematodes. Netherland J. Plant Path. 73: 44-60.

Bos, W. S. 1977. *Aphelenchoides arachidis* n. sp. (Nematoda: Aphelenchoidea), an endoparasite of the testa of groundnuts in Nigeria. Zeit. fur Pflanzenki Pflanzensch., 84: 95-99.

Corbett, D. C. M. 1976. *Pratylenchus brachyurus*. C. I. H. Descriptions of Plant Parasitic Nematodes, Set-6, No. 89, 4 pp.

Cuc, N. T. T. 1982. New weed hosts of rice stem nematode identified in Vietnam. Internat. Rice Res. Newsletter., 7 : 15.

Furtuner, R. and K. J. R. Williams. 1975. Review of the literature on *Aphelenchoides besseyi* Christie (1942), the nematode causing 'white tip' disease in rice. Helminth. Abstr., 44: 1-40.

Green, C. D. and S. Sime. 1979. The dispersal of *Ditylenchus dipsaci* with vegetable seeds. Annals Appl. Biol., 92 : 263-270.

Mathur, V. K., K. C. Sanwal, R. V. Singh and Arjun Lal. 1981. Role of soil clods and plant debris mixed with true seed in dissemination of plant parasitic nematodes. Indian J. Nematol., 11 : 92-94.

Sanwal, K. C. and V. K. Mathur. 1975. Soil as contaminant of wheat seed. Indian J. Nematol., 5 : 118-119.

Southey, J. F. and P. Aitkenhead. 1972. Soil-borne pests and pathogens associated with imported plants with special reference to nematodes. EPPO Bull., 7 : 49-59.

Thorne, G. 1961. Principles of Nematology. McGraw Hill Book Co. Inc., New York, XIV, 533 pp.

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Flue-Cured Tobacco Germplasm Evaluation

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During the past eight years, 99 exotic varieties of flue-cured tobacco germplasm obtained from 11 countries were evaluated for their yield and quality at CTRI Black Soil Farm, Katheru (Andhra Pradesh) in three separate sets consisting 53, 27 and 19 exotics during 1979-81, 1982-85, 1983-86, respectively. In all the sets, differences due to varieties were significant. The interaction, varieties × seasons, was significant for green, bright and TBLE yields in the first set, cured and bright leaf yields in second set, and cured and TBLE yields in the third set. The varieties MRS-2, Rila-9, F-207 and McNair-14 in the first set, Coker 316, Coker 86, NC 98 in the second set and V-156, B. Grain Reditto in the third set were found promising. The data on morphological, chemical and physical characteristics for all the varieties are also presented.

The Central Tobacco Research Institute, Rajahmundry has assembled well over 1,600 germplasm collection in several *Nicotiana* species, including 400 flue-cured Virginia types. The germplasm collections were screened and evaluated systematically for their yield, chemical and physical characteristics as well as for resistance to prevelent diseases and pests. During the period 1984-1987, 99 varieties of flue-cured tobacco introduced through NBPGR from Australia, Bulgaria, Canada, Cuba, Germany, Japan, New Zealand, Poland, Rhodesia, USA and Yemen Arab Republics, were field evaluated in three separate experiments and the results of this study are briefly discussed.

MATERIALS AND METHODS

In the first experimental trial, fifty three exotic genotypes were evaluated with three standard checks, Jayasree and CTRI strain and one advanced breeding line 2178, during the crop season of 1979-81. These 56 genotypes were grown in a rectangular lattice design with three replications. In the second set, twenty seven exotic genotypes were evaluated against three standard varieties, Jayasree, CTRI Special and Godavari Special during 1982-85 in a randomized block design with three replications. In the third set, nineteen exotic genotypes were evaluated against five standard varieties, Jayasree, CTRI Special, Godavari Special, Jayasree MR and CTRI Special MR during 1983-85 in a randomized block design with three replications.

In all the sets, each plot consisted of 28 plants distributed in four rows of seven plants under spacing of 80 cm × 50 cm, respectively. The experimental area received uniform fertilizer of 25 kg N, 50 kg P_2O_5, 50 kg K per/ha and the crop was unirrigated and untopped. The leaf from each plot was harvested as and when mature and then flue-cured and graded. A composite sample from each plot was taken for physical (EMC, Filling Value and Shatter Index) and chemical (Nicotine and Reducing Sugars) evaluation. For characters like plant height, size and number of leaves per plant (total and economic), five random plants spread over the entire plot were tagged, the height was recorded from ground level to the crow's foot.

RESULTS AND DISCUSSION

The results reported in this paper pertain to the black soil tobacco. The differences due to varieties were significant for all kinds of yields in the individual seasons and as well as in the combined analysis. The varieties, F 207, Relia-9, Mc Nair 944, Mc 1, MRS-2 and the advanced breeding line L-2178 gave higher yields of all kinds and were at par with the highest yielding standard variety Jayasree. In the second set, thirty varieties were evaluated during 1982-83 to 1984-85. The differences due to varieties were significant for all kinds of yield. The varieties, NC 98, Coker 86., Speight G 70 and the standard variety Jayasree gave more than 1,700 kg of cured leaf per hectare though their differences were not significant. However, in quality and leaf production, the variety Jayasree topped the list closely followed by Coker 316. In another set, 24 varieties were evaluated from 1982-83. Two years yield data showed that varieties V 156, Virgin Aurea and Riwaka 1 gave significantly higher yields of green and cured leaf than the standard variety Godavari Special. In bright leaf V 156 alone, gave significantly higher yield than Godavari Special. Variety Riwaka 1 gave significantly higher yield than the three standard varieties.

CONCLUSION

It is revealed from the data of the three experiments that the standard variety Jayasree was better in its quality leaf production (TBLE). Varieties 584/80, V 156 and NC 98 were high cured leaf yielders. The varieties Va 407, NC 12 and NC 744 recorded higher values of nicotine even under untopped and unirrigated conditions. The above varieties could be used as donor parents in the improvement of yield and quality of the flue-cured tobacco grown in the heavy black soils under rainfed conditions.

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REFERENCE

Sastri, A. B., R. V. S. Rao, M. Subramanyam and P. V. Prasada Rao. 1983. Distribution of dry matter in different genotypes of flue-cured tobacco (*Nicotiana tabacum* Linn.,) Tob. Res. 9(2) : 71–82.

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Development of Unique Genotypes in Different Field Crops

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Dharwad farm of University of Agricultural Sciences has developed some new genotypes in cotton, chilli and greengram. It has been claimed that these varieties are unique in their characters. The genotypes included 3 varieties in cotton (BAR-97-GB : giant boll variety immune to blackarm disease; JK 276-4 : multiple pest resistant variety, highly tolerant to boll-worm, aphids, jassids, thrips and white flies; BCS-9-95 : extra long staple, high yielding, high ginning variety of Gossypium barbadense; *one each in greengram (KCM-1 : non-shattering, long podded, erect and bold seeded type) and chilli (KDSC 100 to 500 series : virus and leaf spot disease resistant varieties). The paper deals with these new developed cultivars.*

Utilization of germplasm in the transfer of gene confirming resistance to pests and diseases as also better plant type in the development of high yielding cultivars with broad agronomic base has been the main objective in crop improvement programmes in recent years. In the absence of any genepool, the breeders would have the task of creating new and unique genotypes through well planned hybridization programmes or by resorting to mutation breeding for selecting new strains (mutant) not found earlier in cultivated species.

MATERIALS AND METHODS

Six divergent genotypes (JK 99, CPD801, Stoneville 213, DB 811, Dixie King, and MC 45) were used in a composite cross creating improved cultivar BAR JK 97 GB. The composite crossed F_1 progenies to JK 97 *inter-se* mating within families was made for high boll number and boll weight. Further, thirty six genotypes (*G. hirsutum*) were crossed with JK 97 and JK 44 separately and $72F_1S$ were composite crossed as also shown earlier by Jensen (1970). The multiple pest resistant varieties JK 276-4, JK 259-7 and JK 281-1 were evolved through this methodology. Besides, eighteen different genotypes were crossed with S.I. Andrew and composite crossing of F_1 was resorted for the development of BCS-95 and BCS23-18-7. In *mungbean* X-ray radiation (20 kr) was used in the development of non-shattering pod types, bold seeded variety KDM-1. In case of chilli (*C. annuum*) double crosses between Byacagi, Jwala, Sankeshwar and *C. frutescence* were made and promising selection identified.

RESULTS AND DISCUSSION

Commercial cotton crop suffers heavily from damage caused by insect, pests (jassids, boll worms, aphids, thrips, and white flies). Genepool providing resistance to several insect pests of cotton is not available either in the wild or cultivated species of *Gossypium*. Therefore, development of multiple pest resistance in *G. hirsutum* cotton was taken up and new strains JK 576-4, JK 259-7 and 7K 281-1-1 with high yield potential of seed cotton upto 20 q per ha were attained (Kadapa and Thimmaiah, 1983). Cotton cultivars of the *G. barbadense* group possess excellent fibre quality and Egyptian cotton varieties are world famous. These varieties are poor yielder and possess less than 30 per cent lint; variety Suvin released in India produces slightly higher yields but has a GOT less than 28 per cent, although fibre quality is excellent. The present paper highlights the attempt to develop varieties that are not only 50 to 100 per cent high yielding but possess GOT of above 33 per cent with best fibre quality. promising strains included BCS 9-95 and BCS 23-18-7 (Anon. 1986).

Composite crossing of a large number of genetically diverse F_1 hybrid was undertaken. The programme involving several hybrid being highly segregating resulted in unique genetic recombinants. The variability thus generated exhibited rich genetic diversity. Sharma (1979) in a composite cross population showed that genetic diversity created through his methodology was much larger than the existing 6000 cotton germplasm accessions. The procedure allows selection of rare and entirely new recombinants.

In the present investigations, all the new cotton genotypes were developed by composite crossing system. The unique genotype BAR-JK97-GB possessed a boll weight range of 10.2 to 12.8 per cent and also immunity to blackarm disease. In AICCIP trials conducted at Raichur (Karnataka), the variety produced, 48 q per ha seed cotton and 40 bolls per plant (Anon. 1986).

New stains JK 276-4, JK 259-7 and JK 281-1-1 were found to be highly tolerant to all the three boll worms; *Heliothis armigera*, *Erias febia* and *Pectinophora gossypiella* and to jassids (*Empoasea bigutella*), aphids (*Aphis gossypi*). The above strains produced upto 20 q/ha seed cotton without any plant protection measures. In the all India co-ordinated trials *G. barbadense* strains BCS9-95 and BCS23-18-7 produced 20-23 q/ha seed cotton against 10-14 q/ha in *Suvin* and also with superior fibre and spinning quality.

In *Mungbean* (*V. radiata L.*) which suffers heavily from pod shattering, the development of cultivars with non pod shattering habit and bold seededness is of high significance. The variety KDM-1 developed through X-ray radiation showed immense promise. The new bred cultivar produced 1142 kg per ha seeds in multiplication trials and exhibited high non pod shattering habit.

In similar attempt, new chilli (*Capsicum* sp.) varieties were bred. Most of the prevalent varieties suffer heavily from virus diseases, a double cross (Byadagi X *C. frutesence*) X (Jawala X Sankeshwar) was envolved. The populatlons were subjected to 'hot spot' screening for virus diseases.

In conclusion, it may be stated that using appropriate genotypes and adopting composite cross methodology in cotton, mutation breeding in *mungbean* and double hybrid in case of chilli, good results were obtained.

REFERENCES

Anonymous. 1986. Annual Report, AICCIP, 1986.

Jensen, N. F. 1970. Composite Breeding Methods and DSM system in cereals. *Crop Sci.* 18 : 622-626.

Kadapa, S. N. and G. Thimmaiah. 1983. Breeding for Bollworm Resistance in Cotton (*Gossypium hirsutum* L.). Proc. XV. International Congress of Genetics. Abstr. 986 of contributed papers Part-II Session CVB. pp. 553. New Delhi.

Sharma, K. N. 1979. Genetic Variability, Correlations and path anylysis of some characters in two composite crossed S_0 populations of *Gossypium hirsutum* L. M.Sc. Thesis submitted to the Univ. Agric. Sci. Bangalore.

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Studies on Pest-Risk Involved in Import of Medicinal Plants

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Germplasm of medicinal plants introduced through the Bureau comprises not only species of economic importance, but also of wild and related species. In order to know in advance as to which pests can come with the introduced material, crop-wise world literature was screened to compile the information on pests recorded, their nature of damage, life history, distribution, host range and susceptibility to the available disinfestation procedure and possible detection techniques. With this background information, an analysis was made to pinpoint the pest risk that can be present in the introduced material of Cassia, Chrysanthemum, Digitalis, Dioscorea, Glycyrrhiza, Hyoscyamus, Mentha, Olea, Papaver, Plantago, Rauvolfia, Vinca *and* Withania *and in the likely event, how best to detect their presence at the time of quarantine examination, and finally how to liquidate them effectively and lower the quarantine risk so that the much needed medicinal germplasm could be made available to the users in India.*

Some important exotic pests which can come with seeds of these crops as hidden infestation, include Bruchidius *spp.,* Caryedon *spp. and some other bruchids* (Cassia), Bruchidius glycyrrhizae, B. halodendri *and* Bruchophagus glycyrrhizae (Glycyrrhiza), Eurytoma oleae *ssp.* vericolor (Olea), Gymnetron pascuorum *and* G. plantaginis (Plantago), *necessitating X-ray radiography of seeds for detection of infestation as well as salvaging the germplasm. Other important exotic pests which can accompany the plant propagules include* Euscepes postfasciatus, Palaeopus costicollis (Dioscorea *tubers) and several species of aphids, capsids, jassids, mirids and thrips (plants and cuttings of* Chrysanthemum, Glycyrrhiza, Mentha, Olea, Rauvolfia, *and* Vinca) *requiring fumigation of material, detention and refumigation, if necessary.*

In the augmentation of plant genetic resources through introduction, quarantine has a significant role to play so as to exclude the dangerous pests. First logical requisite for effective and efficient quarantine is the knowledge of pests that are likely to sneak in with a particular material and necessary safeguards to prevent their entry (Mc Cubin, 1954). Generally, such information is lacking, especially in case of germplasm which comprises not only of species of economic importance, but also the related species as well as wild and weedy taxa. Therefore, efforts were made to collect and collate relevant data on the insect pests associated with some medicinal plants so as to ensure introduction of valuable germplasm free from exotic pests.

MATERIALS AND METHODS

The study embraced important medicinal plants, namely *Cassia, Chrysanthemum, Digitalis, Dioscorea, Glycyrrhiza, Hyoscyamus, Mentha, Olea, Papaver, Plantago, Rauvolfia, Vinca* and *Withania*. Crop-wise world literature was screened and information collected was systematised in such a manner that it could serve as a data bank from which relevant details required to meet potential quarantine situations could be drawn at the time of quarantine processing of material, as shown in the flow chart (Fig. 1). Information on the pests reported on these crops the world over; biology and habits of different pests and stages thereof (eggs, larvae/nymphs, pupae, adults) which are likely to get transported; the kind of germplasm (seeds, vegetative propagules, whole plants, root/stem cuttings, tubers, etc) and the nature of infestation (latent, visible); according to which a suitable detection and disinfestation procedure is employed, is summarised. Pests not reported from India specially require strict vigil and safeguards to prevent their entry.

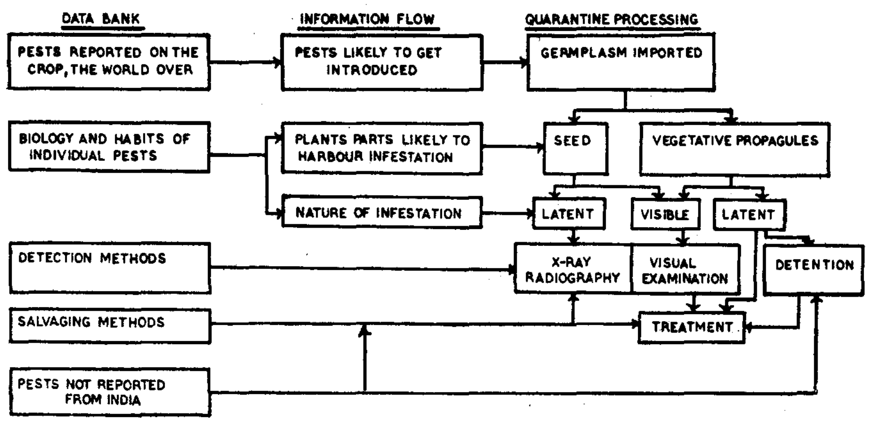

Fig. 1 Information on crop pests as an aid to plant quarantine.

RESULTS AND DISCUSSION

Pest Record

All the medicinal plants included in the study are propagated through seeds, but some of them such as *Chrysanthemum, Dioscorea, Glycyrrhiza, Mentha, Olea, Rauvolfia* and *Vinca* are also propagated vegetatively. Therefore, plant parts other than seed, may also figure in import of germplasm of these genera. Keeping this in view, pest species noted on each of these plant genera from all over the world (Review of applied Entomology, 1913-1985) were grouped according to their feeding habits, the plant parts infested by them and stages thereof. There are no pests reported to feed on seeds of *Digitalis, Dioscorea, Rauvolfia, Vinca* and *Withania*. Therefore, seeds of these crops can be introduced without any pest-risk. However, a routine quarantine inspection must be carried out. Seeds of *Hyoscyamus* are reported to be attacked by *Ptinus fur* and *P. tectus* and those of *Papaver* by *Lasioderma serricorne* and *Trogoderma granarium.* These are common storage pests and can be eliminated by fumigation of incoming seed (Anonymous, 1983).

Pests of major quarantine significance

These include pests which are not yet known from India (Anonymous, 1951-85) and which may accompany the imported germplasm (crop-wise details are given in Table 1). Detection and disinfestation requirements of these pests/pest families, depending upon their biology and habits (Davidson and Peairs, 1966; Kranze *et al.*, 1977; Hill, 1985; Metcalf and Flint, 1979) are discussed below.

TABLE 1. PESTS OF MAJOR QUARANTINE SIGNIFICANCE

Crop	Pest		Plant parts infested	Country reported from
	Name	Family		
Cassia	*Acanthoscelides ferrugineipennis*	Bruchidae	seed	Chile
	Bruchidius mackenziei	Bruchidae	seed	Australia
	Caryedon cassieae	Bruchidae	seed	Rhodesia
	Sennius spp.	Bruchidae	seed	USA
Chrysanthemum	*Bruchidius perparvulus*	Bruchidae	seed	France
	Otiorhynchus spp.	Curculiondiae	root & stem	USA
	Lygus pratensis	Miridae	leaves & shoots	Europe
	Thrips nigropilosus	Thripidae	leaves & shoots	USSR
Dioscorea	*Euscepes postfasciatus*	Curculiondiae	tubers	Oceania
	Palaeopus costicollis	Curculiondiae	tubers	Jamaica
Glycyrrhiza	*Bruchidius glycyrrhizae*	Bruchidae	seed	Iraq
	Bruchophagus glycyrrhizae	Eurytomidae	seed	Iraq
	Acinopterus angulatus	Cicadellidae	leaves & shoots	C. America
	Margarodes glycyrrhizae	Marga rodidae	roots	Iran
Mentha	*Bruchidius albosparsus*	Bruchidae	seed	Africa
	Otiorhynchus ovatus	Curculionidae	roots	USA
	Erythroneura parvula	Cicadellidae	leaves & shoots	UK
	Lygus lineolaris	Miridae	leaves & shoots	USA
Olea	*Eurytoma olea* spp. *vericolor*	Eurytomidae	seed	S. Africa
	Otiorhynchus cribricollis	Curculionidae	roots	Turkey
	Prays oleae	Yponomeutidae	Inflorescence & leaves	USSR
	Aspidiotus nerii	Diaspididae	leaves & shoots	Turkey
Plantago	*Gymnetron pascuorum*	Curculionidae	seed	Denmark
	G. plantaginis	Curculionidae	seed	Italy
Rauvolfia	*Pinnaspis pattersonii*	Coccidae	leaves & shoots	Ghana
	Helopeltis rauwolfiae	Miridae	leaves & shoots	Zaire
Vinca	*Geoica radicicola*	Aphididae	roots	USA
	Neoaliturus tenellus	Cicadellidae	leaves & shoot	USA
	Oncometopia nigricans	Cicadellidae	leaves & shoots	USA

Pests accompanying seeds

Species of families Bruchidae and Eurytomidae are reported to infest seeds of *Cassia*, *Chrysanthemum*, *Glycyrrhiza*, *Mentha* and *Olea*. These oviposit on, or in the seed/fruit. Hatching larvae bore inside the seeds, feed and pupate there. Infested seeds thus look apparently healthy till the adults emerge. Such latent infestation can be detected through X-ray radiography (Wadhi *et al.*, 1967; Wadhi and Verma, 1971). By holding the seed sample as exposed on X-ray plate and using its geometrical confirguation, the infested seeds can be handpicked (Wadhi, 1983). Infestation of Curculionidae in *Plantago* seeds can also be detected and got rid of by X-ray radiography (Anonymous, 1983).

Pests accompanying vegetative propagules

Euscepes postfasciatus and *Palaeopus costicollis* (Curculionidae)—All stages of these weevils are found inside the tubers of *Dioscorea*. Therefore, these cannot be detected through inspection and material must be compulsorily fumigated with methyl bromide @ 56 mg per litre for 4h at 21°C and at NAP (Roth and Richardrson, 1965).

Otiorhynchus spp. (Curculionidae)—larvae of the pest feed among roots and adults on the leaves of *Chrysanthemum*, *Mentha* and *Olea* requiring fumigation of infested material except that of *Chrysanthemum* which is sensitive to the treatment. All stages of these weevils can also come with soil adhering to the plants necessitating introduction of only soil free planting material.

Prays oleae (Yponomeutidae)—Larvae mine the leaves and also bore into inflorescence and fruits of *Olea*. Final instar feeds on the surface and pupate among leaves or bark. The pest can be eleminated by hand removal of pest/infested plant parts or through a suitable treatment.

Aphididae, *Coccidae*, *Diaspididae*, *Margarodidae*—All stages are exposed, nymphs and adults suck the sap from various plant parts of *Glycyrrhiza*, *Olea*, *Rauvolfia* and *Vinca*. These can be detected by careful examination of material with magnifying aids. Susceptibility of eggs to various treatments in most cases is doubtful (Pradhan and Wadhi, 1962). Therefore, it is necessary to detain the material in quarantine after treatment, for completion of the incubation period (about a week). In case the eggs hatch, a second treatment is to be given for complete disinfestation.

Cicadellidae, *Miridae*, *Thripidae*—Pests belonging to these families are similar in habit to those mentioned earlier and so are the detection and disinfestation requirements except that these insects insert their eggs in plant tissue, rendering them undetectable during visual inspection. It is, therefore, necessary to detain the incoming material in quarantine for completion of the incubation period (one to two weeks) so as to allow the eggs, if present, to hatch and infestation to be detected. In the event of visible infestation by adults of these pests, material is required to be treated immediately and then, if necessary, after the detention period, as per schedules available (Anonymous, 1970). However, in view of low plant tolerance to fumigation, it is safer to use disinfestation procedures like mechanical removal of infestation and a recommended insecticidal dip treatment, unless otherwise specified.

CONCLUSIONS

Seeds of *Cassia, Chrysanthemum, Glycyrrhiza, Mentha, Olea,* species and *Plantago* should be compulsorily screened through X-ray radiography for detection of latent infestation and also for salvaging the germplasm.

Seeds of *Digitalis, Dioscorea, Hyoscyamus, Papaver, Rauvolfia, Vinca* and *Withania* should be examined visually and if necessary, be fumigated.

Tubers of *Dioscorea* should be compulsorily fumigated against latent infestation of weevils.

Only soil free plants, rooted cuttings and tubers should be admitted.

Plants and cuttings of *Chrysanthemum, Glycyrrhiza, Mentha, Olea, Rauvolfia* and *Vinca* should be carefully examined with magnifying aids and detained in quarantine for one to two weeks so as to allow the eggs to hatchout. A suitable disinfestation treatment should be given immediately and if necessary, after the detention period.

REFERENCES

Anonymous. 1970. Plant Quarantine Treatment Manual, United States Department of Agriculture. Plant Quarantine Division Hyattsville, Maryland 20782.

Anonymous. 1951-1985. Distribution Maps of Insect Pests. Series A (Agricultural Commonwealth Institute of Entomology, London).

Anonymous. 1983. Annual Report. National Bureau of Plant Genetic Resources, New Delhi.

Davidson, R. H. and L. M. Peairs. 1966. Insect-Pests of Farm, Garden and Orchard. John Wiley & Sons, Inc. N. Y.

Hill, D. 1985. Agricultural Insect-Pests of Tropics and their Control. Cambridge University Press, Cambridge.

Kranz, J., H. Schmutterer and K. Werner (Eds). 1977. Diseases, Pests and Weeds in Tropical Crops. Verlag Paul Parey, Berlin and Hamburg.

McCubin, W. A. 1954. The Plant Quarantine Problem, Ejnar Munksgaard, Copenhagen.

Metcalf, C. L. and W. P. Flint. 1979. Destructive and Useful Insects, Their Habits and Control (Revised by R. L. Metcalf). Tata McGraw-Hill Publishing Company Ltd., New Delhi.

Pradhan, S. and S. R. Wadhi. 1962. Quarantine problems facing the introduction of mango. Bulletin National Institute of Sciences of India. 19 : 106–118.

Roth, H. and M. H. Richardson. 1965. Tolerance of some imported vegetables to methyl bromide fumigation and hot water treatment. J. Econ. Ent., 58 (6) : 1086–1089.

Wadhi, S. R., B. R. Verma, S. Thomas and Rattan Lal. 1967. Detection of phytophagous chalcidoids in seeds for quarantine purposes. Indian J. Ent., 29 (2) : 197–199.

Wadhi, S. R. and B. R. Verma. 1971. Quarantine problems posed by Bruchidius species. Ind. J. Ent., 33 (1) : 34–41.

Wadhi, S. R. 1983. X-ray radiographv in plant quarantine, J. Nuclear Agric. Biol., 12 : 87–89.

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Plant Genetic Resources : Collection and Promising Introductions for arid and semi-arid regions

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Both crop-specific and region-specific/multicrop explorations have been carried out by the Regional Station of NBPGR, Jodhpur since its inception in 1965. 7074 collections of diverse crop germplasm have been made from arid and semi-arid regions of Gujarat, Haryana and Rajasthan. Rich variability in germplasm collected comprises pearlmillet (593), chickpea (116), clusterbean (2969), cowpea (206), mothbean (555), mungbean (721), pigeonpea (76), sesame (499), chillies (123) and several other plants (1216) including vegetables, plants of economic importance, etc. Promising accessions have been identified in following agricultural crops : (i) cowpea (vegetable type : NS 24/8-2 (Pusa Aseem), P 460-1-1; grain type : EC 13060, PLC 7); (ii) guar (vegetable type branched : IC 11704 (Sharad Bahar), IC 11388; grain type branched : IC 9065, IC 9229/P$_3$*, IC 11521; grain type single stemmed : PLG 80, PLG 85), (iii) moth (PLMO 39, PLMO 55, IC 8851); (iv) mung (EC 35537, PLM 44); and (v) til (EC 43656, EC 43559, IC 14072) which have been recommended for cultivation in arid and semi-arid regions. Among horticultural plants, four varieties of ber, viz. Gola, Seb, Mundia-Marhera and Jogia have been identified which are best suited to this region. An indigenous collection of seedless pomegranate has shown excellent performance. Natal plum* (Carissa grandiflora *EC 37513) and* C. edulis (*EC 35952) introduced from USA have shown good performance. Out of a dozen collections of jojoba* (Simmondsia chinensis), *a liquid-wax yielding plant introduced from USA, one accession (EC 33198) has been found suitable. Among the forage resources,* Acacia albida (*EC 133772 ex., Senegal*), Atriplex canescens (*EC 129768*), A. halimus (*EC 129767*), A. numularia (*EC 129766*), *all from Tunisia, and* Cassia sturtii (*EC 129010 ex. Australia*) *have been identified which are better suited to this region. Two species of* Agave *viz.* A. americana *and* A. sisalana *were found promising.*

Germplasm collection and introduction of new crop plant species, their wild relatives and divergent forms have played tremendously important role in exploitation of such resources in the past. Several countries have benefitted imensely and have also been able to overcome the problems being confronted by them. The regional station of NBPGR located in the arid region (desert) of Rajasthan has introduced, evaluated and identified several promising varieties and strains which are discussed in the present paper.

MATERIALS AND METHODS

Both crop-specific and region specific/multicrop explorations were undertaken using random collection strategies. Sampling adequate amount of seeds representative of a local population, germplasm collection amounting well over 87,074 accessions were built at Jodhpur from arid and semi-arid regions of Rajasthan, Gujarat and Haryana. Rich diversity comprised pearlmillet, chickpea clusterbean, cowpea, moth bean, mung bean, pigeon pea, sesame, chillies and several other plants including vegetables and other wild plant species of economic importance (Table 1).

TABLE 1. GERMRLASM COLLECTIONS MADE BY NBPGR REGIONAL STATION JODHPUR (1980–1986)

Group	Crop	Number of Collections
Cereals and millets	Barley (48), Maize (64), Pearlmillet (593), sorghum (48), wheat (40).	793
Pulses/legumes	Chickpea (116), cowpea (206), guar (2969), moth (555), mung (721), pigeonpea (76), urid (78).	4721
Oilseeds	Castor (22), groundnut (66), naiya (26) taramira (16), til (499)	629
Fibre crops	Cotton (104)	104
Fruits	Ber (*Zizyphus mauritiana*) (18), ber (*Z. nummularia*) (16) ber (*Z. rotundifolia*) (19), Matira (27).	80
Vegetables	*Bhindi* (32), brinjal (9), chillies (123), *methi* (14)	178
Others	Aak (5), grasses (23), kenaf (46), ker (35), ringni (7), *Sesbania* spp. (43), sunn hemp (37), tumba (95), *Urginea indica* (12), wild bitter gourd (13), wild *bhindi* (16) miscellaneous (237),	469

RESULTS AND DISCUSSION

Germplasm collections evaluated well over two decades led to the identification of promising accessions. The elite strains found promising are discussed below : (i) cowpea (vegetable type) NS 24/8-2 (Pusa Aseem), P 460-1-1; grain type : EC 13060, PLC 7); (ii) guar—vegetable type branched—IC 11704 (Sharad Bahar) and IC 11388; grain type branched; IC 9065, IC 9229/P3 and IC 11521; grain type single-stemmed : PLG80, PLG 85; (iii) moth bean (PLMO 39, PLMO 55, IC 8851); (iv) mung bean (EC 35537, PLM 44) and (v) sesame (EC 43656, EC 43559, IC 14072) which have been recommended for cultivation in arid and semi-arid regions (Chopra and Mital, 1979).

Data on the yield of these accessions are given in Table 2. From the germplasm of pearlmillet (2,000) and groundnut (2,000), received from ICRISAT for evaluation, several lines have been found performing well. In pearlmillet, 22 accessions having awned type ear head, 20 with bold-seeded grain and 12 good for fodder have been identified. Based on grain yield data, 80 accessions have been selected for further evaluation. In groundnut, 103 accessions showed early flowering; and the basis of pod weight/plant, 33 accessions have been selected for further evaluation.

TABLE 2. YIELD OF PROMISING ACCESSIONS OF VARIOUS FIELD CROPS (AVERAGE YIELD OVER THREE YEARS)

Crop	Type	Accessions	Yield (q/ha)
Cowpea	Vegetable	NS 24/8-2 (Pusa Assem)	82.0
		P 460-1-1	69.0
	Grain	EC 13060 (USSR)	8.5
		PLC 7	9.0
Guar	Vegetable type, branched	IC 11704 (Sharad Bahar)	180.0
		IC 11388	130.0
	Grain type, branched	IC 9065	18.0
		IC 9229/P3	17.5
		IC 11521	16.8
	Grain type, single stemmed	PLG 80	18.8
		PLG 85	18.0
Moth bean	—	PLMO 39	5.6
		PLMO 55	5.0
		IC 8851	5.5
Mung bean	—	EC 35537	10.5
		PLM 44	9.8
Sesame	—	EC 43656 (Tanzania)	6.5
		EC 43559 (Mexico)	7.0

Among horticultural plants, four varieties of *ber* viz. Gola, Seb, Mundia, Marhera and Jogia have been identified which are best suited to the arid region of Rajasthan, adjoining Haryana and Western Uttar Pradesh. An indigenous collection of seedless pomegranate has shown excellent performance. Natal plum (*Carissa grandiflora* EC 37513) and *C. edulis* (EC 35952) introduced from USA have shown good performance (Chopra and Mital, 1979).

Several other economic plant introductions are being tried at this station. Out of several collections of jojoba (*Simmondsia chinensis*), a liquid-wax yielding plant introduced from USA, one accessions (EC 33198) has been found suitable. Two species of *Agave* for fibre *viz. A. americana* (EC 27644) and *A. sisalana*, introduced from USA have been found promising under arid and semi-arid conditions (Chopra and Mital, 1979). Among the forage resources, *Acacia albida* (EC 133772 ex. Senegal), *Atriplex canescens* (EC 129768), *A. halimus* (EC 129767) and

A. numularia (EC 129766), all from Tunisia (Chopra *et al.*, 1982) and *Cassia sturtii* (EC 129010 ex. Australia) have been identified, which are better suited to this region. *Parthenium argentatum*—guayule (rubber plant), *Euphorbia tirucalli* (hydrocarbon plant), *Acacia* sp., *Prosopis* sp., *Eucalyptus* sp., etc, are being evaluated.

REFERENCES

Chopra, D. P. and S. P. Mital. 1979. New plants for semi-arid zone of Western Rajasthan. Indian Fmg.

Chopra, D. P., Ranbir Singh and K. L. Mehra. 1982. Forage *Atriplex* for Western Rajasthan. Indian Fmg. 2 (12) : 7-9.

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Short Communication

Diversity of Himalayan Corn

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In the last two decades or so, 1,571 maize collections were made from different parts of the country, particularly from the Eastern Himalyan region and subsequently classified into 15 races and 3 sub-races, each with characteristics complex of traits associated with it (Singh, 1977 a, b). Also, over 800 maize collections from various parts of the country were further added to the above diversity by the NBPGR since its inception in 1976. Of these, more recently, 617 collections were made from the Western Himalayan region, particularly from Jammu hills, Jaunsar and Bhabar region, Pauri Garhwal, Tarai Bhabar regions of Kumaon and plains of Uttar Pradesh and Haryana; while 280 maize collections were added from Eastern Himalayan region, particularly from Sikkim and Garo, Khasi and Jaintia hills in Meghalaya. A rich diversity was observed for the grain character viz. flint, semi-flint, dent, opaque, floury and pop, which were white, yellow, creamish, brown, purple, red, blackish and varied grades of colour mixtures.

EVALUATION AND IDENTIFICATION OF PROMISING TYPES

The collections were grown in an augumented design at the Issapur Experimental Farm of NBPGR in the *kharif* 1986. The check varieties used were : Vijay, Tarun, Hunis, Diara and Basi. Some of the notable characteristics were observed in the collections from Garo and Khasi Hills. An Indian race *Khasi Riewhadem*, which has the largest ears among the Indian races, is still being preserved by the Khasi tribes. This race is highly productive, has creamish/white/yellow bold flinty grains and is much preferred locally. Among others, landrace like *Merakhu Bolma* from Garo Hills, has creamish/yellow opaque grains; others showed irregular but pointed kernel at base with conical ears; collections belonging to the primitive race *Tirap-Nag-Sahypung* showed most of the characters desired for the high population densities, medium height, erect leaves, small tassels and numerous ears.

Of the collections from Western Himalayas, representing bold, yellow to bright-yellow kernel and with medium to late maturity (distinct from Jaunpuri and Jalandhari groups) types, HP 73 and HP 106, gave high yields comparable with the released hybrids or composites. This showed high yield potential of local germplasm from the Western Himalayas. Another collection HP 119 proved to withstand drought. Some collections were found to belong to 'Bold Flint group' and thus considered to be of immense use in the improvement of maize varieties. Some of these collections possessed eight kernel rows with yellow to bright yellow bold kernels and medium maturity. Another group of collections from Western Himalayas showed early maturity, medium ear length, slender with strong taper from base to tip, regular rows with multiplication of rows at the base. Majority of these collections belong to the race *Maidani Makka* and its sub-race 'Ganga'.

Some of the accessions which showed tolerance to leaf blight (*Helminthosporium turcicum*) at the Bureau's Regional Station, Shillong were BDJ/NKG-1, BDJ/NKG-8, BDJ/NKG-78 and BDJ/NKG-213 from Western Himalayas and the accessions BD-66, BD-120, BD-122, etc, were from the Eastern Himalayas. A total of 231 entries, particularly from tribal areas of Jaunsar and Bhabar and remote areas of Almora, were screened for reaction to *Helminthosporium turcium* after artificial inoculation at the Bureau's Regional Station, Bhowali and P 36 (Jaunsar) and P 414 (Almora district) showed tolerance. A wide range of variation was observed in plant, ear characters, plant height (140 to 310 cm), leaf length (32.0 to 105.0 cm), leaf width (3.3-11.0 cm), ear length (9.5 to 26.0 cm) and ear diameter (2.6 to 5.2 cm).

An 'Inventory on Indian Maize Germplasm' for part of the germplasm collections evaluated, has been prepared and a set of these collections has been kept for long term storage in the National Repository of NBPGR. The other set, as working collections for maintenance and supply, has been stored in the Germplasm Evaluation Division, NBPGR, New Delhi.

REFERENCES

Bhag Singh. 1977a. Races of Maize in India, Indian Council of Agricultural Research, New Delhi. pp. 106.

Bhag Singh. 1977b. Evaluation of primitive cultivars from North-Eastern Himalayan region in relation to lineages. Indian J. Genet. 37(1) : 103–13.

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Short Communication

The Role of Genetic Resources in Tuber Crop Improvement

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Over the years, the Central Tuber Crops Research Institute, Trivandrum (Kerala) has accumulated 3,250 accessions of diverse genetic resources of tropical tuber crops. These include cassava (*Manihot esculenta*), sweet potato (*Ipomoea batatas*), yams (*Dioscorea esculenta, D. alata, D. rotundata*), aroids (*Colocasia esculenta, Xanthosoma sagittifolium, Amorphophallus campanulatus*), Coleus (*Coleus parviflorus*), yam been (*Pachyrrhizus erosus*), winged bean (*Psophocarpus tetragonolobus*), arrow root (*Maranta arundinacea*) etc. The utilisation of this diversity for identifying promising types is discussed. Critical evaluation of the germplasm and grouping of the accessions in various classes based on different morphological and tuber characters resulted in the identification and release of a few clones such as "*Sree Latha*". "*Sree Keerthi*", "*Sree Roopa*", "*Sree Priya*" and "*Sree Subhra*" for general cultivation while a few others formed the basic parental materials in developing superior hybrids in cassava and sweet potato. In cassava, "M4" which is an introduction from Malayasia, is the most popular cultivar in Kerala for table purposes.

In any kind of meaningful plant breeding programme, accumulation of genetic diversity in the crop is highly desirable. In recent years, awareness has been generated with regard to germplasm collection, conservation and exchange and CTCRI has taken up a serious attempt in the collection, evaluation and conservation of germplasm materials of different tuber crops. In the past twenty four years, CTCRI has built up a reasonable collection in tropical tuber crops (Table 1).

TABLE 1. GENETIC RESOURCES OF DIFFERENT TUBER CROPS MAINTAINED AT CTCRI

Crop	Accessions
Cassava	1,289
Sweet potato	733
Toro (sp. *Colocasia*)	311
Tannia (sp. *Xanthosoma*)	64
Elephant foot yam (sp. *Amorphophallus*)	96
Lesser yam (*Dioscorea esculenta*)	97
Greater yam (*D. alata*)	213
White Yam (*D. rotundata*)	370
Coleus	64
Yam bean	11
Winged bean	1
Arrow root	1
Total germplasm assembled	3,250

Among these, exotic material is represented from African and South American countries, Japan, USA, Taiwan, Puerto Rico, Russia, Fiji, Nepal, Sri Lanka, China, Philippines, Thailand etc., through critical multiplication evaluation trials over a period of time, promising desirable clones were identified in cassava, aroids, yams and *Coleus*.

EVALUATION OF GERMPLASM

Cassava

The studies have revealed that in cassava, among the exotic collections, 34% clones were spreading while in the indigeneous lines, 13% showed spreading habit. Variations were also observed for plant height, flowering habit, pigmentation in stem, leaf, petiole and emerging leaf and in tuber skin, rind and tuber flesh. Similarly, variations occur in pollen fertility and HCN content in tubers. The maximum HCN content recorded in the exotic collection (Ce-461) was 290 μg/g while the content was 220 μg/g in the indigenous line Ci-135. Among the exotics, the high HCN clones represented 7.5% and 0.9% in the indigenous lines. A few of the indigenous and exotic clones have also been identified as field tolerant to the common pests (spider mite) and diseases like cassava leaf spot and mosaic disease. The cultivar M 4, introduction from Malayasia, is a well accepted variety for table purposes. The indigenous accession, Ci-856 has been identified as the most promising clone for early harvest with 35-40 t/ha yield at 7th month stage while others with similar yields at 10-11 months maturity. A few other accessions in cassava have been developed through hybridization programme. Among these, H 97, H 165, H 226 and Sree Visakham (H 1687) have resulted from a single cross while the hybrid Sree Sahya (H 2304) was developed from multiple cross (Magoon *et al.*, 1970; Jos *et al.*, 1980). All these varieties have been reported to yield 30-45 t/ha.

Sweet potato

A few strains have been used in the hybridization programme for developing new and improved varieties. Three hybrids, viz. H41, H42 and H268 have been developed and released for general cultivation based on their superior yield, quality and acceptability (Magoon *et al.*, 1970; Limaya and Kore, 1978; Nawale, 1981). Two recently recommended varieties in sweet potato, viz, Sree Nandini (76-OP-217) and Sree Vardhini (76-OP-219) are developed from open pollinated seeds (bulk) from elite female clones in the germplasm accessions (Nayar *et al.*, 1984). These have been recommended for early harvest based on their yield potential of 20-25 t/ha at 100-105 days maturity. A few other clones have also been identified from the germplasm material. One such hybrid is noted for its high carotene content of about 7000 IU and 90-100 days maturity.

Aroids

Wide morphological variation was noticed in the germplasm resources in *Colocasia* while variability was limited in *Xanthosoma* and *Amorphophallus* except for a few traits, such as pigmentation, tuber size and shape. Two high yielding desirable clones identified *in Colocasia* have been designated as Sree Rashmi (C-149) and Sree Pallavi (C-266). These have been recommended for release in Kerala State and has been recorded 15-20 t/ha yield in these clones.

Yams

The major yam species under cultivation in India are lesser yam (*D. esculenta*) and greater yam (*D. alata*). White yam (*D. rotundata*) is a new introduction in India from Africa. Among 213 accessions of *D. alata*, 18 were exotic. Of 97 accessions in *D. esculenta*, 89 are indigenous and 8 are exotic, received from Puerto Rico, Africa and Nepal. White yam (*D. rotundata*) ranks first among yams in area and production on global, basis. Open pollinated seeds of four varieties of white yam, viz. Iwo, Umdika, Ihopia and Boki were received from the International Institute for Tropical Agriculture, Nigeria in 1976. The evaluation of clonal generations derived from the seedling progenies resulted in the identification of 370 clones of white yam which have been included in the germplasms collection of the Institute. Sustained efforts have resulted in the identification of one selection in lesser yam, Sree Latha (De-11) and two each in greater-yam Sree Keerthi (Da-60) and Sree Roopa (Da-80) and white yam, Sree Subhra (I-146) and Sree Priya (U-195-2) which have been recommended for release in Kerala based on their consistent high yield performance. The yield in Sree Latha ranged from 20-25 t/ha while in Sree Keerthi and Sree Roopa from 25-30 t/ha. The yield range in Sree Subhra and Sree Priya was 34-40 t/ha and the tubers are quite acceptable.

Minor tubers

Crop like *Coleus*, yam bean, winged bean, arrow root etc, are minor tuber crops because of their limited area of cultivation, production and demand. *Coleus* tubers are aromatic and used as vegetable. Evaluation of 20 germplasm accessions in *Coleus* has resulted in the selection of CP-11 as a promising line. The evaluation of another 44 accessions have indicated the presence of superior clones in the crop, variability, however is limited.

CONCLUSION

In cassava, S-856 is a recent selection for early harvest from indigenous germplasm and has been recommended for release in Kerala. Two other varieties selected from indigenous germplasm, have been recommended for release in Kerala. Two varieties selected from indigenous germplasm in *Colocasia* for general cultivation are C-149 and C-226. In lesser yam, the cultivar Sree Latha (De-11) is released from the indigenous germplasm collection. Similarly two clones of greater yam viz. Da-60 and Da-80 have also been recommended for release which are superior selections made from indigenous stocks. In cassava, prominent genetic stocks are H 97, H 165, H 266, Sree Visakham

(H 1687) and Sree Sahya (H 2304) which have been released at state and/or national level. H 41 and H 42 strains of sweet potato were developed from single cross while H 268 has resulted from a double cross. 76-OP-217 and 76-OP-219 are two selections made in sweet potato for early harvest, identified from progenies of open pollinated seeds collected from promising female parents in the germplasm collection. It is thus evident that the genetic resources available at CTCRI have significantly contributed in the development of superior cultivars in tropical tuber crops.

REFERENCES

Jos, J. S., N. Hrishi, S. B. Maini and R. G. Nair. 1980. Two high yielding hybrids of cassava. J. Root Crops. 6 : 1-6.

Limaye, V. P. and V. N. Kore. 1978. Performance of high yielding sweet potato variety hybrid-268 under Konkan (Mahrashtra) conditions. J. Root Crops. 4(2) : 43-45.

Magoon, M. L., S. G. Appan, R. Krishnan and R. C. Mandal. 1970. Some promising high yielding hybrids and selections of cassava. SABRAO Newsletter. 2 : 19-26.

Magoon, M. L., S. G. Nair, R. Krishnan and R. C. Mandal. 1970. Three promising high yielding hybrids of sweet potato. SABRAO Newsletter. 2(2) : 115-118.

Nawale, R. N. 1981. A study on the stage of harvest in sweet potato variety, H 268, under Konkan (Maharashtra) conditions. J. Root Crops. 87 : 29-31.

Nayar, G. G., P. Kamalam and R. B. Nair. 1984. Two promising sweet potato selections for early harvest. J. Root Crops. 10 : 79-80.

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Short Communication

Genetic Resources of Tropical Tuber Crops

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Cassava and sweet potato are the two major tropical tuber crops important for industry, as well as for food. While cassava has a restricted distribution in humid tropical areas, sweet potato is grown from humid tropics to sub-tropical/ sub-temperate regions in the lower Himalayas. Cassava cultivation has now been successfully extended to sub-humid tropical areas of India. Tuber crops and their wild species maintained at NBPGR, Trichur station are listed in Table 1.

TABLE 1. GERMPLASM OF TROPICAL TUBER CROPS MAINTAINED AT TRICHUR

Crop	Species	Accessions
Cassava	*Manihot esculenta*	57
Sweet potato	*Ipomea batata*	6
Greater yam	*Dioscorea alata*	177
Lesser yam	*D. esculenta*	41
Potato yam	*D. bulbifera* var. *sativa*	4
Taro	*Colocasia esculenta*	410
Coco yam	*Xanthosoma sagittifolium*	21
—	*Alocasia macrorhiza*	5
Elephant foot yam	*Amorphophallus companulatus*	70
Chinese potato	*Coleus parviflorus*	38
West Indian arrow root	*Maranta arundinacea*	18
Queensland arrow root	*Canna edulis*	2
Wild yam	*D. hamiltonii*	5
	D. wallichi	5
	D. tomentosa	3
	D. oppositifolia	5
	D. pentaphylla	5
	D. bulbifera var. *verosa*	6
	D. anguina	2
	D. hispida	3
Total		883

Cassava (*Manihot esculenta* crantz)

The crop was introduced in India during British colonial period by the Maharajah of Travancore and now it is grown commercially mainly in Kerala and Tamil Nadu. The indigenous and exotic collections of this crop and its related species have been accumulated in CTCRI, Trivandrum and the Institute has made commendable contributions in all aspects of this crop. To enrich genetic variability, a recently collaborative exploration programme was taken up with CTCRI by NBPGR and 57 collections made from North Kerala.

Sweet potato (*Ipomoea batata* (L.) Lam.)

This crop is highly adapted to various agro-climates and therefore, has spread to even semi-temperate regions. In India, it is cultivated all over and is a major crop in Uttar Pradesh, Bihar and Orissa.

Greater yam (*Dioscorea alata* L.)

It is the most important Asian yam cultivated in India. It has originated through domestication/selection of wild forms related to two commonly occurring wild species such as *D. persimilis* and *D. hamiltoni* in South Asia (Purseglove, 1974; Coursey, 1976). Both species occur in the Indo-Burmese region and the latter is very commonly available in the rain forests of the Western Ghats. Arora and Nayar (1984) have reported the occurrance of wild *D. alata* in tropical and sub-tropical Himalayas. The crop is widely cultivated except in arid regions. Collections (177) accumulated at the station are from Kerala, Tamil Nadu, Karnataka, parts of Maharashtra, Madhya Pradesh and Himachal Pradesh.

Distinct morphotypes based on the above ground and below ground traits have been differentiated. Tuber shapes are broadly cylindrical, digitate and round. A trial conducted consecutively for 3 years showed that collection No. 5, No. 102 and No. 35 yielding 31.4 t/ha 30.8 t/ha and 27.6 t/ha; respectively were significantly superior to the others. Majority of the collections were male. Muralidharan and Velayudhan (1985a) have reported the performance of promising collections of *D. alata* alongwith their important morphological characters. Among the new collections evaluated during 1986, No. 193 and 240 yielding 38.0 t/ha and 35.0 t/ha respectively topped the list. A catalogue on Crop genetic resources including greater yam (Muralidharan *et al.*, 1983) has been published.

Lasser yam (*Dioscorea esculenta* (Lour.) Burkill)

Lesser yam is mainly distributed in Kerala, parts of coastal Karnataka and North-Eastern region. Collections from Kerala have been made by this station. These exhibited little variability with respect to above ground morphology; however, tubers varied in size, shape, hairiness, texture, colour and cooking qualities. In a trial on 9 promising collections conducted during 1986, collections No. 7, 5 and 37 proved to be superior, yielding 18.6 t/ha, 17.6 t/ha and 17.3 t/ha, respectively.

Potato yam (*Dioscorea bulbifera* L. var. *sativa*)

It is only a minor tuber crop and its distribution is restricted to Kerala and Tamil Nadu. Bulbils resembling potato are consumed as a vegetable. About four collections from Kerala and Tamil Nadu were made. No variation except for leaf size and bulbil size was noticed. A wild relative of this crop viz, *D. bulbifera* var. *verosa* occurs widely in India.

Taro (*Colocasia esculenta* Schott.)

In India, the crop is widely grown from humid tropics to sub-tropical areas and is also adapted to semi-arid conditions with irrigation. So far 410 collections mainly from Kerala, Tamil Nadu, parts of Karnataka, Maharashtra, Madhya Pradesh, Orissa, North-Eastern and North-Western regions have been made in *C. esculenta* var. *esculenta*, *C. esculenta* var. *antiquorum* and wild stoloniferous, semi-stoloniferous and non-stoloniferous types. These collections were grouped into 29 distinct morphotypes based on the aboveground and underground morphology. Variability in wild *Colocasia* collections from Kerala and Karnataka were also reported (Velayudhan and Muralidharan, 1985).

Evaluation of the germplasm resulted in isolation of five promising lines based on the corm and cormel yield which varied from 15-19 t/ha. In preliminary screening of the collections for diseases in collaboration with CTCRI, Trivandrum, 62 collections were found to be free from diseases when scored 65 days after planting. A catalogue based on 60 descriptors has been published.

Coco yam (*Xanthosoma saqittifolium* Schott.).

It has originated in South America and spread to South and South-East Asia and Africa. It is restricted to high rainfall regions in Western peninsular and North-Eastern regions. It is similar to taro in growth habit and cultivation but yields are higher. So far 21 collections have been made from Kerala. Varieties identified comprise a form with stoloniferous tubers which flowers and sets seed collected once from Thenmala in South Kerala, and two types with much variation in tuber size in duration, differing in plant habit and colour of flower.

Elephant foot yam (*Amorphophallus companulatus* Blume)

It is mainly grown in Kerala, Tamil Nadu, Andhra Pradesh and the North-Eastern region. The crop has originated in South-East Asia. Chromosome number of $2n = 28$ is reported. Seventy two collections, mainly from Kerala and Tamil Nadu, were made comprising two distinct varieties of cultivated *Amorphophallus*. The commonly cultivated type throughout India has a main rhizome bearing few tuberous outgrowths. While the others locally known as *Karuna* in Tamil Nadu, has cylindrical thick tubers within comparatively smaller main mother rhizome. Preliminary studies on the morphology of the collections resulted in the identification of 7 distinct morphotypes including *Amorphophallus bulbifer* which is a wild relative of the crop (Arora and Nayar, 1984). The collection also include wild elephant foot yam (*A. companulatus*) from plains and foot hills of the Western Ghats in Kerala.

Chinese potato (*Coleus parviflorus* Bush)

In India, it is grown mainly in Kerala and Southern parts of Tamil Nadu. It is locally known as *koorka* and forms an important seasonal vegetable. Out of 38 collections made in 1984, 5 distinct morphotypes based on habit, size of leaf, branching pattern, pigmentation on stem, wartiness, shape and colour of tuber were identified. Preliminary screening for nematode infection on tubers (this is a serious problem of the crop in this area) has revealed a collection (No. 15) free of nematodes, and tolerant to root-knot nematode (*Meloidogynea* sp.) infection (No. 13, 30 and 23). Muralidharan *et al.* (1985b) grouped 41 of the original collections into 6 clusters based on D^2 analysis of 7 morphological characters.

The ten base centres of the National Bureau of Plant Genetic Resources will collect tropical tuber crop germplasm, with CTCRI, Trivendrum. Though these are not priority crops, yet because of the fast rate of genetic erosion caused by changes in cropping pattern and habitat destruction, native types are being lost. Identification of types which are highly productive, of shorter duration, resistant/tolerant to insect pests and diseases and adapted to various agro-climates may lead to increase in area under cultivation and greater production and utilisation in this group of crops.

REFERENCES

Arora, R. K. and E. R. Nayar. 1984 : Wild relatives of crop plants in India. NBPGR Sci. Monogr. 7. National Bureau of Plant Genetic Resources, New Delhi.

Coursey, D. G. 1976. Yams. N. W. Simmonds (Ed.). Evolution of Crop Plants. London, New York.

Muralidharan V. K., K. C. Velayudhan and T. A. Thomas. 1983. Catalogue on Crop Genetic Resources. National Bureau of Plant Genetic Resources, Regional Station, Trichur, India, 112 p.

Muralidharan, V. K. and K. C. Velayudhan. 1985a. Performance of promising collections of *Dioscorea alata* Linn. from Kerala. Proc. Nat. Symp. Production and Utilization of Tropical Tuber Crops. Indian Soc. for Root Crops, CTCRI, Trivendrum. p. 63–64.

Muralidharan, V. K. and K. C. Valyudhan. 1985b. Variation in a collection of *Coleus parviflorus* Benth. Proc. Nat. Symp. in Production and Utilisation of Tropical Tuber Crops, Indian Soc. for Root Crops, CTCRI, Trivendrum. p. 83–86.

Purseglove J. W. 1974. Tropical Crops, Monocotylidons, Longman Group. 607 pp.

Velayudhan K. C. and V. K. Muralidharan. 1985. Variability in a collection of *Colocassia* from the wild. Proc. Nat. Symp. in Production and Utilization of Tropical Tuber Crops, Indian Soc. for Root Crops. CTCRI, Trivendrum. p 45–49.

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Short Communication

Germplasm Holdings of Agri-Horticultural Crops in Gene Bank

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The National Bureau of Plant Genetic Resources at New Delhi has the national mandate to collect, evaluate, document and conserve genetic diversity in crop plants and their wild relatives. Seed storage facilities have been developed and the National Gene Bank (repository) holds over 1,00,000 collections.

India is an important centre of diversity for many crops. Concerted efforts have been made to collect this diversity in various agri-horticultural crop plants, which, with the spread of HYVs, is getting erooed. Thus, large indigenous collections have been built up and these include primitive cultivars/landraces, wild/weedy types, obsolete cultivars, currently grown varieties, etc. The best way by which the plant genetic resources could be conserved safely and cheaply is through seed storage, and facilities for this, have been established at NBPGR.

Seeds are compact, they require less space and are easy to handle and store. The moisture content (m.c.) of majority of agri-horticultural crops could be reduced upto 5-8% at low temperature of 15°C and at 15% RH. These seeds fall in the category of orthodox seeds.

Gene bank Operational Procedure

Purity analysis of the seed samples is done. The seeds are cleaned, germinability checked and processed for storage. First undersized, shrivelled, immature seeds and pieces of seeds resulting from breakage less than one half of their original size, diseased seeds, insect and nematode infested seeds are rejected. Empty glumes, and sterile florets of grasses and cereal, weed seeds and other debris are separated out.

Accessions are tested for viability standards following ISTA rules, 1985. All accessions meeting the viability standard of 85% or more are processed further for drying to the required moisture content of 5-7 per cent. Wherever, samples show less than 85% viability, the seed supplier is advised to send freshly harvested seed for storage in the gene bank. The recommended size of seed sample for storage of crops with heterogenous population is 12,000 seeds per accession in the base collection and 5,000 in the active collection and for crops with genetically homogenous population 4,000 for base collection and 3,000 for active collections.

After germination and moisture testing, the dried seeds are transferred to three layered specially designed laminated aluminium foil packets as per IBPGR standards and then packets are hermetically sealed. The sealed packets are stored safely at about +4°C temperature for medium term and at —20°C for long-term.

Germplasm Holdings at Genebank

Upto December 1988, the Gene Bank holdings comprised 1,02,352 accessions of different agri-horticultural crops (Table 1) consisting of cereals (28,002), pseudo

TABLE 1. GERMPLASM ASSEMBLAGE IN NATIONAL REPOSITORY (UPTO 1988)

Crops	Accessions conserved
Cereals	28,002
Pseudocereals	1,988
Millets & minor millets	8,142
Pulses	16,432
Fibre crops	245
Medicinal & Aromatic Plants	126
Oil seeds	9,073
Vegetables	929
Others	135
Released varieties	307
Exotic germplasm	16,322*
Exploration material	20,651*
Total	1,02,352

*Kept as reference voucher specimen.

cereals (1,988), millets and minor millets (8,142), pulses (16,432), fibre crops (245), medicinal and aromatic plants (126), oilseeds (9,073), vegetables (929), released varieties (307), exotic germplasm (16,322), exploration material (20,651) and others (135).

Recently, storage facilities were increased to accomodate over 2 lakh samples through addition of four more cold store modules (Watford, UK).

REFERENCE

Anonymous. 1985. International rules for seed testing. Seed Sci. Technology. 13(2) : 307–520.

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Short Communication

Evaluation of Oat Genetic Resources

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The genetic resources of *Avena*, mainly exotics, maintained at NBPGR totals 1000 accessions, which present an array of non-descript types, commercially grown varieties, improved lines and different species (Table 1). The majority of accessions were assembled in the past two decades. The available germplasm was introduced from more than 26 countries (Table 2).

TABLE 1. GENETIC RESOURCES OF *avena* SPECIES MAINTAINED AT NBPGR, NEW DELHI

Diploid (2n = 14)	Tetraploid (2n = 28)	Hexaploid (2n = 42)
A. brevis (2)	*A. abyssinica* (8)	*A. sativa* (881)
A. canariensis (2)	*A. barbata* (4)	*A. byzantina* (42)
A. damascena (1)	*A. magna* (4)	*A. chinensis* (1)
A. hirtula (2)	*A. murphyi* (1)	*A. fatua* (4)
A. longiglumis (3)	*A. vaviloviana* (1)	*A. ludoviciana* (1)
		A. macrostachya (1)
A. pilosa (1)	*A. weistii* (2)	*A. nuda* (17)
A. prostrata (1)		*A. sterilis* (10)
A. strigosa (10)		
A. ventricosa (1)		

Number of accessions are given in parentheses

TABLE 2. OAT GERMPLASM RESOURCES (EXOTIC & INDIGENOUS) AUGMENTED BY NBPGR

Country	Accessions	Country	Accessions
Argentina	62	Israel	4
Australia	117	Italy	3
Belgium	1	Kenya	1
Canada	46	Netherlands	4
Chile	1	New Zealand	2
Cyprus	1	Portugal	14
Denmark	2	Sweeden	7
Eucador	1	Switzerland	2
Finland	4	United Kingdom	24
France	2	USA	506
German Democratic Republic	2	USSR	38
Federal Republic Germany	17	Yugoslavia	2
Hungary	62	Miscellaneous	55
India	20		
Total germplasm			1,000

Preliminary Evaluation

The germplasm collections were grown in augmented block design (Federer, 1956) in single row plots of 3.0 m long and 0.45 m apart using 5 checks. The data were recorded on 5 competitive plants from each accession, using 32 quantitative and qualitative descriptors and descriptor states. The descriptor list was prepared by NBPGR.

The germplasm collections exhibited good amount of variability, for all the traits except tillers per plant, florets per spikelet and outer glume width. Mean, range and coefficient of variation for different traits are given in Table 3. Comprehensive catalogue, based on the data collected and arranged in computer readable form, has been prepared.

TABLE 3. MEAN, RANGE AND CO-EFFICIENT OF VARIATION IN *Avena* GERMPLASM FOR DIFFERENT QUANTITATIVE TRAITS

Descriptor/Descriptor State	Mean	Range	CV (%)
Leaf length (cm)	32.26	13.77- 61.97	17.96
Leaf width (cm)	1.63	0.33- 4.91	26.69
Flag leaf length (cm)	20.14	4.30- 44.70	24.22
Flag leaf width (cm)	1.49	0.62- 3.31	25.99
Leaves on the main culm	6.57	3.67- 9.95	10.17
Culm diameter (cm)	0.54	0.26- 0.97	17.58
Nodes on the main culm	5.89	2.38- 9.51	20.67
Longest internode length (cm)	17.87	7.38- 37.37	20.67
Tillers/plant	5.66	0.74- 9.50	18.54
Peduncle length (cm)	35.96	13.12- 62.08	21.16
Axis length (cm)	27.07	4.84- 56.80	23.96
Axis nodes	7.87	4.71- 11.63	12.32
Spikelets/panicle	58.27	17.12-135.84	30.75
Florets/spikelet	2.11	0.82- 3.15	14.96
Outer glume length (cm)	2.61	0.55- 3.95	10.04
Outer glume width (cm)	0.59	0.15- 0.99	15.74
Plant height (cm)	126.85	31.50-221.90	14.87
Green fodder yield (1 m row)	1.76	0.16- 7.66	38.87
Seed yield/5 panicles (g)	53.72	1.85-107.53	55.00
100 grain weight (g)	3.66	0.95- 6.17	23.22

Promising Varieties/Strains Identified

Several promising introductions for grain, green fodder and multi-purpose types were identified in the preliminary evaluation/experimental trials. Some of the collections obtained from Australia, USA and Canada were identified as short duraion grain types. Medium early to late fodder/dual purpose types were from Australia, UK, USSR and USA. These promising types include grain varieties—NP 101 (ex Australia), Rapida (ex USA) and dwarf oat selections like NP 101 (medium tall type with lax panicles) and EC 56175 (short statured, stiff straw with compact panicles), both from Australia.

REFERENCE

Federer, W. T. 1956. Augmented design. Hawaiian Planter's Record. 55 : 191-207.

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Short Communication

Introduction of Plant Genetic Resources in Non-Conventional Plants and Vegetables

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Introduction of economic plants in the form of seeds, fruits, cuttings, rooted stocks etc. has been in vogue since pre-historic times from one part of the world to another. Nomads, traders, religious missionaries and travellers have been instrumental in the spread of such materials to distant regions. In medieval period with the development of faster modes of land and aquatic transport, the exchange of seeds and plants witnessed frequent and enhanced introduction. Coffee, a native of South-East Africa reached India through Saudi Arabia. *Solanum tuberosum, Nicotiana tabacum* and *Lycopersicon esculentum,* all native to South America were introduced in India during early 10th century. *Arachis hypogaea* native to Brazil found its way into India during early 16th century and *Trifolium alexandrium* used as a green legume fodder in India was introduced in the early years of present century from Egypt.

Since the inception of National Bureau of Plant Genetic Resources in 1976, a total of 3,48,536 accessions of different agri-horticultural and silvi-pastoral plants have been introduced. This paper, briefly reports the material introduced in non-conventional plants and vegetables.

Non-conventional plants

Amongst the introduced plants which have great potential and can grow in desert and other drought conditions is EC 33198 of Jojoba (*Simmondsia chinensis*). The seeds contain 50 per cent oil used in the wax industry and as a lubricant. Guayule (*Parthenium argentatum*) also grows in deserts (Anon. 1975) and cultivar Arizona No. 2 (ex USA) introduced in India has given best performance at Jodhpur and its rubber content ranged between 6 to 8 per cent in one year old plant (Anon. 1983). *Euphorbia* species are also high potential hydrocarbon yielding plants. *Euphorbia tirucalli* is reported to yield 37 to 50 barrels of oil per hectare per year. It is reported to have given 6.2 per cent hydrocarbon under non-irrigated conditions. *E. antisyphilitica,* containing high quality candelilla wax, can be grown successfully on dry and marginal lands. Besides, *Leucaena* species (*L. leucocephala, L. pulverulenta, L. diversifolia* and *L. esculenta*) have been introduced. Salvadore (EC 12290, ex Australia) and K-8 (EC 124343, ex Philippines) showed best performance at Jodhpur, Bhavanagar and Trichur. Variety K-155 and K-156 are also reported to be promising under Indian conditions. The introductions in non-conventional plants during 1976–86 are given in Table 1.

TABLE 1. GERMPLASM INTRODUCTION IN NON-CONVENTIONAL CROPS (1976–85)

Crop Species	Accessions	Source Countries
Parthenium argentatum	92	Mexico, USA
Parthenium fruticosum	1	USA
Simmondsia chinensis	69	Mexico, Israel, UK, USSR, Tanznia
Leucaena leucocephala	390	Australia, Philippines, Malawi, Colombia, USA, Sierra-Leone, France
Other *Leucaena* spp,	60	Australia, USA, France.

Among forage plants, salt tolerant *Atriplex nummularia*, *A. halimus* (EC 129607), *A. cenescens* (EC 129768) and *Acacia albida* (EC 123772, ex Senegal) with potential to grow in prolonged dry season have been introduced. *Prosopis tamarugo* and *P. juliflora* (EC 38596) have also been observed to perform well under arid conditions. Other important species include *Ceratonia siliqua* and *Cucurbita foetidissima* introduced in India and are thriving well on poor soils.

Vegetable crops introductions

Promising introductions in vegetable crops include tomato, *Capsicum*, french bean, cowpea, cauliflower, carrot, garlic and onion. Groupwise details of different vegetable crop introductions are given in Table 2.

The introduction of tomato germplasm about three decades back, such as Sioux (ex USA), labonita (ex USA) and Molakai (ex Australia) have shown tremendous potential under Indian conditions. Other recent collections include EC 129571 and EC 130044, CV Patriot (ex USA) resistent to *Fusarium* wilt and root-knot nematodes; Karobeta (ex Bulgaria) resistant to TMV, cracking tolerent, β-carotene rich (3-4 mg/100 g) and ascorbic acid rich (20-30 mg/100 g), EC 162506, EC 162507, EC 162511 and EC 122516 (ex Taiwan) all heat and bacterial wilt tolerant and resistant to TMV. In *Capsicum*, California Wonder, World beater, Yolo Wonder-tolerant to TMV, Mississipi nema heart, a root-knot resistant type (ex USA). In sweet pepper, six accessions, EC 175960–66 (ex Hungary) are determinate, white, sweet with L gene blocky, and erect types with resistance to red spider. In French bean, Sanilac, BC-6 resistant to alpha, beta and gamma races of *Collectotrichum lindemuthianum* and races of BCMV. In cowpea, Pusa barsati (ex Philippines) adapted to long day conditions, EC 5000 (ex Rhodesia), high green pod yielder (Anon. 1985), EC 169716–25 (ex Nigeria) resistant to bruchids and aphids. In water melon, Ashahi Yamato (ex Japan), Sugar baby, Charleston Grey, Sugarlee (all from USA) are resistant to *Anthracnose* and *Fusarium* wilt. In muskmelon, Green Ice-resistant to three races of powdery mildew (*Sphaerotheca fulgines* L.) is vitamin C rich, CV WI 998 possesses resistance to melon aphid, watermelon mosaic virus 1 and 2, powdery mildew and sulpher tolerance. Cultivars Honeydew, Honeybush, Musketeer and Midget (ex USA), also resistant to *Fusarium* wilt, have been introduced in the recent past. In garlic, a collection with large bulbs and cloves have been introduced from Sultanate of Oman and in

TABLE 2. INTRODUCTION OF GERMPLASM IN VEGETABLE CROPS (1976-86)

Crop Species	Accessions	Source Countries
Tomato *Lycopersicon esculentum*	1,570	USA, Bulgaria, Israel, Denmark, Netherlands, Australia, Italy, Japan, Philippines, Poland, USSR, Taiwan
Onion *Allium sativum* and related sp.	507	Australia, Netherlands, Denmark, Indonesia, Japan, USA, USSR, France, Hungary, Brazil, Iran, Poland, Nigeria, Germany, Taiwan
Colcrops (Cabbage, cauliflower Brussel's, sprout, Chinese cabbage)	1,361	Italy, Netherlands, UK, Taiwan, USA, USSR, Japan
Capsicum (Chillies, Sweet pepper and other *Capsicum* species)	1,233	Hungary, USA, USSR, Italy, Philippines, Australia. Czechoslovakia, Nigeria, Zambia, Netherlands, Taiwan, Yeman Arab Republic
Cucurbits (melons, cucumbers, squashes, gourds, pumpkin)	1,346	USA, USSR, UK, Philippines, France, Zambia, Nigeria, Turkey, Netherlands, Mexico, Hungary
Peas (*Pisum sativum*)	119	Bulgaria, Bangladesh, USSR, Newzealand, USA, Australia, Italy, Czechoslavakia
French bean (*Phaseolus vulgaris*)	178	USA, Bulgaria, Taiwan, Australia, Germany, Japan, Czechoslovakia
Brinjal (*Solanum melongena*)	141	Japan, Nigeria, Philippines, Australia, Israel, USA, USSR
Root vegetables (carrot and radish)	388	Australia, France, Netherlands, Denmark, Japan, Australia, France, Netherlands, USSR, USA, Brazil, Zambia, UK, Taiwan, Korea, Hungary
Leafy vegetables (*Lactuca*, *Spinacea*, *Asparagus* and *Trigonella* species)	77	Netherlands, UK, Poland, Italy, USA, USSR
Abelmoschus	598	Nigeria, West Africa, Ivory Coast, Philippines, USSR, UK, Singapore, Zambia, Turkey, Brazil, Sudan

onion cv NU Mex BR-1 being short day, resistant to bolting and pink root disease (ex USA) is a promising introduction. Cauliflower accessions EC 175800 (ex USA) are reported to be multidisease resistant. In carrot, cv. Beta III (EC 180042) undergoing trials and adaptations studies has a very good flavour, is rich in carotene and vitamin A. It is being tested for vitamin A deficiency diets. In squash, cv. Early Straight Neck (ex USA) has vigrous bushy plants, creamy yellow fruits, and high yield. In Chinese cabbage, breeding lines resistant to club root (ex USA) and EC 16874-51 (ex Taiwan) are heat tolerant and resistant to black rot. Among lesser known leafy vegetables, *Cnidoscolus* sp. (EC 171029, ex Mexico) have been introduced and shown promise (Singh *et al.*, 1986).

REFERENCES

Anonymous. 1975. Underexploited Tropical Plants with Promising Economic value, NTIS Accessions No. P 825/656 pp. 187. National Academy of Sciences, Washington D C

Anonymous. 1983. Review of Research since 1976. (QRT). NBPGR, Regional Station Jodhpur. pp. 19–23.

Anonymous. 1985. Handbook of Cultivars. CSC. Deptt. of Agril & Co-op, Ministry of Agriculture & Rural Development, Govt. of India, New Delhi.

Singh, B. P., B. M. Singh, R. K. Saxena and Pratibha Brahmi. 1986. Introduction of Germplasm Resources in Vegetable Crops Suitable for Stress Conditions and Resistant to Diseases and Pests. Paper presented at the National Symposium on New Horizons in Resistance Breeding for Vegetable Crops. 14-16 February. 1986. JNKVP, Jabalpur, MP.

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Short Communication

Plant Genetic Resources Activities at NBPGR Regional Station, Akola

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The Regional Station at Akola was established in 1977, in the campus of Punjabrao Krishi Vidyapeeth. The prime objective of this station is to explore, collect, evaluate, maintain, catalogue and conserve the vast genetic diversity of agri-horticultural crops of Central and Western India and also of the introduced material suited to sub-humid environments. The efforts made are briefly dealt with.

Collection of Germplasm

Nine exploration trips have been undertaken and both crop specific (onion and garlic) and multicrop collection programmes carried out. The diversity collected is listed in Table 1. The regions explored were Vidarbha, Marathwada, western

Table 1. Crop diversity collected in central India by NBPGR, Regional station, Akola

Crop Group	Crops collected	Samples collected			
		1980	1981	1986	Total
Cereals & Pseudocereals	Paddy, wheat, maize and amaranth	40	291	43	374
Millets	Sorghum, pearlmillet, finger millet, kodo millet, foxtail millet, barnyard millet, proso millet, little millet.	132	367	46	545
Legumes	Sem, cowpea, mung bean, urid, gram, Horse gram, ricebean, pea, pigeon pea, lentil, khesari, french bean, lima bean, soybean, winged bean, sword bean, double bean etc.	134	1185	61	1380
Vegetables	Onion, garlic, brinjal, chillies, tomato, okra, kenaf, bitter gourd, guar, snake-gourd, drumstick, sponge gourd, *tinda*, *methi*, carrot, bottlegourd etc.	76	1206	34	1316
Oilseeds	Sesame, linseed, castor, safflower, brassicae, groundnut, niger and sunflower.	114	588	66	768
Others	Job's tear, ginger, yam, tobacco, *Colocasia*, turmeric, citrus, papaya, custard, apple, *Sesbania*, *Vernonia*, *Jatropha* etc.	22	221	16	259
Total		518	3858	266	4642

Maharashtra, south western and Eastern Madhya Pradesh (Chhattisgarh), north western Andhra Pradesh, south-western Karnataka. The collections were also made from remote hilly areas of Gawilgarh Hills, Mahadeo Hills and Maikala hills of Satpura ranges. Samples were also collected from the tribal dominated areas like Bastar, Melghat (Amravati), Bagicha and Jashpur (Raigarh, M. P.) etc. Much variability was collected in millets, grain legumes, oilseeds, vegetables, bulbous crops, tuber crops etc.

Germplasm Evaluation and Maintenance

At present the Regional Station has the working collection of nearly 21,000 germplasm lines, major crop groups being grain legumes/pulses (7,330), oilseeeds (5,170), minor millet (5,850), vegetables (1,968) and pseudo-cereals (884). The crop-wise germplasm holding being maintained is as follows :

A. Grain Legume Crops : Soybean (*Glycine max*)-2,311; pigeon-pea (*Cajanus cajan*)—2,000; chickpea (*Cicer arietinum*)-1,341; horsegram (*Macrotyloma uniflorum*) 602; french bean (*Phaseolus vulgaris*)-346; winged bean (*Psophocarpus tetragonolobus*)-251; cowpea (*Vigna unguiculata*)-41; Lentil (*Lens esculenta*)-247; Lima bean (*Phaseolus lunatus*)-20 and khesari (*Lathrus sativus*)-28.

B. Oilseeds Crops : Sesame (*Sesamum indicum*)-1,990; safflower (*Carthamus tinctorius*)-1,773; groundnut (*Arachis hypogaea*)-496; Niger (*Guizotia abyssinica*)-267; linseed (*Linum usitatissimum*)-513 and castor (*Ricinus communis*)-129.

C. Millets and Minor Millets : Foxtail millet (*Setaria italica*)-915; kodo millet (*Paspalum scrobiculatum*)-501; proso millet (*Panicum miliaceum*)-476; little millet (*Panicum sumatrense*)-271; finger millet (*Eleusine coracana*)-1,761; barnyard millet (*Echinochloa* sp.)-398 and Sorghum (*Sorghum bicolor*)-1,526.

D. Vegetable Crops : Guar (*Cyamopsis tetragonoloba*)-27; okra (*Abelmoschus esculentus*)-533; chillies (*Capsicum annuum*)-90; egg plant (*Solanum melongena*)-27, garlic (*Allium sativum*)-523 and onion (*Allium cepa*)-735.

E. Horticultural and other crops : Pomegranate-3; *Leucaena*-33; *Simarouba glauca*-1; *Malphigia* species-1; Papaya-2; Jojoba-1; Job's tear-9; jute mallow-8; kenaf-11 and mesta-4.

Germplasm Exchange and Supplies

The Regional Station has supplied seed samples of over 23,000 diverse germplasm to different institutes. The seed samples supplied included crops such as soybean (8,176), safflower (3,182), sesame (2,395), minor millets (3,499), kulthi (1,202), amaranth (1,809) and others (2,743).

The Regional Station has also published crop catalogues on soybean, sesame and French bean.

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Short Communication

Collection, Maintenance and Evaluation of Aonla (*Emblica officinalis* Gaertn) Germplasm

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Aonla is an important indigenous minor fruit plant of India, known for its medicinal, nutritive value, high productivity and hardy nature. It is a natural source of vitamin C (550-750 mg/100 g) which is well preserved due to the presence of polyphenols.

Inspite of productivity, tolerance to salt affected soils (10 ECC or 30 ESP) and nutritive value, several factors limit the commercial orcharding of *aonla*. These include lack of knowledge regarding its suitability to marginal and salt-affected soils and its varied uses, prolonged juvenility and lack of good cultivars.

Characteristics of Aonla *cultivars*

The promising cultivars of *aonla* possess the characteristics of dwarf tree stature, precocious and regular prolific bearing habit, medium fruit size (45-55g), fibreless and shining fruits with attractive appearance and rich in vitamin C.

Aonla, being so important, only little efforts with respect to improvement and description of its cultivars have been made. Some cultivars are based on fruits size (Amal and Raghwan, 1957), such as Banarasi Bansi red, Francis and others according to fruit colour as Green Tinged, Red Tinged, Pink Tinged and White Streaked have been identified. Singh and Arora (1967) studied the physico-chemical variations of two cultivars of *aonla* at maturity. Further, Singh (1974) described three important cultivars viz. Banarasi, Francis and Chakaiya grown in Uttar Pradesh, particularly in districts of Pratapgarh and Varanasi. Teaotia *et al.*, (1968) also described the physico-chemical characteristics of *aonla* cultivars grown in Uttar Pradesh. These cultivars have their own merits and demerits.

In the present study, seedling variation in the material available in the major *aonla* growing tract of Pratapgarh district were critically surveyed and few promising ones identified. These seedling variations, alongwith those of well known cultivars, were grouped on the basis of season of maturity, fruit size and bearing potential.

Some important cultivars

Banarasi : This is an early cultivar of *aonla*. The tree has upright growing habit, fruits are large in size (46.6g/fruit), flattened oblong, three lobed with smooth skin (yellowish) segments raised in three parts, 6 strip, thin, solid; flesh moderately fibrous, soft and semi-translucent. This cultivar contains maximum amount of vitamin C. Fruits are commercially used for preparation of preserves but often

TABLE 1. PHYSICO-CHEMICAL COMPOSITION OF *aonla* STRAINS

Strains	Fruit wt (g)	Frut vol (ml)	T. S. S. (%)	Total sugar (%)	Acidity (%)	Vit. C (mg/100g)	Productivity
Banarasi	46.6	47.7	12.5	4.6	1.50	650.0	Shy bearer
Chakaiya	30.5	32.0	10.5	4.0	1.65	602.0	Productive
Francis	41.5	42.0	12.0	4.5	1.70	385.0	Productive
NA 4 (Krishna)	40.0	42.0	11.5	4.9	1.40	475.0	Moderately Productive
NA 5 (Kanchara)	32.0	33.5	10.0	4.0	1.45	500.0	Productive
NA 6	38.7	41.0	11.0	5.0	1.45	410.0	Moderately Productive
NA 7	47.5	50.0	11.5	4.6	1.60	506.3	Productive
NA 8	37.9	38.7	10.0	4.0	1.70	502.5	Moderately Productive
NA 9	47.5	49.0	12.5	4.6	1.45	500.6	Moderately Productive

NA—Narendra *aonla*.

crack into number of segments during processing and storage. This is a shy bearing cultivar because of low number of female flowers (0.51/branchlet) and self incompatibility. Hence, this cultivar is not being recommended now for commercial plantation.

CV. NA 4 : This is probably a chance seedling of Banarasi cultivar and is locally known as 'Krishna'. It is an early maturing strain with moderate fruiting. Fruits are medium to large in size (40g/fruit), flattened, conical, angular, basin papillate in shape; skin very smooth, yellowish in colour with red blush on exposed surface. The fruits have 6-8 stripes, not very distinct, segments thin, angular, flesh almost fibreless, hard and semi-translucent. Fruits contained fairly high amount of vitamin C. This seems to be an ideal cultivar because of low fibre content and non-cracking of segments during processing.

CV. NA 9 : This is also an early strain and has probably originated as chance seedling from Banarasi cultivar. It has moderate bearing. Fruits are large in size (47.5 g/fruit) flattened, skin is smooth, strip 6-8, distinct, solid, thin, flesh moderately fibrous, soft and semi-translucent. Fruits contains medium amount of vitamin C and can be used for preserve making.

CV. Francis : The tree has drooping branches and thus known as *Hathijhool.* This is a moderate bearing cultivar (3.01 female flowers/branchlet). Fruits are medium to large in size (41.3g/fruit), flattend, oval, skin smooth, greenish yellow, strips 6, distinct, solid, thick at upper side and thin at basin, flesh soft, nearly fibreless and has moderate keeping quality. This cultivar is highly susceptible to fruit necrosis. In certain years, 70-80 per cent fruits get infected with necrosis and these are not suitable for preservation purposes.

CV. NA 6 : This is a mid season strain, fruits being medium in size, flattened in shape, skin smooth, greenish yellow in colour, strips 6-8, distinct, thin flesh fibreless, soft, fruit cracking is very common and has poor keeping quality. This is a moderate bearer (2.50 female flowers/branchlet).

CV. NA 7 : This is a seedling selection from the open pollinated seeds of cv. Francis. The tree has upright growth habit instead of drooping branches as in Francis. It bears profusely, fruits flattened oval, basin irregular and conical in shape., skin smooth, yellowish green flesh. It is very interesting to note that this strain does not show any symptom of fruit necrosis and hence can be used for preserve making.

CV. Chakaiya : This is a late maturing variety. The tree has spreading habit and bears profusely and possesses 4.0 female flowers per branchlet. Fruits are small to medium in size (30.5 g/fruit), flattened, skin is smooth, russet green in colour, strip not distinct, thin, solid, flesh, fibrous. The fruits have strong attachment, therefore, premature drooping is not a serious problem. Fruits have moderate keeping quality and are suitable for preparation of pickles and other products. This strain does not have the problem of fruit necrosis. Because of profuse bearing, freedom from fruit necrosis and premature drooping, this cultivar is gaining popularity for commercial plantation.

CV. NA 5 : This is perhaps a chance seedling of Chakaiya and locally known as Kanchan in Pratapgarh. The tree has spreading habit. It bears profusely because of higher number of female flowers (4.69/branchlet). Fruits are small to medium sized (32 g/fruit), flattened oblong, skin smooth, yellowish in colour, strip 6, distinct, solid, segments; flesh fibrous, hard and ideally suitable for processing industry.

CV. NA 8 : This is a late maturing strain. Fruits medium in size, flattened oblong, segmented, skin smooth, yellowish green in colour, semi-translucent, strip 6, distinct, flesh moderate fibrous, hard and a moderately fruiting strain.

REFERENCES

Amal, E. K. and R. S. Raghavan. 1957. Physiology and vitamin in *Emblica officinalis*. Proc. *Indian Acad, Sci*, **47** : 312-314.

Singh, R. N. 1974. Hardy *aonla* (*Phyllanthus emblica* L.), ideal for dry regions. *Indian Hort.*, 19 (3) : 17-18.

Singh, J. R. and J. S. Arora. 1967. Physico-chemical difference in two varieties of *aonla* (*Phyllanthus emblica* L.) at maturity, *Punjab. Hort. J.*, **7** : 145.

Teaotia, S. S., D. B. Singh, R. D Singh and R. N. Singh. 1968. Studies of some varieties of *aonla* (*Phyllanthus emblica* L.) of Eastern Uttar Pradesh. *Punjab Hort. J.*, **8** : 241-244.

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Short Communication

Variability in Genetic Resources of Vetiver

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Two explorations were undertaken to augment the genetic resources in vetiver in 1984, 22 genetic stocks were collected from Bharatpur-Bayana, Bharatpur-Sewar, Bharatpur-Agra and Roopdas highways, while in 1986, 40 collections were made from Keoladeo National Park (Ghana Bird Sanctuary), Bharatpur (where populations of *khus* occur in a protected area of about 29 sq. km).

These 22 genetic stocks from Bharatpur collection were planted in 5 row plots at Issapur Experimental Research Farm in August 1984. Data on growth and root characters were recorded during January 1986, 18 months after planting, when the roots were dug up.

Data were recorded on six characters for 21 accessions (Table 1). The amount of variation observed was for minimum number of stems/plant (12-185) in NC

TABLE 1. ROOT YIELD, OIL CONTENT AND OTHER ATTRIBUTES WITH MEAN VALUES/PLANT OF VETIVER COLLECTIONS

Accessions		No. of stems	No. of roots	Root diameter (mm)	Root lenth (cm)	Root weight (g)	Oil content (%)
NC 66403	Bund-A	113	274	2.8	23	600	0.75
NC 66404	Bund-B	64	284	2.8	23	582	0.60
NC 66405	Sewola	116	436	2.9	24	905	0.30
NC 66406	Bamanpura	63	230	2.9	24	432	0.40
NC 66407	Jhatolighana	113	331	2.4	26	739	0.60
NC 66408	Barson	95	277	2.9	23	593	0.62
NC 66409	Nagla Bartai	47	223	2.7	24	395	0.28
NC 66410	Chakbhanera A	86	442	2.8	24	1035	0.34
NC 66411	Chakbhanera B	52	286	2.8	25	520	0.30
NC 66412	Uncha Nagla	53	268	2.8	23	516	0.37
NC 66413	Darapur khurd	81	441	2.9	23	818	0.66
NC 66414	Malha A	52	334	2.9	27	740	0.37
NC 66415	Malha B	116	431	2.2	24	952	0.60
NC 66416	Sewar Road A	123	391	2.4	23	854	0.65
NC 66417	Sewar Road B	109	510	2.2	25	813	0.38
NC 66418	Jaicholi A	88	353	2.1	21	615	0.50
NC 66419	Jaicholi B	116	352	2.2	24	811	0.34
NC 66420	Jaicholi C	95	329	2.3	25	994	0,37
NC 66422	Sewar Bridge	105	500	2.3	25	1140	0.25
NC 66423	Bagdhari 101	101	333	2.4	26	754	0.60
NC 66424	Sewar Rly tract	75	326	2.1	23	723	0.33

66424 to maximum number of stems per plant in NC 66403 (30-312). The highest mean value for number of stems per plant was recorded in NC 66416 (123). Average number of roots per plant, a character for which this taxon is valued, was observed in NC 66417 (510). The highest root diameter was recorded in NC 66405, NC 66406, NC 66413, NC 66414 (2.9 mm) and the lowest in NC 66424 and NC 66418 (2.1 mm). The root length in all the collections showed little variation-21 cm (NC 66418) to 27 cm (NC 66414). Root weight per plant was found to be the highest in NC 66422 (1140 g) followed by NC 66410 (1035 g) and NC 66420 (994 g), with the highest oil content in NC 66403 (0.75 per cent), followed by NC 66413 and NC 66414 (0.66 and 0.65 per cent), NC 66404, NC 66407, NC 66415 and NC 66423 (0.60 per cent). In general high root yielding cultures gave low oil content.

Studies of physico-chemical constants showed that most of these collections are characterised with low to medium acid value (13.00 to 37.03), high esters (35.49 to 99.92) and high free vetiverol content (44.25 to 79.09). These high values of free vetiverol are indicative of good quality of oil from odour point of view. Gas chromatography studies revealed that these oils contain khusinol and khusilal, the chemomarkers of North Indian vetiver oils. The superior germplasms identified are NC 66403, NC 66404 and NC 66416, which gave oils of superior quality having excellent odour value.

Aroma characteristics

Perfumery industry valued vetiver oil due to its sweet, rooty/woody odour. The odour of most of these collections was observed more towards North Indian vetiver style. Some collections possessed high odour value. Whenever there is an increase in khusilal peak in GC, aldehyde note gets increased. Most of these collections possessed dominant odour characters of wild vetiver.

It was observed that NC 66416, which possessed medium root yield with an oil content of 0.65 per cent, free vetiverol to the tune of 79.09 per cent was the best out of the whole lot. The percentage of total vetiverol content is also very high (85.74 per cent). Its overall odour effect is very attractive. This has already been multiplied from the counterpart clones for maintaining its purity and can be utilized straightway.

Other two collections, NC 66403 and NC 66404 form good body, though these initially give South Indian apprehension. These possess low percentage of free vetiverol (44.25 and 48.96 per cent, respectively), but do have total vetiverol to an extent of 69.90 and 68.32 per cent. Odour of NC 66404 is typical rooty/woody, long lasting and having completely round note. Its oil has been commended by a number of perfumers.

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Short Communication

Collection and Evaluation of Genetic Resources of Tuber Crops in Orissa

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One of the fastest and the easiest ways of developing improved varieties is to properly exploit the available genetic variability. However, the cultivated, semi-cultivated and even the wild forms in tuber crops have been lost considerably due to erosion and efforts are thus needed to collect and preserve the exsiting variability. Most tuber crops are highly heterozygous in nature and exhibit considerable variation.

GERMPLASM COLLECTION

Attempts were made to collect variability in tuber crops from indigenous as well as exotic sources, particularly tribal dominated tracts holding different primitive cultivars in the plains and mountains and inhabited by different ethnic groups (Table 1).

TABLE 1. TUBER CROPS COLLECTED AND MAINTAINED AT THE CENTRAL TUBER CROPS RESEARCH INSTITUTE, REGIONAL STATION, BHUBANESWAR

Common Name	Species		Germplasm available
Cassava	*Manihot esculenta*	(i) Exotic	202
		(ii) Indigenous	34
Sweet potato	*Ipomoea batatas*	(i) Exotic	—
		(ii) Indigenous	139
		(iii) Developed	268
Yams	*Dioscorea alata*		49
	Dioscorea esculenta		3
	Dioscorea rotundata		5
Aroids	*Colocasia esculenta*	(i) Indigenous	75
		(ii) Wild	3
	Amorphophallus campanulatus	(i) Indigenous	15
Chinese potato	*Coleus parviflorus*		1
Arrow root	*Maranta arundinacea*		1
Yam bean	*Pachyrrhizus erosus*		1
Total diversity maintained			796

EVALUATION

The germplasm of yams, sweet potato, cassava, aroids and other tuber crops were evaluated for different useful characters under Orissa conditions. Emphasis has been laid on the characters which have bearing on the local needs.

Aroids

The collections of *Colocasia* were evaluated for characters like plant height, number of branches, length of petiole, diameter of petiole, length of leaf, width of leaf, yield of corms, flowering behaviour and pigmentation patterns on leaf, petiole and leaf veins. The collections showed a good range of variability for almost all the characters except number of branches.

Cassava

Extremely good genetic variability was observed in most of the important agronomic traits. Besides, the general screening of cassava germplasm for morphological characters, collections have also been evaluated for characters, such as tuber production, high starch content, lower cyanide content, shade tolerance, tolerance to water logged conditions, flavour of tuber, adaptation to cool temperatures, drought tolerance, high harvest index, shorter crop duration, cooking quality, lower fertilizer requirement and physiological traits.

Two cassava types viz., H-212 and H-125 have been identified as high tuber yielders at 8 and 10 months harvest stage, respectively. Physiologocal traits associated with productivity, such as retention of leaves on the plant, branching pattern and root bulking were also studied.

The sweet potato types have been evaluated for different characters like vine length, weight of the vine, leaf characters, number of nodes on the stem, flowering behaviour, incompatibility, weight of tubers, shape of tubers, infestation of weevils, sweetness and cooking quality of tubers, etc. The collections have shown variability in almost all the characters studied. Some high yielding types, highly carotenoid type and a type resistant to weevil has been identified from the available germplasm.

Yams

Dioscorea alata and *D. rotundata* were evaluated for several useful characters, such as number of tubers per plant and the tuber yield per plant. Varieties Da-25 (1.36 kg per plant) and Da-24 (1.14 kg per plant) were selected for their high tuber yield per plant.

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Short Communication

Introduction and Collection of Plant Genetic Resources of Medicinal and Aromatic Plants and their Utilization

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National Bureau of Plant Genetic Resources, New Delhi

The Division of Germplasm Exchange successfully introduced a broad spectrum of genetic diversity comprising well over 1160 accessions in 96 genera and 275 species of different medicinal and aromatic plants (1976-1986) from 38 countries of the world, under phytosanitary conditions.

The entire range of exotic medicinal and aromatic materials imported was not used and conserved by any single agency. Collections were maintained to the extent possible at different institutions and locations by the specialists/scientists concerned with these crops throughout the country. The pharmaceutical industries were dependent on the collections of raw materials from wild sources both in India as well as abroad. As such, several of the plant collections under cultivation were introduced from countries like USA, USSR, Hungary, GDR, FDR, Japan, Poland, United Kingdom, Bulgaria, Portugal, Czechoslovakia, France, Italy and Australia. Some of the important plant genetic resources introduced included *Anethum graveolens*, *Atropa* sp., *Glaucium flavum*, *Lavandula vera*, *L. angustifolia*, *Matricaria Chamomila*, *Pyrethrum* sp. and *Salvia sclarea* from Bulgaria; *Aconitum nepallus*, *Chrysanthemum cinerarifolium*, *Glycyrrhiza glabra* and *Plantago* sp. from Czechoslovakia; *Papaver bracteatum* ($2n = 14$), *P. orientale* ($2n = 28$) and *P. somniferum* ($2n = 22$) from Finland; *Pogostemon cablin* from Indonesia; and *Apium graveolens*, *Artemisia annua*, *Datura* sp., *Glycyrrhiza glabra*, *Gentiana* sp., *Hypericum perforatum*, *Hyssopus officinalis*, *Lavandula angustifolia*, *Mentha* sp., *Ocimum* sp., *Plantago psyllium*, *Salvia officinalis*, *Satureja hortensis*, *Silybum marianum*, *Solanum laciniatum* and *Valeriana officinalis* were introduced from Hungary and Germany.

Utilization of germplasm collections

The main recipients of germplasm collected/introductions made by the NBPGR were the network of All India Co-ordinated project on Medicinal and Aromatic Plants and scientists handling medicinal and aromatic plants in agricultural universities and other centres. Besides, the Bureau too evaluated and conducted performance trials of such materials at its Headquarters and some of its regional stations. These efforts culminated in the identification of several promising genotypes, some of which were released as primary introductions.

Promising introductions of importance

Introduction activities resulted in selection of promising material in different medicinal and aromatic plants. In this context, mention may be made of

Artemisia annua, a native of Indo-china, with the active constituent artemisinine. This drug could be used for controlling malaria, where existing antimalarial drugs failed, leaves of EC 172510 (USA) at the flowering stage yielded artemisinine content of 0.02 per cent. Artemisinine and Arteannuim are used for cerebral thrombosis in China (Duke, 1983).

Catharanthus roseus. G. Don (Syn. *Vinca rosea*), a native of the carribean islands in the West Indies, and naturalised all over the tropics was found to grow wild along the coastal area of Tamil Nadu, Andhra Pradesh, Karnataka, Assam and West Bengal. The leaves, rich in vincristine (VCR) and vin-caleuco-blastine (VLB) could be used in the treatment of cancer. Ajmalicine and serpentine from roots are used for controlling high blood pressure. There are two other constituents, viz, vindoline and catharanthine in leaves, which could be used in synthesis of VLB analogs. An exotic introduction, EC 120837 (USSR), rich in alkaloids was identified as promising at NBPGR, rich in alkaloid content (Mandal and Maheshwari, 1987).

In pyrethrum (*Chrysanthamum cinerariifolium*), promising introductions were EC 138836-37 (Malawi) with white and pink flowers and several accessions procured from Kenya, particularly EC. 145650 was a promising type with prolific flowering.

EC. 115996 of foxglove (*Digitalis lanata*) from Poland was selected for higher content of glycoside in the foliage at Solan in 1983. Seventeen accessions of *Glycryrrhiza glabra* and other related species were received from various countries. Though no significant differences among accessions were recorded for root yield, EC. 128587 (Pakistan) and EC 114304 (USSR) gave significantly higher glycyrrihizic acid percentage than others. *Glycyrrhiza foetidissima* (EC 144048, ex. USSR) contained a very high amount of glycyrrhizic acid (14.87 per cent).

In *Hyoscyamus muticus*, among others, EC 93928 (Germany) showed high alkaloid content of 0.122—0.59% (Mital and Saxena, 1977). *H. albus*, EC 85759 (Germany), showed high herbage yield of 400-500g/plant on a fresh weignt basis and 0.085-0.1065 per cent alkaloid content (Saxena *et al.*, 1978).

Among *Lavandula* sp. *L. stoechas* ssp. luisieri (EC 120176) from portugal and *L. angustifolia* (EC 165432) and (EC. 154023) from UK were found to establish well at Kodaikanal and flowering twigs gave an oil yield of 0.30 per cent on distillation.

In *Mentha piperita,* EC 41911 (USSR) showed promise for higher herbage yield, essential oil content (0.5%) and menthol (60%) (Maheshwari *et al.*, 1983). This accession was recommended for release for cultivation.

Thirteen accessions in *Matricaria chamomila* gave promising results at Kodai-kanal centre and were put for multiplication.

In anise (*Pimpinella anisum*) anethole rich collection, EC 22091 (France) was evaluated and one plant was identified best which is rich in anethole content (Pareek *et al.*, 1980).

Ocimum oil is used in perfumery and food flavouring industry. *Ocimum basilicum* (EC. 176934 from France) with the highest percentage of oil (0.43%) and linalool (76.86%), *Papaver somniferum* (EC 196429) containing considerable amount of morphine (0.40-0.82%) and noscapine (0.12-0.27%) were promising. EC 196430 with high percentage of morphine (0.33-0.77%); papavarine 0.00-0.20% and moscapine-0.03-0.04% and EC. 196433 (morphine-0.31-0.67%) and papavarine-0.06-0.19%; (Wickstrom *et al.* 1982 and 1984 were introduced from Finland. In *Papavar bracteatum*, EC 196437 and EC 196438 were chemotypes varying in thebaine-alpinigenine (Nyman and Bruhn, 1979; Philipson, 1983) and rich in thebaine content of 30.50 per cent and 0.48 per cent (Pyysalo *et al.* 1987).

In hops (*Humulus lupulus* L), promising varieties like late cluster (EC. 38868, USA), Tardifde bourgigyne (EC 38804, Japan), Hybrid-2 (EC 3496, S. Africa) and F 51 (EC 39993, S. Africa) were identified in trials conducted at Simla. Other promising materials were *Rosemarinus* sp. EC. 154021 from UK with 0.10 per cent essential oil, *Solanum khasianum* and *S. laciniatum* (EC. 113464, USA) with high solasidine content in aerial parts (0.05%) and in dry berries 6.6%).

The efforts made by the Bureau in the introduction and collection of genetic resources of medicinal and aromatic plants during the last decade include species of *Artemisia, Catharanthus, Chrysanthemum cinerariafolium, Digitalis, Glycyrrhiza, Hyoscyamus, Lavandula, Matricaria, Rosemarinus, Solanum* and *Humulus lupulus*. This has helped the country in augmenting the capacity for production of alkaloids and essential oils much required in drug pharmaceutical and essential oil industries.

REFERENCES

Duke, J. A. 1983. Another billion dollar weed. The Bot. Grower 1(2) : 3-4.

Maheshwari, M. L., Sangita and Jitandra Mohan. 1983. Exotic Peppermints. Perf. and Flav. Assoc. India, J. 5(4) : 15-27

Mandal, S. and Maheshwari, M. L. 1987. High pressure liquid chromatographic determination of vindoline, catharanthine, vincaleu koblastine and vincristine in Perwinkle leaf. Indian J. Pharm. Sci 49(6) : 205-209.

Mital, S. P. and R. K. Saxena. 1977. Egyptian henbane—a promising drug plant. Horticulture. 23(1) : 11-12.

Nyman, U. and J. C. Bruhn. 1979. Papaver bracteatum. A summary of current knowldege. Planta Medica. 35 : 98-117.

Pareek, S. K., Maheshwari, M. L., Trivedi, K. C. and R. Gupta, 1980. Anise new carh crop. Indian Farming. 30(10) : 25.

Philipson, J. D. 1983. Inter-specific variation and alkaloids of papaver species. Planta Medica 48 : 187-192.

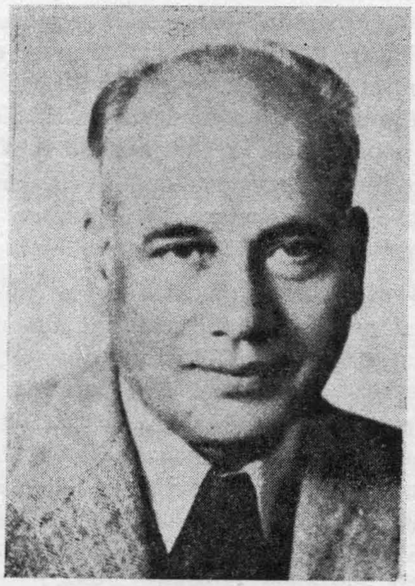
Pyysalo, H., C. J., Widen, C.•A. Salemink, A. Rouji and A. Ojala by Pyysah. 1987. Interspecific hybridization in Papaver 2. Alkaloid coontents their interspecific hybrids.-Ann. Pot. Fennici. of Papaver somniferum and species of section oxytona as well as

Saxena, R. K., M. A. Kidwai and M. W. Hardas. 1978. Plant Introduction experiments with henbanes—new raw material for Indian drug Industry. Indian Drugs. 16(5) : 102-104.

Wickstrom, K., C. J. Widen, H. Pyysalo and C. A. Sakenubj 1982. Quantitative data on the alkaloid contents of *papaver somniferum* and *P. bracteatum* cultivated in Kuopio, Finland in 1979-80. United Nations Secretariat, 40 : 1-10.

Wickstrom, K., C. J. Widen, H. Pyysalo and C. A. Salemink. 1984. Alkaloid formantation of *Papaver somnifernm* in Finland. Ann. Bot. Fennici. 21 : 201-208.

OBITUARY



DR. B. P. PAL

The Indian Society of Plant Genetic Resources is deeply grieved on the sad demise of Dr. B. P. Pal, a doyen of Indian Agriculture and a plant breeder of great eminence. He was the patron of ISPGR and his passing away in the afternoon of 14th September, 1989 at AIIMS, New Delhi is condolled by all its members.

Dr. Benjamin Peary Pal was born at Mukandpur in Punjab on 26th May, 1906. He received his early school education in Burma, which was then a part of British India. He had a brilliant academic career althrough. He graduated from Rangoon University in 1924 and distinguished himself by winning the Mathew Hunter Prize for standing first among all science graduates in the university. He obtained his post graduate (M. Sc.) degree with 1st class honours in Botany. He won the state scholarship for studies at the Cambridge University, England for his Doctoral degree.

Dr. Pal returned to Burma in 1933 and was appointed Assistant Rice Research Officer at the Central Rice Research Station. Later in the same year, he was selected as the Second Economic Botanist at the Imperial Agricultural Research Institute (now called Indian Agricultural Research Institute) at Pusa, Bihar. Dr. Pal became the first Imperial Economic Botanist in 1937. The post was later redesignated as Head of the Division of Botany which he held for nearly 13 years. In 1950, he took over as Director of the Indian Agricultural Research Institute and continued until May, 1965. Later in the same year, he was appointed as the first Director General of the Indian Council of Agricultural Research. During this period (1948-1965) he laid the foundation of plant introduction activities at IARI, which later became Plant Exploration and Collection Organisation, and finally became a full fledged Division of Plant Introduction. Dr. Pal had a highly distinguished research career spread over several decades, and happened to be the most renowned and illustrious plant breeder of great eminence. His contribution to the development of high yielding rust resistant varieties of wheat is considered to be of great practical scientific significance. Equally well known are his contributions to the improvement of potatoes and tobacco. Development of unique varieties with rare and bewitching colours of Indian roses is perhaps the best recognition of his love to the nature. His passion and devotion to rose breeding was not only legendary but deeply inspiring.

Dr. Pal earned great scientific fame, recognition, and was bestowed with several prestigeous honours and awards. The prominent among these include, Rafi Ahmad Kidwai Memorial Award (1957), Padma Shri (1959), Birbal Sahni Medal (1962) and Padma Bhushan (1968). He also received Srinivasa Ramanujam Medal (1964), INSA Grant Medal (1970), Agri-Horticultural Society of India, Barclay Medal (1971), Asiatic Society, Aryabhatta Medal (1980), INSA, Chatterjee Memorial Award (1982), Indian Science Congress Association and Sir Williams Jones Medal (1982). He was elected President, Indian Science Congress Association (1951, 1957-58, 1965-67). Additional member (1977-78), Treasurer (1952), Secretary (1953-56), Vice President (1960-61, 1973-75), Editor of Publications (1960-61) and President (1975-76), INSA. He was also conferred Doctor of Science (D.Sc.) honoris causa by the Punjab Agricultural University, Ludhiana, Haryana Agricultural university, Hisar, Banaras Hindu University, Sardar Patel University and Indian Agricultural Research Institute, New Delhi. He also received prestigeous Sanjay Gandhi Memorial Award (1982) for his contribution to the environmental conservation. The O. P. Bhasin Award was also bestowed upon him in 1985.

Dr. B. P. Pal was conferred fellowships of many learned Academic Societies in India and abroad. He was a distinguished Fellow, Royal Society of London; Honorary Fellow, Linnean Society, London; Foreign Member, All Union Lenin Academy of Agricultural Sciences; Honorary Member, Japan Academy, Genetics Society of Japan; President of Indian Society of Genetics and Plant Breeding; Indian Botanical Society; Horticultural Society of India; and Society for the Advancement of Breeding Researches in Asia and Oceania. Dr. B. P. Pal was a highly respected and admired person. He was a great humane and visionary. He endeared himself to every one because of his grace, deep love for nature and science and a good sense of humour. He remained a bachelor throughout his life and devoted selflessly his time to the passions of science, nature, fine arts and creativity. In him, scientific community in general and Indian Society of Plant Genetic Resources in particular has lost a patron, great advocate of plant genetic resources, and a conservationist, under whose shadow the sapling of genetic resources emerged, nurtured and got established firmly. We owe a great deal to this departed soul.

We all pray, 'May his soul rest in peace.'

(Continued from first cover page)

Short Communications

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