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MAIZE GERMPLASM COLLECTIONS FROM NORTH-EASTERN HIMALAYAN REGION

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Presence of striking variability for maize has been reported from the north eastern region of India which is earmarked as one of the centre of diversity for this crop. Maize germplasm has been collected from the Himalayan region periodically and such collections continue to fetch some of the types which were primitive and resembled closely to the postulated ancestors of maize. Unconscious selections made by different ethnic groups has helped in preservation of maize diversity. In three exploration trips, 799 landraces were collected from Arunachal Pradesh (252), Assam (24), Manipur (47), Meghalaya (184), Mizoram (99), Nagaland (62), Sikkim (122) and others (9). A wide range of variability for plant, ear and kernel characters was observed. Nature and extent of variability has been described.

Key words : Maize, germplasm, exploration/collection

Maize germplasm has been collected from the Himalayan region periodically ever since Anderson (1945) and Stoner and Anderson (1949) reported the presence of striking variability for this crop in the north eastern Himalayas. Such collections continue to fetch some of the types which were primitive and resembled closely to the postulated ancestors of maize as pointed out by Dhawan (1964) and Thapa (1966). A systematic indexing of 1571 accessions from various parts of India, particularly the eastern and western Himalayan regions, into 15 "races" and 3 "sub-races" ranging from primitiveness to advancement, in terms of crop evolution, was done by Singh (1977). Due to preponderance of traditional cropping systems of mixture crops under shifting cultivation pattern in the north east, some of these races e.g., 'Khasi Riewadem' are retained in its equilibrium form even to date.

The north-eastern Himalayan region is earmarked as one of the centres of diversity in maize. In the process of evolution, unconscious selections made unknowingly by different ethnic groups helped preserve and contribute to the diversity of maize crop which was supplemented by other factors like open-pollinated nature of maize, the cryptic changes in the genetic make-up of the crop due to sudden release of energy following tremors in the north-eastern

Himalayan zone etc. The local corn germplasm may be of importance due to several primitive features including popping types, marked striation of the kernels, small sized ears and more number of ears per plant etc. and also the possibility of getting transgressive segregants in crosses with the maize landraces from the new-world. The present paper highlights the attempts made to collect maize germplasm particularly from north-eastern Himalayas during the years 1991 and 1992. Collection and conservation of these diverse types in maize would be useful for posterity.

COLLECTION AREAS AND STRATEGY

Three exploration trips were undertaken for the collection of maize landraces under NBPGR-IPGRI collaborative maize collection project. In total, 799 collection were made from various parts of the north-eastern states viz., Arunachal Pradesh (East Siang, West Siang and West Kameng); Assam (Kamrup, Karbi Anglong, Kemi and Dhekiajuli); Nagaland (Kohima, Jaluki, Ngwalwa and Punglaw); Manipur (Tabenlang, Chandel, Senapati and More); Mizoram (Aizawl, Kolashib south, Kolashib, Kawanpuri and Taitow); Tripura; Meghalaya (Garo Hills, Khasi Hills, Jaintia Hills and Khilling Hills) and Sikkim (East

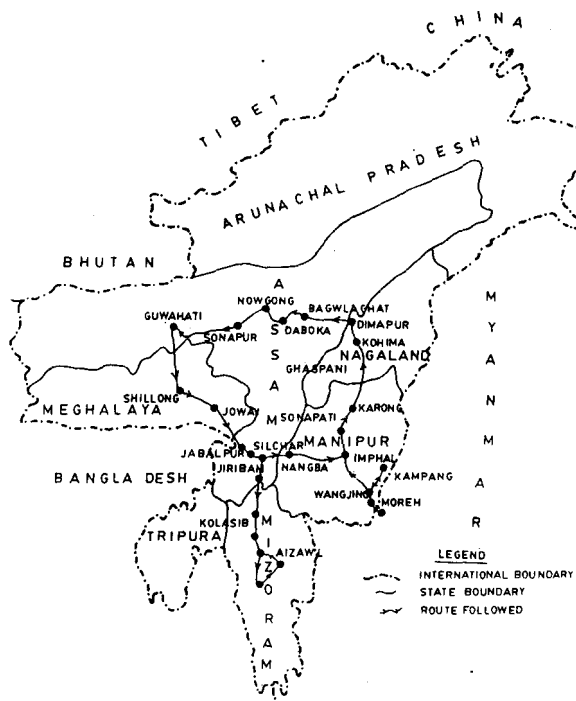


Fig. 1. Route map for maize germplasm collection from parts of N.E.H. Region (Sept - Oct 1991)

Sikkim, North Sikkim and South Sikkim). The route maps followed during these explorations are given in Fig. 1 to 4. The majority of the collection in this study were made directly from the farmers' field during the harvest season. An effort was made to obtain 10-15 ears from each field and to include in this number as much variation as possible in respect of ear and plant types. Detailed passport data on each accession were collected and studies were made on population sample. The collections were dried, catalogued and photographed.

Standard descriptors were used for taking the notes on ear and kernel characters. The frequency of accessions for each characters were calculated on the basis of scores given such as ear length (cm) (1 = 5-10, 2 = 11-15 and 3 = >15); kernel row number (1 = 8-10, 2 = 12-16, 3 = >16); kernel number per row (1 = < 15, 2 = 15-30, 3 = >30); kernel type (1 = flint, 2 = semiflint/semident, 3 = pop and 4 = others); kernel colour (1 = yellow, 2 = white, 3 = others) and ear number (1 = 1, 2 = 2, 3 = 3 and above). After taking the data, a sample ear of each accession was selected, whereas the remaining ears were shelled and the seed was mixed.

Table 1. Maize diversity collected during 1991-1992

State	No. of collections	Altitude (m)
Mizoram	99	350-1300
Nagaland	62	310-570
Manipur	47	280-1259
Meghalaya	284	400-1800
Arunachal Pradesh	252	200-2300
Sikkim	122	330-1900
Assam	24	250-1350
Others	9	-
Total	799	

GERMPLASM VARIABILITY

In recent explorations, extensive variability for various ear and kernel characters was recorded in collections made from the north-eastern region of India. The variability in maize cultivars from Sikkim, Meghalaya, Arunachal Pradesh, Manipur and Assam was outstanding. The study of natural populations and data recorded at site revealed that a wide range of variability existed with respect to ear length, ear diameter, ear number per plant, kernel row arrangement, kernel rows, kernels per row, kernel type and kernel colour. Dwarf to tall landraces (1-2.2 m) continue to occupy the region differing

widely in adaptation to varying altitudes (200-2500 m) and soil conditions from mountainous, sub-mountainous ranges slopping to the plains of assam. Some of the landraces collected from Khilling area of east Khasi Hills were reported to be early maturing (75 days) and are still under cultivation.

Kernel row arrangement showed interesting feature and it varied from 'regular', 'irregular to base', 'irregular to tip', 'irregular from base to middle of the ear' and 'totally irregular'. In this collection, majority of the landraces had regular kernel row arrangement, though in some accessions, totally irregular or other kernel row arrangement also occurred suggesting primitiveness of the landraces. The frequency distribution for different ear and kernel characteristics is given in Table 2. Much variation occurred in ear length (6-22 cm).

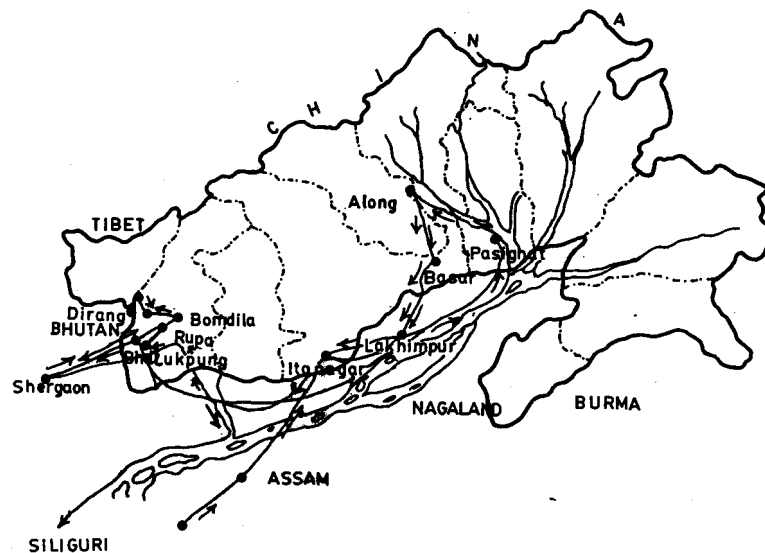


Fig. 2. Route map for maize germplasm collection from Arunachal Pradesh (Sept. 1991)

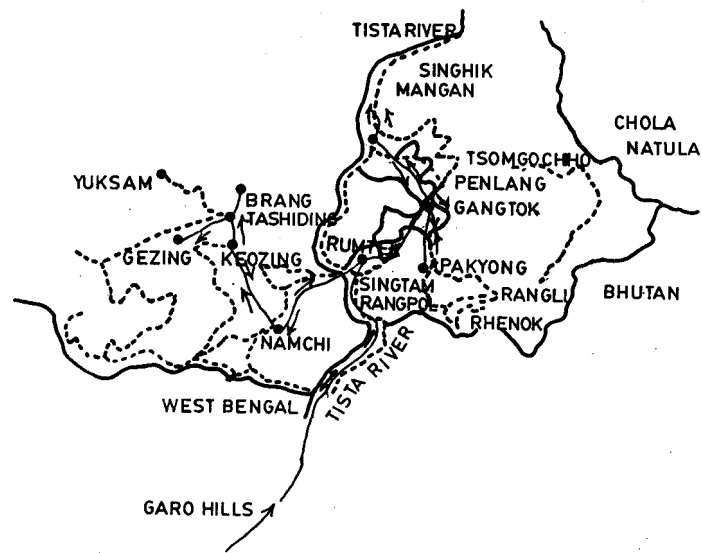


Fig. 3. Route map for maize germplasm collection from Sikkim (Nov. 1992)

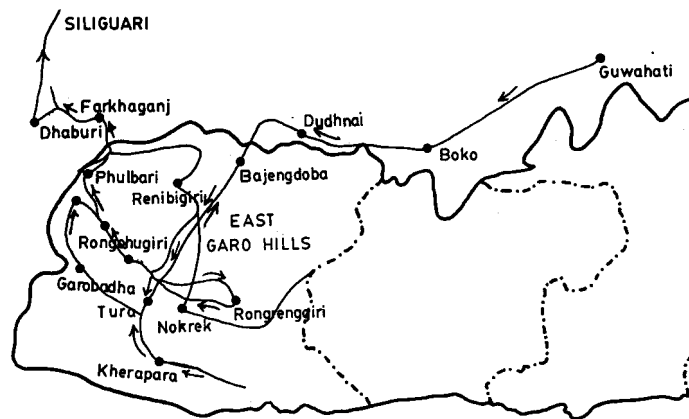


Fig. 4. Route map for maize germplasm collection from Garo Hills (Nov. 1992)

Table 2. Frequency distribution for different ear/kernel characteristics in maize germplasm (Percentage values in the parenthesis)

Character/Grade	Frequency			
	1	2	3	Total
Ear length	110 (13)	533 (67)	156 (20)	799 (100)
Kernel rows	90 (11.5)	665 (82)	44 (5.5)	799 (100)
No. of kernels per row	90 (11)	564 (70)	145 (19)	799 (100)
No. of ears per plant	532 (66)	75 (10)	192 (24)	799 (100)
Kernel type	593 (74)	50 (6)	156 (20)	799 (100)
Kernel colour	574 (72)	35 (4)	190 (24)	799 (100)

* = see text for details

About 67 per cent accessions had ear length between 11-15 cm, whereas 20 per cent accessions had ear length more than 15 cm. A good amount of variability was observed for the prolificity of the ear and it varied from 1-5. Ear number per plant in 76 per cent accessions was either one or two, whereas in 24 per cent accessions the number was either 3 or more. Ear diameter varied from 1.8 cm to over 4.5 cm. Kernel rows varied from 8 to as high as 22. Kernel rows between 12-16 possessed in 67 per cent accessions, whereas about 6 per cent (44) accessions had kernel rows more than 16. Kernel number per row between 15-30 were found in 76 per cent accessions and only 18 per cent accessions had more than 30 kernels per row.

A wide range of variability existed in kernel colour (yellow, white, purple, dark-purple, cherry, blackish to varied admixtures). About 72 per cent collections had yellow kernel colour. Whereas, only a few accessions (35) possessed white kernels. Kernel type varied from flint, semiflint, semident to pop. Of the total collections, 74 per cent collections had flint kernel type and 20 per cent had pop kernel type. The frequency of semiflint and semident was very low (5%). It was observed that yellow flint types were predominant and under cultivation throughout the north-eastern Himalayan region of India. Earlier reports (Wellhausen, 1965) suggested that Indian maize seemed to be nearly, yellow, flint with long slender ear, somewhat enlarged at the 'butt' with light yellow endosperm and shallow grains closely resembling the early yellow flints grown in North-eastern parts of United States of America.

This collection represented primitive to advance types (Fig. 5). It is worthwhile to record again that the primitive types and other landraces encountered about the 20 years ago are still prevalent in pure form to a larger extent in the Garo Hills and other parts of north-east India. Some of the strains from Sikkim had very close resemblance to the postulated ancestors of maize. Further, this diversity collected or observed, represents 10 of Indian maize

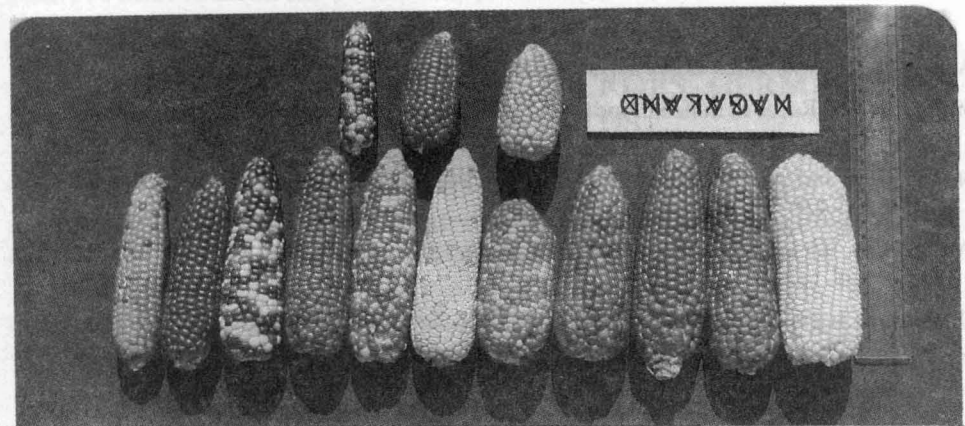


Fig. 5. Maize collections from NEH region representing primitive to advance types



Fig. 6. A primitive land race of maize stored separately from an improved cultivar

racess reported from the north-eastern Himalayan Region by Singh (1977). The north-eastern region is not only having this wide spectrum of genetic variability but it is clear that this diversity falls in distinct groups, whose identity has been preserved over centuries. These races provide useful information on the types of variability available and the varietal populations that would be suitable in meeting the needs of specific breeding programmes.

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MANAGEMENT OF VEGETABLE CROPS GERMPLASM - CURRENT STATUS

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National Bureau of Plant Genetic Resources (NBPGR), New Delhi is the mandatory National Active Germplasm Collection Site for vegetable crops in the Indian National Plant Genetic Resources System (IN-PGRS). NBPGR is responsible for maintaining base collection/working collections of many vegetable crops such as Solanaceous (eggplant, tomato, chillies), Leguminous (cowpea, pea, beans), Cucurbitaceous (pumpkin, gourds, melons and cucumber etc.), Leafy (spinach, Chinese cabbage, methi etc.), Bulbous (garlic and onion), Root crops (radish and carrot) and okra. Considering the importance of distribution of diversity in Indian Gene Centre, IBPGR has also assigned crop responsibility for 5 vegetable crops viz., okra, eggplant and lablab bean (global), chillies and radish (Asian). Comprehensive collections have been made through exploration in the sub-continent and sizeable number introduced from abroad. More than 15500 collections in different vegetables have been made since 1986 to 1994-95 and about 18000 lines imported from several countries during the same duration. Characterization and preliminary evaluation is carried mainly at Issapur Farm, New Delhi and several centres of NBPGR. The current holdings of vegetable crops (over 24000) and tuber vegetables except potato (about 2,000) is under evaluation at different centres. Several promising lines have been identified. Some 5,735 samples of vegetable crops have been kept in long-term storage (-20°C). The working collection are maintained in medium-term storage ($+40^{\circ}\text{C}$). Besides several vegetables are conserved *in-vitro* through tissue culture. Documentation of information, related to plant genetic resources provides basis for utilization of potential germplasm in crop improvement. Based on the characterization and preliminary evaluation, germplasm accessions are catalogued to facilitate breeders in selecting the material of their interest. So far, 14 catalogues have been published on various vegetable crops like french bean, tomato, okra, chillies, winged bean and cowpea. NBPGR has strong linkages with several Institutes/Universities in India in respect of vegetable crops. Seeds of promising lines are supplied directly to indentors which include farmers and seed growers also.

Key words : Vegetable crops, germplasm, management

Vegetables, comprising of solanaceous, cucurbitaceous, leguminous, leafy, cole, root, rhizomatous and bulbous crops, constitute one of the biggest group of cultivated plants. These represent a wide array of taxa and groups depicting diverse edapho-climatic adaptability, plant types and usage based upon consumption of different plant parts for food. Vegetables provide vitamins, minerals

and protein and remain indispensable component of human diet for vegetarians and non-vegetarians alike. The Indian sub-continent, which represents one of the 8 Vavilonian centres of origin and diversity of crop plants, exhibits preponderance of variable forms of different vegetable crops viz., landraces, primitive types, old and obsolete cultivars etc. Unconscious selection at farmers fields, isolated niches in diverse agroclimatic zones and tribal pockets, and traditional knowledge of various ethnobotanical uses of individual types are among the several factors leading to the accumulation of variability. The presence of few large-area based monocultures in vegetable crops, in contrast with cereals, render increased chances for collection of additional variability as well as new genes. National Bureau of Plant Genetic Resources (NBPGR), New Delhi is the nodal agency for the Indian National Plant Genetic Resources System (IN-PGRS) and also the mandatory National Active Germplasm Site (NAC) for the vegetable crops under this system (Rana, 1991). In addition, NBPGR holds the IBPGRI assigned crop responsibility for okra, eggplant and lablab bean (Global); and regional responsibility for chillies and radish (Asian). The present paper deals with the status of plant genetic resources activities of vegetable crops at the Bureau, particularly solanaceous crops (eggplant, tomato and chillies), leguminous crops (cowpea, pea and beans), cucurbitaceous crops (pumpkin, gourds, melons and cucumbers), bulbous crops (garlic and onion), root crops (radish and carrot) and okra.

GERMPLASM EXPLORATION AND COLLECTION

About 16,000 germplasm accessions of different vegetables, tuber, spices and condiments crops were collected through several crop-specific and multicrop expeditions conducted by NBPGR alone or in collaboration with other Institutes, during the period 1986 to 1994-95 (Table 1). The yearwise split up showed a systematic reinvigorated effort with collection of maximum accessions in the year 1989-90 (3974 accessions). These intensive efforts were continued in the subsequent years also as is evident in the Table-1. These collections showed substantial variation in terms of taxa, agronomical and quantitative morphological traits. Some notable collections for the related wild species include *Albemoschus tetraphyllus*, *A. tuberculatus* and *A. ficulneus* in okra, *Solanum surattense*, *S. torvum*, *S. indicum*, *S. incanum* and *S. insanum* in solanaceous vegetables and *Vigna unguiculata* ssp. *sesquipedalis* and *V. unguiculata* ssp. *angularis* in legume vegetables etc. In ridge gourd, several morphotypes of 'Satputia' were collected which bear fruits in clusters. Similarly, *Nenua* and *Chiwra*, having white seeded long fruits constituted prominent collections with adequate commercial potential. Among the states/regions showing interesting variability for specific crops were Madhya Pradesh, particularly Bastar belt and Sarguja hilly tracts for bottle gourd and North-eastern region, Maharashtra and Uttar Pradesh for cultivated brinjal and related wild species. Brinjal

accessions viz., **Kachabachia**, **Ramnagar** and **Balfawa Baigan** from eastern Uttar Pradesh, showed potentials for cultivation in the off-season. Variability in cowpea included types with extra-long snake like pods from north-eastern region and very small seeds/pod types from arid western zone. Enormous variability has been collected in chillies, onion, parwal, beans, cucurbits among vegetables, *Dioscorea* and cassava among tuber crops and *Piper*, *Curcuma* and *Zingiber* among spices and condiments (Rana *et al.*, 1993).

Table 1. Exploration and collection of indigenous germplasm of vegetable crops (1986 to 1994-95)

Year	No. of Exp. undertaken	Diversity Collected (No. of samples)			
		Vegetable	Tuber	Spices	Total
1986	28	1615	201	118	1934
1987	29	673	216	207	1096
1988	32	1220	33	400	1653
1989-90	48	3111	260	603	3974
1990-91	29	2799	-	-	2799
1991-92	22	1600	20	144	1764
1992-93	10	1559	-	-	1559
1993-94	7	350	-	-	359
1994-95	7	455	-	-	455
TOTAL	212	13382	730	1472	15584

INTRODUCTION OF EXOTIC GERMPLASM

Table 2 shows the number of germplasm accessions imported from other countries through introduction and exchange for the years 1986 to 1994-95. In all, over 18,000 accessions were introduced from 16 countries which covered 19 crop species in vegetables, 4 in tuber crops and 10 in spices and condiments. Some of the promising exotic introduced germplasm, ex. USA and Israel, may be enlisted in tomato for disease, pest and nematode resistance (EC-173859, EC-179883, EC-182761 to EC-182874, EC-196588 to EC-196597, EC-198416, EC-200769 to EC-200776 and EC-204194 to EC-204198). Some of these lines possessed additional desirable characters like resistance to biotic and abiotic stress and

heat tolerant. Cultivar Montecarlo (Ex USA EC-179189) was preferred for its deep red, globe shaped fruits. Germplasm accessions EC-248282 to EC-248311 ex. taiwan were the promising processing types. In onion, F1 hybrids having yellow coloured bulbs, and good storage quality (EC-177284, EC-177285, and EC-187221 to EC-187225) were imported from the Netherland and Germany.

Table 2. Introduction of exotic germplasm of vegetable crops (1986 to 1994-95)

Year	Number of accessions introduced			
	Vegetables	Tuber crops	Spices	TOTAL
1986	1957	73	7	1937
1987	783	720	4	1507
1988	2257	168	38	2463
1989-90	802	145	26	973
1990-91	1321	155	13	1489
1991-92	1176	148	51	1375
1992-93	2296	42	-	2338
1993-94	5208	-	-	5208
1994-95	1104	-	-	1104
TOTAL	16904	1451	139	18394

In cole crops, lines with multiple disease resistance (EC-175800 to EC-175806, ex USA, and EC-187228 to 187230, ex Canada, and better curd quality (EC-243384, ex Taiwan) were promising. Similarly, germplasm accessions with desirable characters were also observed in carrot (EC-274883 to EC-274886, ex Netherlands, EC-178385, ex Italy and EC-187207, ex USA), bell pepper (EC-280642, ex Netherlands), cucumber (EC-178495 and EC-329300, ex USA) and several other vegetable crops (Rana *et al.*, 1993).

Quarantine and phytosanitary inspection of the introduced germplasm is mandatory. NBPCR performs this National responsibility through the single window entry system for research materials/propagules. The post entry quarantine inspection includes physical inspection of seed, seed pathology and field screening. Efforts are also made to salvage the contaminated infested or infected seed or plant materials using appropriate techniques. Some important pathogens and pests intercepted on exotic vegetable crops alongwith the source country of the important germplasm is reported by Rana *et al.* (1993).

Table 3. Active germplasm holdings of vegetables crops at NBPGR

Crop/ Station	Delhi	Shi- mla	Bho- wali	Shill- ong	Jodh- pur	Akola	Amra- vati	Thri- ssur	Total
Vegetables									
Okra	2082	-	-	-	62	1147	-	263	3554
Brinjal/ eggplant	2321	-	-	-	-	-	-	-	2321
Onion	780	-	13	-	-	-	553	-	1346
Garlic	899	-	82	-	-	-	-	-	981
Tomato	2822	-	-	-	-	-	-	-	2822
Cucurbits	937	-	-	-	-	-	-	165	1102
<i>Allium</i> spp.	-	-	20	-	-	-	-	-	20
Chillies	-	-	-	-	-	-	388	365	753
Total	9841	-	115	-	62	1147	941	793	12899
Leguminous vegetables									
Frenchbean	132	2751	1291	-	-	-	-	-	4174
Cowpea	2461	-	13	-	345	-	-	498	3317
Peas	1738	120	95	-	-	-	-	-	1953
Sword bean	210	-	-	-	-	-	-	-	210
Lab- Lab bean	718	-	-	-	-	-	449	-	1167
Yam bean	-	-	-	-	-	-	33	-	33
<i>Mucuna</i>	198	-	-	-	-	-	-	-	198
Total	5457	2871	1399	-	345	-	482	498	11052
Tuber crops, species etc.									
Greater yam	-	-	-	-	-	-	-	181	181
Lesser yam	-	-	-	-	-	-	-	51	51
Elephant foot yam	-	-	-	-	-	-	-	121	121
Chinese potato	-	-	-	-	-	-	-	57	57
Cassava	-	-	-	-	-	-	-	154	154
Taro	-	-	-	112	-	-	-	130	242
Ginger	-	-	-	61	-	-	-	80	141
Coco yam	-	-	-	-	-	-	-	828	828
Sweet potato	-	-	-	-	-	278	-	-	278
Total	-	-	-	173	-	278	-	1602	2053
Grand Total	15298	2871	1514	173	407	1425	1423	2893	26004

Active germplasm holdings

The current holdings of different vegetable and tuber crops exceeds 26,000 accessions which are maintained at NBPGR Headquarters and its various regional stations (Table 3). These stations are located in diverse agroclimatic zones of the country ranging from as near to the equator as 10° 50' N at 50m above m.s.l. at Thrissur in Kerala State to 31° N latitude at 2076 m above n.s.l. at Shimla located in the Shivalik range of the Himalayas. The longitudinal range varies from 73°E at Jodhpur (224 m above a.s.l.) in the arid zones of Rajasthan to 91° 80' E at Shillong (1496 m above n.s.l.) in Meghalaya State. This agroclimatic diversity influences the choice of crops allocated to individual stations. Tuber crops and spices etc. are predominantly maintained as live collections at Trichur centre. However, taro and Ginger are equally distributed at Shillong centre, in addition to Thrissur. Onion, cucurbits, frenchbean and cowpea etc. are maintained at more than one locations as per crop responsibilities to centres (Table 3) whereas a few accessions of some other crops are also maintained as active collections at multiple locations as a follow up of collected germplasm from their respective zones.

Evaluation and Documentation

These germplasm are grown for 2 years for characterization and preliminary evaluation as per workable descriptors and their descriptor states finalized by NBPGR taking into consideration the IPGRI's list of descriptors for respective crops, if available. Promising germplasm lines are reported in the NBPGR Newsletter and Annual Reports for the active reference of users. Field days are held for spot selection of desirable types by the geneticists, breeders and industry. Catalogues are also published (Table 4) covering the entire range of descriptors and ready-to-use queries. Further three more catalogues on okra and one on *Dioscorea alata* L. have also been published during the years 1990-1993. The exhaustive lists of promising types of various vegetable crops identified at different NBPGR stations are provided by Gupta *et al.* (1993), Rana *et al.* (1993) and Rai (1993). Some of the improved varieties originated as direct selections from germplasm in these crops include Pusa Harbhajan in pea, La Bonita in tomato, Sel-2 in Okra, Rituraj in Cowpea, Sharad Bahar in Guar, Ratnar Sel. in Onion and AKWB-1 in winged bean etc.

Table 4. List of Catalogues published by NBPGR on vegetable crops

Sr. No.	Crop	Year	Number of Accessions	Number of Descriptions
1	Cowpea	1981	707	34
2	Cowpea	1982	683	24
3	Frenchbean	1981	1773	16
4	Oliferous brassicae	1986	555	7
5	Tomato	1982	80	21
6	Winged bean	1983	1439	31
7	Cowpea	-	259	23
8	Chillies	-	102	9
9	Turmeric	-	113	22
10	Yam	-	110	34
11	Okra	1990	361	-
12	Okra	1991	219	38
13	Okra	1993	107	36
14	Discorea	1991	175	33

Germplasm Conservation

Above 7,600 germplasm accessions of 14 vegetable crops were conserved *ex situ* in long term repository of National Gene Bank upto March 31, 1995 (Table 5). These included highest number in cowpea (*Vigna unguiculata*; 1475 accessions) followed by clusterbean (*Cymopsis tetragonoloba*; 1395 accessions), Okra (*Abelmoschus esculentus*; 1382 accessions), Lablab bean (*Lablab purpureus*; 901 accessions) and Onion (*Allium cepa*; 704 accessions). Substantial diversity is conserved in cases of solanaceous vegetables also, viz., potato (494 accessions), tomato (450 accessions), and brinjal (331 accessions). The difficulties in attaining proper seed sample with complete physiological maturity, proper seed moisture, high germination percentage and sample size are some of the factors which are duly taken care of during evaluation and multiplication before supply to genebank.

Table 5. *Ex situ* conservation of vegetable germplasm at long term repository of National Gene Bank (upto March 31, 1995)

Crop	Botanical Name	Number of accessions
Brinjal	<i>Solanum</i> spp.	331
Tomato	<i>Lycopersicon esculentum</i>	450
Potato	<i>Solanum tuberosum</i>	494
Chillies	<i>Capsicum annum</i>	143
Onion	<i>Allium cepa</i>	704
Bitter gourd	<i>Momordica charantia</i>	51
Cabbage	<i>Brassica oleracea</i> var. <i>capitata</i>	47
Cluster bean	<i>Cyamopsis tetragonoloba</i>	1395
Cowpea	<i>Vigna unguiculata</i>	1475
Faba bean	<i>Vicia faba</i>	31
Frenchbean	<i>Phaseolus vulgaris</i>	110
Lablab bean	<i>Lablab purpureus</i>	901
Okra	<i>Abelmoschus esculentus</i>	1382
Fenugreek	<i>Trigonella</i> spp.	140
TOTAL		7654

CONCLUSIONS

Above 3,300 germplasm accessions of different vegetable crops were supplied all over the country to different indentors for use in the fundamental and applied research (Gupta *et al.*, 1993). This clearly illustrates that the PGR programme on vegetables at NBPGR is effectively oriented towards germplasm utilization. Efforts are also made to have a two-way interaction with the user Institutes/Agencies which would help in formulation of further collection strategy of individual crops besides multiplication/regeneration of the preferred elites.

The Indian National Plant Genetic Resources System is fluid and viable. Although NBPGR is the key National Active Germplasm Site for vegetable crops under this system, three more NAGS are essentially integrated to this programme due to their involvement and allocation for potato; tuber and rhizomatous crops; and plantation and spices. These are CPRI, Shimla for potato; CPCRI, Kasaragod for plantation crops and CTCRI, Sreekarayam (Thiruvananthapuram) for tuber crops. An outstanding feature of the IN-PGRS is the conservation and management of PGRs related to their effective use by collaboration between the NBPGR and user agencies through workshops,

symposia, trainings, bilateral programmes and workplans under MoUs (Rana *et al.*, 1993). The ultimate objective, nevertheless remains safe conservation of the vegetable crops genetic resources for posterity and their sustainable utilization for the viability of crop improvement programmes.

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DIVERSITY IN *SESAMUM* GERMPLASM OF SOUTHERN AND WESTERN DISTRICTS OF ORISSA

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Sesamum occupies an important position among oilseed crops of Orissa. It is grown in high lands in June-December in hilly districts and in lowlands in January-April (dry season) after harvest of paddy. Cultivated sesame mostly belongs to *Bhadei* (May-July), *Maghi* (Aug-Nov/Dec) and *Nilaji* (January-April) types. During a survey to collect, evaluate and conserve the genetic resources of this important crop, sesame growing belt consisting of seven districts of eastern ghat and central plains region of Orissa was explored during November 1992. The areas explored are situated between 70° 31' to 22° 34' N latitude and 81° 24' to 87° 21' east longitude, with topography varying from hilly undulating in eastern ghats to plain areas in central table land, between 135 to 700 m elevation. In total forty eight accessions of cultivated sesame consisting of 2 accessions of *Bhadei*, 43 accessions of *Maghi* and 3 accessions of *Nilaji* and 2 accessions of wild *Sesamum* were collected. The paper presents details of the variability collected.

Key words : Sesame, diversity, collection, characterization, ethnobotany

Orissa is rich in diversity of both wild and cultivated sesame. The crop is grown in the highlands of hilly districts during the wet season (June - December) and also in the low lands of coastal plains during the dry season (Jan. - April). The large scale cultivation of high yielding varieties like *Kalika*, *Kanak* and *Vinayak* posed a serious threat to the existence of local cultivars. The tribal pockets of peninsular India are still rich sources of wide genetic diversities of wild relatives, landraces and traditional cultivars. In an exploration undertaken during November 1992, the eco-geography of the areas explored, the diversities observed, the ethnobotanical information gathered and the mode of genetic erosion observed are enumerated in this paper.

ECOGEOGRAPHY OF THE REGION

The area explored is situated between 17° 31' and 22° 34' N latitude and 81° 24' to 87° 20' east longitude. The topography of the area is hilly, undulating

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with lush green valleys and forests in the interior districts and plain lands in the central plain region. The region experiences annual precipitation of 1534 mm to 1710 mm. The soil is sandy loam to red calcareous in Koraput, Nawarangpur districts and black in Kalahandi district of Orissa. The pH of the soil varies from 4.9 to 5.5 in high altitude regions (Similiguda, Pottangi) and 5.6 to 6.5 in Nawarangpur and Umerkote area. The Nawarangpur and Umerkote belt are rich in iron and aluminium but deficient in micronutrient content. The altitude of the areas varies from 120 to 940 m. But the *Sesamum* cultivation was observed only between 300 ft. to 2100 ft. above mean sea level. Repeated minikit trials of different cultivars of sesame were failure in regions beyond 640 m above sea level.

METHODOLOGY OF COLLECTION

Prior information about the ecogeography, occurrence of wild relatives and their distribution pattern were surveyed from the flora and literature (Haines, 1925; Hooker, 1885; Mooney, 1950). The collection time coincided with the maturity time of *Sesamum*. Collection the farmer's fields, farm store and partly hilly and forest areas in the south of Ganjam and continued in Rayagada, Koraput, Malkangiri, Nawarangpur, Kalahandi, Bolangir and Sambalpur districts. The traditional old farmers were contacted to know about the occurrence of wild *Sesamum*. Both random and bulk sampling were followed.

Table 1. District-wise collection for *Sesamum* germplasm in Orissa

Collection area/ Districts	No. of sites visited	Altitudinal range (above msl)	No. of samples collected cultivated wild	Total
Ganjam	1	33-380	1 -	1
Rayagada	5	240 - 410	4 -	4
Koraput	6	530 - 1020	3 -	3
Malkangiri	7	130 - 285	5 1	6
Nawarangpur	13	66 - 640	5 -	5
Kalahandi	11	240 - 340	8 -	8
Bolangir	14	148 - 760	12 1	13
Sambalpur	14	130 - 285	10 -	10
Total	71	33 - 1020	48 2	50

SAMPLES COLLECTED AND VARIABILITY OBSERVED

During the mission, a total number of 50 samples were collected from 71 sites spread over a distance of 2365 kms. Diversity includes of *Sesamum*

indicum as well as *S. mulayanum*. Cultivated sesame belong to three major duration groups viz., *Bhodei* (May - July), *Maghi* (August - November/December) and *Nillaji* (January-April). Majority of collections (43) belonged to the *Maghi* duration group next in order being *Nillaji* (3), *Bhodei* (2) and wild group (2). Considerable variation was observed in the *Sesamum* cultivars with regards to colour of corolla, and stem at the time of maturity, pattern of branching, number of locules per capsule, shape of capsule and colour of seeds. The flowers are mostly solitary and the size of the flower varied among the accessions. The total number of four loculed, six loculed and eight loculed sesame accessions were 44, 3 and 3, respectively including the wild sesame having four loculed capsules. Variation in seed colour (black and red) and duration was observed within the *Bhodei* group. The height of the black seeded plants was 5' - 6', stem were square shaped, branched and capsules were narrow oblong type. The morphological characteristics of the red seeded *Bhodei* were same as the black seeded types except the seed colour and duration. Variability was observed with respect to morphological and quantitative traits among the *Maghi* duration group. The diversity was exhibited in height of the plant, dwarf (34.0 cm) to tall (118.0 cm), basal to top branching type, pattern of fruit bearing (alternate or opposite), hairiness in leaf, stem, capsule and corolla. The capsules were mostly broad oblong and four loculed. But six and eight loculed capsules were also collected. The majority of the four loculed capsules have black coloured seeds and few have white coloured seeds. The six loculed capsules have only white coloured seeds. Colour of the seed varied from grey, red, black to shiny black in *Maghi* til. Popular local types were *Malkangiri* local, *Krishna* til, *Athagharia Jhumi*, *Jhunti* and *kalia* til. The *Nillaji* or *Kharatia rasi* were collected from farm stores. The varieties are grown after harvesting of late paddy where there is some moisture. The seed colour was red.

IN-SITU VARIABILITY

A wide variability in different characters was observed among the forty eight accessions of cultivated (*S. indicum*) species collected during the course of exploration (Table 2). The *in-situ* variation in quantitative characters like plant height ($\bar{x}$ = 68.4 cm. range 34.0 - 118.0 cm), number of branches per plant ($\bar{x}$ = 4.02, range 22.00 - 13.0), number of capsules per plant ($\bar{x}$ = 14.2, range 5.0 - 98.0), the length of the 4 loculed capsule ($\bar{x}$ = 2.03, range 1.3 - 2.5), the length of the 6 loculed capsules ($\bar{x}$ = 1.85, range 1.8 - 1.9), the length of the 8 loculed capsule ($\bar{x}$ = 2.35, range 2.0 - 2.7), the width of the 4 loculed capsuled ($\bar{x}$ = 0.59, range 0.4 - 0.7); 6 loculed capsules ($\bar{x}$ = 0.58, range 0.5 - 0.6), 8 locules capsules ($\bar{x}$ = 0.65, range 0.6 - 0.7), number of seeds in the 4 loculed varieties ($\bar{x}$ = 40, range 32.0 - 44.0), 6 loculed varieties ($\bar{x}$ = 70, range 51.0 - 86.0), 8 loculed varieties ($\bar{x}$ = 79, range 72.0 - 86.0), the weight

of the capsule of 4 loculed varieties ($\bar{x}$ = range 9.5 - 10.0) 6 loculed 6 loculed ($\bar{x}$ 11.0, range 11.0 - 12.0g), 8 loculed ($\bar{x}$ 11.6, range 11.5 - 12.0 g). The 100 seed weight of 4 loculed varieties ($\bar{x}$ = 240.0 mg, range 225.0 - 250.0 mg), 6 loculed varieties ($\bar{x}$ = 195.0 range 165.0 - 227.0 mg) and 8 loculed varieties ($\bar{x}$ = 180.0, range 180.0 - 220.0 mg) were quite wide. These characters observed in the field should not be considered as stable genetic characters since the plants were grown under very poorly managed areas.

Table 2. Variability of sesame cultivars

Characters	Range	Mean
Plant height (cm) (20)	34.0 - 118.0	68.4
Branches/plant (20)	2.0 - 13.0	4.02
Capsules per plant (25)	5.0 - 98.0	14.2
Length of the capsule (cm) (10 each)		
(4 loculed)	1.3 - 2.5	2.03
(6 loculed)	1.8 - 1.9	1.85
(8 loculed)	2.0 - 2.7	2.35
Width of the capsule (cm)		
(4 loculed)	0.4 - 0.7	0.59
(6 loculed)	0.5 - 0.6	0.58
(8 loculed)	0.6 - 0.7	0.65
No. of seeds in the capsule (10 each)		
(4 loculed)	32 - 44	40
(6 loculed)	51 - 86	70
(8 loculed)	72 - 86	79
Weight of the capsule (g)		
(4 loculed (10))	9.5 - 10.0	9.5
(6 loculed (10))	11.0 - 12.0	11.0
(8 loculed (10))	11.5 - 12.0	11.6
100 seeds weight (mg)		
(4 loculed)	225 - 250	240.0
(6 loculed)	165 - 227.0	195.0
(8 loculed)	180 - 220	200.0

Values in parentheses indicate number of samples studied

It is interesting to note that the 8 loculed capsules possessed double the number of grains than the 4 loculed capsules. Although the 100 seed weight for 8 loculed capsules was less than that of the 4 loculed capsules by 40.0 mg, the additional number of seeds contained in the 8 loculed capsules compensated the per capsule seed weight to the extent of 166 per cent. It is, therefore, advisable to incorporate the 8 loculed capsule characters to the high yielding background in order to achieve additional yield over the traditional 4 loculed capsules. These local collections might have possessed genes for resistance to various biotic and abiotic stresses which need further confirmation and exploitation.

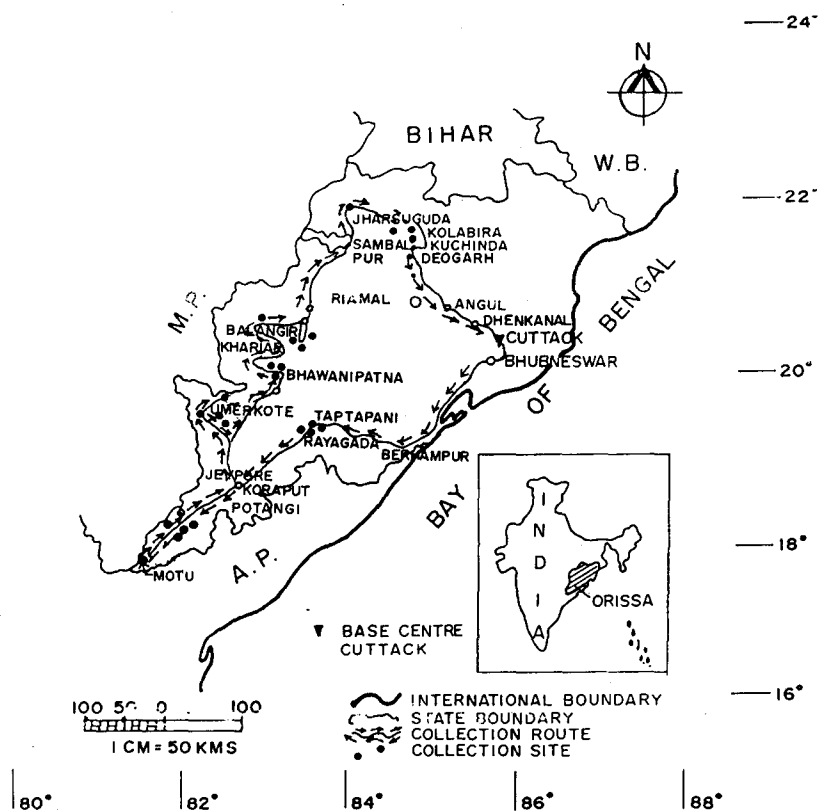


Fig. 1. Map showing the area/region explored, route and collection sites visited

OCCURRENCE OF WILD SESAME

During the mission, two accessions of wild til were collected. Wild *til* (D-1928) collected from *Malkangiri* showed tall habit (3-7 ft.), profuse branching of four loculed capsules, narrow and oblong type and black and small sized seeds. It was identified by the experts of BSI, Calcutta as a weedy accession of *S. indicum*. The other one (D-1951) collected from Bolangir, possessed a few to non-branching stems, with plant height of 2-3 ft. The capsules were broad oblong, four loculed, thick and triangular while the seeds were red with beautiful ornamentations on the seed coat. It was ascertained from the local inhabitants that this species was spontaneous and of rare occurrence in the hillocks of Sarmuhan, Bolangir. It has a shattering habit like any other wild species and is not used for any purpose. It was identified by the experts of BSI Calcutta as *S. mylayanum* Nair.

ETHNOBOTANICAL INFORMATION

Gingelly, in addition to its use in culinary has immense medicinal values. The local inhabitants use til oil for curing of constipation in cattle @ 250 ml a single dose per cattle. Til oil mixed with liquid Ammonium forte and turpentine oil is used for curing sprain in cattle as well as men. Til oil cake is widely used by local inhabitants for curing *Fatua* disease in cattle. The oil of black seeded *til* was reported to have colling effect. In Hindu mythology the black seeded til mixed with gold is used in "yagna" to satisfy evil demons called "Tilatarpana". Sesame seeds with rice and honey are used to prepare the funeral cakes called "pindas" that are offered to the ancestors in the *shraddha* ceremonies by the relations of the deceased (Dymock *et al.* 1893). The offering of sesame seeds is considered effective in removing sins (Gupta, 1971).

GENETIC EROSION

Different types of loss of genetic resources were observed in the locality explored. Firstly, the introduction and cultivation of high yielding varieties (HYV's) has proved to be quite profitable. Such a practice of switching over to HYV's has resulted in forceful loss of valuable traditional genetic resources. Secondly, switching over to certain other remunerative cash crops is another cause of loss of germplasm. Thirdly, the frequent failure of monsoon resulting in drought spell and complete loss of the crop in these localities is another cause of loss of traditional varieties. In view of such genetic erosion regular collection, evaluation and conservation of the germplasm is essential.

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NATURE AND MAGNITUDE OF GENETIC VARIATION IN THE MACRO $\times$ MICROSPERMA GENEPOOL OF LENTIL

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The experimental material comprised the progenies of three crosses, namely, HPL 4 $\times$ L 830 (123 progenies), HPL 1 $\times$ L 1282 (295) and HPL 3 $\times$ L 1282 (170) involving HPL 4, HPL 1 and HPL 3 as macrosperma and L 830 and L 1282 as microsperma types. The progenies were evaluated in Augmented Block Design. Data was recorded with respect to seed yield, harvest index, pod length seeds per pod, single seed weight, days to flowering and days to maturity. Mean performance of the progenies showed that 7 progenies in HPL $\times$ L 830, 18 progenies in HPL 1 $\times$ L 1282 and 14 progenies in HPL 3 $\times$ L 1282 cross for seed yield were found to be significantly superior to the best check viz., HPL 5 (Vipasha). Variance analysis revealed a wide range of variability for all the traits except phenological traits where the range of variation was narrow. The magnitude of co-efficient of variation (CV) was high for harvest index, seed yield, seeds per pod and seed weight, whereas it was least for days to maturity and days to flowering. Heritability (bs) was high for the traits and crosses studied. High heritability was found to be coupled with high genetic advance for seed yield, harvest index, seed weight and seeds per pod.

Key words : *Lens culinaris*, hybridization, analysis of variance

In lentil (*Lens culinaris* Medik.), the introgression of microsperma with macrosperma types is viewed as potentially productive area of hybridization. In order to define effective breeding and selection scheme that would have high probability of success, it is imperative to understand the nature and magnitude of genetic variation generated from the gene pool of micro-macrosperma lentils.

MATERIALS AND METHODS

The experimental material consisted of three crosses, namely, HPL 4 $\times$ L 830, HPL 1 $\times$ L 1282 and HPL 3 $\times$ L 1282 involving HPL 4, HPL 1 and HPL 3 as macrosperma and L 830 and L 1282 as microsperma types. One hundred and twenty three, 295 and 170 F₃ derived progenies of HPL 4 $\times$ L

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830, HPL 1 $\times$ L 1282 and HPL 3 $\times$ L 1282 crosses, respectively, along with five checks (including parents) were evaluated in augmented block design. HPL 5 (Vipasha), a released variety for the mid hills of Himachal Pradesh was used as standard check. Data were recorded with respect to seed yield per plant (g), harvest index (%), pod length (mm), sink efficiency (%), seeds per pod (no.), single seed weight (mg), days to flowering and days to maturity AND analysed with respect to various parameters of variability as per Federer (1956).

RESULTS AND DISCUSSION

Analysis of variance revealed that micro-macrosperma hybridization in lentil has generated a large amount of genetic variability for all the traits and crosses studied. The number of progenies which were found significantly superior to the best check (HPL 5) were 7, 10, 1 and 3 in HPL 4 $\times$ L 830; 18, 20, 10 and 12 in HPL 2 $\times$ L 1282 and 14, 17, 13 and 16 in HPL 3 $\times$ L 1282 cross for seed yield, harvest index, seed weight and seeds per pod, respectively. Various parameters of variability showed a wide range of variability and high amount of variances both at phenotypic and genotypic levels for all the traits except days to flowering and days to maturity where it was less (Table 1). Coefficient of variation (cv) both at phenotypic (PCV) and genotypic (GCV) levels in each cross revealed that the magnitude of variation was very high for seed yield, harvest index, seeds per pod and single seed weight, moderate for pod length and sink efficiency and low for days to flowering and days to maturity. Seed yield which is of direct interest to the breeders have the highest CV in HPL 4 $\times$ L 830 cross. In the present material the range of variation resulted almost in equal PCV and GCV, indicating little variation for majority of the traits studied, and that too were not much influenced by the environment. Therefore, selection based on phenotypic value of such stable characters is expected to be effective with equal probability of success. It also indicates that the differences between lines are due to their genotypic constitution. The present estimates of CV were sufficiently higher than those reported for world lentil germplasm with respect to seed yield, seed weight and seeds per pod, however, they were at par for phenological traits (Erskine, 1985). Similar estimates of genetic variability in lentil for most of the traits have also been reported earlier (Singh and Singh, 1969; Szucus, 1973; Todorov, 1980).

Heritability (bs) which decide the intensity of selection was very high (60-90%) for all the traits in all the crosses hence, the expression of these traits can be modified through hybridization, followed by selection. High heritability for some of these traits have also been reported earlier by Muehlbauer (1974). Genetic advance is another important parameter for determining the magnitude of expected genetic change that can occur due to selection. It also provides information on the relative contribution of environment on the

variation of a particular character. In the present material, harvest index, seed yield, seeds per pod and seed weight showed high genetic advance, the

Table 1. Estimates of parameters of variability in three crosses, namely, HPL $\times$ L 830 (1), HPL 1 $\times$ L 1282 (2) and HPL 3 $\times$ L 1282 (3) of lentil.

Traits	Mean	Range	Vp	Vg	PCV	GCV	Heritability(%)	Genetic advance as % of mean
Seed yield per plant (g)								
1	0.81	0.30-1.50	0.06	0.05	30.96	28.04	83.33	52.04
2	0.84	0.27-1.70	0.06	0.05	33.84	27.40	83.35	50.64
3	0.86	0.30-1.38	0.05	0.04	26.64	23.20	80.00	42.27
Harvest index (%)								
1	38.15	18.50-62.86	245.30	159.11	41.05	33.06	64.86	54.87
2	38.80	22.42-58.40	239.00	157.50	39.83	32.34	65.89	54.00
3	33.28	16.20-61.50	209.36	171.45	43.77	39.84	81.22	73.29
Pod length (mm)								
1	1.02	0.90-1.51	0.03	0.02	17.63	12.07	67.30	23.76
2	1.01	0.80-1.25	0.02	0.01	14.00	10.84	50.00	13.84
3	1.07	0.08-1.40	0.01	0.008	8.35	7.23	80.00	15.40
Sink efficiency (%)								
1	0.79	0.66-0.88	0.004	0.003	7.48	6.93	75.71	13.18
2	0.80	0.61-0.90	0.03	0.02	21.55	18.34	67.06	29.80
3	0.81	0.65-0.86	0.005	0.003	8.46	7.30	60.00	10.02
Seeds per pod								
1	1.39	0.90-2.15	0.11	0.09	24.18	21.82	81.81	40.85
2	1.41	0.90-2.14	0.10	0.07	22.75	19.03	70.00	32.80
3	1.20	1.00-2.00	0.20	0.18	37.26	35.35	90.00	67.09
Single seed weight (mg)								
1	39.59	21.10-58.75	89.04	64.25	23.84	20.28	72.19	35.44
2	35.39	20.26-49.73	42.09	29.89	18.35	15.10	71.09	26.81
3	37.05	23.96-52.92	76.22	60.00	24.56	20.65	78.71	38.20
Days to flowering								
1	126.69	121.00-127.00	1.25	0.82	0.81	0.93	65.60	1.23
2	121.32	117.00-126.00	1.79	1.41	1.10	1.00	78.75	1.78
3	120.52	121.00-125.00	6.64	5.20	2.14	1.87	78.31	3.45
Days to maturity								
1	163.65	155.00-170.00	43.66	30.38	4.04	3.37	69.35	5.77
2	165.24	156.00-170.00	36.00	24.51	3.63	3.00	68.35	5.13
3	164.67	159.00-178.00	34.47	23.40	3.57	2.94	68.00	4.99

improvement upon these characters can be made effective even by applying low selection pressure. High genetic advance for seeds per pod and seed weight has also been reported earlier (Singh and Dixit, 1970; Chowdhury *et al.*, 1976). High genetic advance was found to be coupled with high heritability for seed yield, harvest index, seeds per pod and seed weight. This shows the probable presence of additive gene action for these traits. Therefore, these characters could be considered important for the genetic amelioration of lentil crop because it enable the breeders to operate simple selection methods to improve such type of traits. On the other hand phenological traits indicate low CCV, due to high environmental fluctuations leading to low heritability and genetic advance and to improve upon such traits a proper combination of mass, family and progeny testing selection is needed.

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GENETIC VARIABILITY IN GUAR FOLLOWING HYBRIDIZATION AND IRRADIATION

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The present investigations were undertaken with a view to study the nature and magnitude of variability in an experiment comprising of unirradiated 15 F_1 's and 15 F_2 s and the irradiated 15 F_1 M_1 's and 15 F_2 M_2 's population of guar. It was observed that irradiation caused earliness in flowering and maturity and increase in 100-seed mass and reduction in the remaining characters. The phenotypic and genotypic coefficients of variation increased for pod length, seeds per pod, protein and gum content and reduced for days to flowering, maturity, plant height, clusters and seed yield per plant in both F_1M_1 and F_2M_2 i.e. the irradiated populations. High estimates of heritability and high genetic gains were observed for number of clusters and seed yield per plant in F_1 and F_2 populations. The mean value was reduced and coefficient of variation was increased in majority of the crosses in F_2M_2 or F_2 population for some of the characters. However, reverse was also observed for some characters.

Key words : Guar, *Cyamopsis tetragonloba*, variability, hybridization, irradiation

Owing to small sized, delicate flowers and low seed setting in outcrossed flower buds in guar, not much diverse breeding material could be generated through hybridization. Nevertheless, mutation breeding offers an alternative to hybridization since quantitative variation generated by the two methods is equally heritable (Gregory, 1956). Moreover, the reports are also not available on the effects of mutagens when super imposed on hybridization in guar. Accordingly, the present investigation was undertaken with a view to study and compare the variability generated through hybridization alone and by the combined effect of hybridization and irradiation.

MATERIALS AND METHODS

A six parent diallel excluding reciprocals was attempted to obtain 15 F_1 crosses. The half of the seed of each F_1 cross was irradiated with 40 KR gamma rays using a ^{60}Co source and the rest seeds were untreated and used as control. These two sets of material were grown in the field to advance

them to F_2M_2 and F_2 seed generations. Fresh F_1 crosses in all possible combinations excluding reciprocals were again prepared among the same six parents. The half of the seed from each cross was again irradiated with the same source and the remaining half seed was kept as control. This set of material gave rise to F_1 and F_1M_1 generation.

The unexposed and gamma rays exposed progenies comprising of 15 F_1 's, 15 F_2 's, 15 F_1M_1 's and 15 F_2M_2 's were sown during kharif, 1990 in a randomised complete block design with three blocks. Each F_1 and F_1M_1 hybrid was sown in 2.8 m long rows was spaced 45 cm apart. Each F_2 and F_2M_2 progeny was represented by 6 rows each with the same inter and intra-row spacings as in F_1 and F_1M_1 's. Five random and competitive plants from each F_1 and F_1M_1 and twenty plants in each F_2 and F_2M_2 were taken for recording data on 11 characters. Protein content was determined by the analytical method as proposed by McKenzie and Wallace (1954) and gum content was estimated according to the method described by Das *et al.* (1977). Mean, coefficient of variation, heritability and genetic advance were calculated.

RESULTS AND DISCUSSION

A comparison of mean values of the eleven characteristics studied in F_1 , F_1M_1 , F_2 and F_2M_2 generations (Table 1) revealed that mean values for all the characters except 100-seeds mass were reduced in the treated populations. Thus the desirable variability was generated as early flowering and maturity and more seed mass are considered desirable traits in guar breeding.

Chowdhury *et al.* (1975) also observed a decrease in mean values for number of branches and seed yield per plant in M_2 than control but increase in peduncle length and plant height was observed in guar. The mean values for various traits in irradiated populations were also found low as compared to unirradiated populations by many other workers (Virupakshappa *et al.*, 1988; Krull and Frey, 1961; Kumar *et al.*, 1988), however, for some traits it remained either unaltered or higher in treated populations (Sharma *et al.*, 1982; Sinha and Joshi, 1986).

The values for variance in different generations revealed that both g.c.v. and p.c.v. were reduced in F_1M_1 and F_2M_2 populations. Chowdhury *et al.* (1975) also reported increase in variation for six quantitative characters in irradiated populations in guar. Gregory (1956) was one of the first to use irradiation and hybridization conjunctively in peanut breeding programme and showed increase in variation in both irradiated parents and hybrids than in unirradiated hybrids. Gregory's findings were further supported by the other investigators who also worked on irradiated hybrid populations (Krull and Frey, 1961; Emery and Wynne, 1976; Sharma *et al.*, 1982; Sinha and Joshi, 1986; Kumar and Yadava, 1988). However, the variance induced by radiation

Table 1. Comparison of genetic parameters in various generations

Parameter	Generation	1	2	3	4	5	6	7	8	9	10	11
Mean	F ₁	44.18	115.78	105.12	22.0	94.55	5.48	7.91	2.33	13.04	29.03	30.34
	F ₁ M ₁	39.22	109.93	90.76	16.78	82.38	4.22	5.43	2.55	9.22	25.98	27.28
	F ₂	39.53	116.02	98.71	21.21	77.50	5.45	7.88	2.31	12.01	27.55	32.31
	F ₂ M ₂	35.94	110.38	88.04	16.42	68.05	4.94	6.95	2.44	10.78	25.04	29.53
Genotypic coefficient of variation (GCV)	F ₁	7.10	4.35	22.12	46.77	26.15	3.20	4.24	12.04	35.74	6.05	8.09
	F ₁ M ₁	4.40	3.72	12.41	44.75	29.35	8.55	16.09	10.16	30.94	7.94	13.80
	F ₂	9.95	5.68	16.12	42.87	16.84	3.73	3.11	8.68	27.14	7.18	6.40
	F ₂ M ₂	8.09	3.38	14.00	19.29	12.77	4.57	5.45	8.80	11.14	7.39	8.98
Phenotypic coefficient of variation (PCV)	F ₁	7.18	4.38	22.15	47.03	26.33	3.59	4.53	12.25	36.16	6.25	8.52
	F ₁ M ₁	4.50	3.82	12.56	44.91	29.49	8.83	16.35	10.69	31.36	8.14	14.10
	F ₂	9.98	5.74	16.18	42.91	16.92	4.00	3.57	8.93	27.42	7.34	6.79
	F ₂ M ₂	8.15	3.41	14.01	19.43	12.80	4.94	5.76	9.13	12.10	7.70	9.15
Heritability (Broad sense)	F ₁	97.82	98.34	99.73	98.92	98.62	79.16	87/60	96.59	97.68	93.70	09.08
	F ₁ M ₁	95.53	94.92	97.69	99.28	99.01	93.95	96.85	90.37	97.30	95.16	95.84
	F ₂	99.25	98.01	99.19	99.81	98.97	87.30	75.55	94.56	97.98	95.68	88.64
	F ₂ M ₂	98.40	98.29	99.83	98.55	99.54	85.82	89.49	93.02	84.72	92.21	96.71
Genetic advance (% of mean)	F ₁	14.46	8.88	45.51	95.83	53.30	5.86	8.17	24.38	72.77	12.06	15.82
	F ₁ M ₁	8.85	7.47	25.27	91.86	60.15	17.08	32.62	19.91	62.87	15.95	27.83
	F ₂	20.41	11.50	33.07	88.23	24.50	7.19	5.56	17.39	54.34	14.47	12.41
	F ₂ M ₂	16.52	6.91	28.81	39.45	26.27	8.73	10.61	17.49	21.12	14.63	18.17

1 = Days to first flowering, 2 = Days to maturity, 3 = Plant height, 4 = Number of clusters per plant, 5 = Number of pods per plant, 6 = Pod length, 7 = Number of seeds per pod, 8 = 100-seeds mass, 9 = seed yield per plant, 10 = Protein content, 11 = Cum content.

Table 2. Coefficient of variation (c.v.) and mean values for various characters within each cross of F₂ and F₂M₂ generations

Crosses	Days to flowering				Days to maturity				Plant height			
	CV		Mean		CV		Mean		CV		Mean	
	F ₂	F ₂ M ₂	F ₂ M ₂	F ₂ M ₂	F ₂	F ₂ M ₂	F ₂	F ₂ M ₂	F ₂	F ₂ M ₂	F ₂	F ₂ M ₂
HG 75 × CP 68	12.06	16.49	41.22	38.57	6.03	6.78	115.03	112.42	21.27	26.71	97.11	92.24
HG 75 × PLG 85	9.87	14.59	40.62	38.45	7.96	5.66	116.47	111.74	23.53	28.62	100.41	90.44
HG 75 × FS 277	9.20	10.95	46.10	39.91	6.09	4.11	127.78	114.89	21.03	26.10	119.72	103.39
HG 75 × HG 314	10.75	12.53	46.51	41.10	5.28	5.5	126.20	114.39	21.59	35.32	109.80	103.84
HG 75 × HG 79-1-5	13.80	14.08	38.88	36.79	5.59	4.08	114.21	116.04	23.43	19.31	93.56	78.75
CP 68 × PLG 85	14.34	17.29	34.87	33.54	5.85	7.52	108.51	107.33	28.42	32.52	86.21	78.93
CP 68 × FS 277	17.28	22.37	36.32	31.96	8.73	6.87	114.62	111.42	20.44	30.44	90.23	95.59
CP 68 × HG 314	16.86	17.22	36.71	33.44	6.46	8.24	115.61	106.50	27.60	32.98	89.33	80.60
CP 68 × HG 79-1-5	17.68	16.93	35.64	30.42	8.63	11.04	108.12	103.20	27.22	19.77	69.33	59.03
PLG 85 × FS 277	12.77	12.40	39.43	36.46	8.27	6.35	115.79	109.36	29.07	28.47	117.66	80.99
PLG 85 × HG 314	10.17	9.20	39.39	35.31	6.84	7.40	114.61	109.55	22.84	28.36	109.76	98.16
PLG 85 × HG 79-1-5	10.37	10.76	35.98	34.48	8.25	13.43	107.17	104.44	28.58	35.47	85.59	83.17
FS 277 × HG 314	11.96	9.62	46.21	36.68	4.89	4.67	128.10	113.19	23.10	27.43	129.15	104.16
FS 277 × HG 79-1-5	11.51	9.67	37.08	35.86	6.54	6.58	111.71	110.94	31.83	24.88	98.10	90.59
HG 314 × HG 79-1-5	12.31	10.14	38.02	36.69	5.95	6.69	116.44	110.28	35.88	28.40	84.64	80.73
HG 75 × CP 68	41.99	39.34	32.35	19.37	52.60	47.43	86.33	73.48	8.38	10.37	5.25	4.81

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Crosses	Days to flowering				Days to maturity				Plant height			
	CV		Mean		CV		Mean		CV		Mean	
	F ₂	F ₂ M ₂	F ₂ M ₂	F ₂ M ₂	F ₂	F ₂ M ₂	F ₂	F ₂ M ₂	F ₂	F ₂ M ₂	F ₂	F ₂ M ₂
HG 75 × PLG 85	54.05	52.18	17.41	14.62	48.59	60.44	69.97	62.28	6.98	9.24	5.44	4.30
HG 75 × FS 277	48.56	53.33	14.27	15.47	49.12	53.30	92.10	55.38	8.53	10.77	5.51	5.07
HG 75 × HG 314	49.14	63.46	16.24	14.04	50.82	65.55	68.97	58.70	11.55	9.84	5.85	5.13
HG 75 × HG 79-1-5	51.02	54.56	35.60	19.17	61.37	66.19	94.24	66.69	7.88	9.70	5.33	4.86
CP 68 × PLG 85	53.77	67.14	17.39	13.97	57.65	59.19	73.3	68.53	11.30	14.20	5.31	4.93
CP 68 × FS 277	38.94	83.77	29.79	13.93	50.77	74.82	95.58	61.64	7.34	12.71	5.77	5.03
CP 68 × HG 314	65.44	49.88	19.88	16.86	68.31	53.47	77.69	66.43	8.60	8.51	5.23	4.79
CP 68 × HG 79-1-5	44.92	49.08	40.31	19.64	53.70	73.21	84.26	68.34	8.98	13.17	5.12	5.01
PLG 85 × FS 277	43.08	42.76	12.51	14.50	47.07	61.46	54.41	63.91	8.92	7.62	5.49	5.25
PLG 85 × HF 314	36.76	30.79	14.99	17.57	41.98	36.08	65.81	85.86	8.13	11.41	5.41	5.06
PLG 85 × HG 79-1-5	27.97	46.73	20.84	19.73	42.73	51.66	85.87	81.32	7.82	10.37	5.50	5.00
FS 277 × HG 314	46.00	57.97	9.00	10.04	58.29	60.46	54.19	64.16	9.14	17.66	5.68	4.71
FS 277 × HG 314	46.00	57.97	9.00	10.04	58.29	60.46	54.19	64.16	9.14	17.66	5.68	4.71
FS 277 × HG 79-1-5	56.44	60.74	16.58	15.8	52.82	48.80	78.97	63.46	8.76	10.63	5.60	5.17
HG 314 × HG 79-1-5	64.65	49.93	21.02	22.27	56.71	53.98	81.11	80.53	9.66	10.12	5.28	5.04
HG 75 × CP 68	8.63	11.27	7.99	6.81	13.08	15.04	2.37	2.46	46.29	59.32	10.78	11.21
HG 75 × PLG 85	10.74	11.32	8.01	5.78	12.14	14.22	2.06	2.32	40.14	66.23	9.64	9.86

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Crosses	Days to flowering				Days to maturity				Plant height			
	CV		Mean		CV		Mean		CV		Mean	
	F ₂	F ₂ M ₂	F ₂ M ₂	F ₂ M ₂	F ₂	F ₂ M ₂	F ₂	F ₂ M ₂	F ₂	F ₂ M ₂	F ₂	F ₂ M ₂
HG 75 × Fs 277	9.21	13.61	7.82	6.84	16.37	10.39	2.26	2.31	53.75	44.85	13.88	9.61
HG 75 × HG 314	13.02	12.21	7.37	6.87	12.07	13.48	2.32	2.30	59.44	55.69	9.37	9.84
HG 75 × HG 79-1-5	9.26	11.24	7.99	6.83	14.41	15.58	2.29	2.31	69.15	57.78	14.62	10.28
CP 68 × PLG 85	11.56	17.27	7.35	7.00	12.99	15.87	2.54	2.52	54.07	60.64	10.08	9.30
CP 68 × FS 277	9.38	13.87	7.89	7.16	14.24	20.15	2.63	2.88	42.52	62.08	17.12	11.63
CP 68 × HG 314	12.69	9.74	7.72	6.80	9.79	16.47	2.45	2.61	62.41	60.50	12.13	13.90
CP 68 × HG 79-1-5	11.14	14.25	7.90	7.14	11.07	15.32	2.35	2.48	53.60	66.29	20.37	9.82
PLG 85 × FS 277	9.73	11.19	8.32	7.36	23.45	22.37	2.09	2.28	40.19	44.18	8.21	10.39
PLG 85 × HG 314	8.84	15.20	8.03	7.13	16.75	17.80	2.03	2.19	42.39	41.71	9.20	11.89
PLG 85 × HG 79-1-5	8.60	9.16	8.14	7.50	15.71	13.55	2.10	2.14	42.55	54.12	10.73	11.64
FS 277 × HG 314	12.11	23.66	8.01	6.93	16.20	21.20	2.53	2.83	63.10	47.57	10.92	10.72
FS 277 × HG 79-1-5	11.08	15.36	7.94	7.15	12.74	17.05	2.59	2.58	57.55	40.80	11.54	9.73
HG 314 × HG 79-1-5	10.30	15.85	7.77	6.88	17.45	13.62	2.12	2.35	56.98	46.49	11.53	11.83

and by hybridization were not always cumulative as has been reported by Gupta and Virk (1977), Virk *et al.* (1978) and Virupakshappa *et al.* (1980).

The heritability estimates in broad sense coupled with genetic advance were found to be higher for number of clusters and seed yield per plant in F_1 , F_1M_1 and F_2 generations, for number of pods per plant in F_1 and F_1M_1 generations while for remaining characters the values for genetic advance were less. Krull and Frey (1961) also reported that variability caused by irradiation in oats was equally heritable as that arising through hybridization.

A comparison of coefficient of variability (c.v.) within F_2 and F_2M_2 generations for each cross (Table 2) denoted that majority of the crosses had an increase in c.v. over F_2M_2 generation. This increase was of considerable magnitude in some crosses whereas in other crosses a decrease in c.v. was observed, hence the changes observed were genotypes and character specific. This could be attributed to the differential radio-sensitivity of the genotypes (Crosses) and the trait under study which influences not only the total rate but also the spectrum of recoverable mutations. The influence of a particular genotypes on the mutation spectrum is rather unpredictable (Borojevic *et al.*, 1977).

The increase in variability (cv.) in F_2M_2 over its control counterpart could be due to micromutations, enhanced recombination resulting from increased crossing-over among linked loci or an increase in somatic crossingover and breakage of tightly linked regions and permitting higher crossing over within those regions which as a whole results in the release of additional genetic variability. In some crosses, the decrease in coefficient of variation could be attributed to either experimentation techniques such as sample size and sampling error or biological reasons such as antagonism of variability released by recombination in otherwise unirradiated set.

There were a few crosses for each character which exhibited an increase in both mean performance and coefficient of variation in F_2M_2 over F_2 . For seed yield HG 75 $\times$ CP 68 and PLG 85 $\times$ HG 79-1-5 and for 100-seed mass HG 75 $\times$ CP 68, HG 75 $\times$ PLG 85 and CP 68 $\times$ FS 277 were included in this category. These crosses can be exploited for harnessing of their desired variability in future guar breeding programmes including intermating and selection in succeeding generation.

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EVALUATION, ENHANCEMENT AND CONSERVATION OF TEA GERMPLASM IN KANGRA VALLEY

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Due to wide genetic variability in tea populations created by the indiscriminate early introductions and free hybridization among them, clonal selection to exploit natural variability for the improvement of tea has been advocated. The bush population even in a single small field of tea shows great variation in growth, branching habit, size, shape, texture and pose of the leaf, as well as in the inherent quality and yield of the bushes. Keeping this in mind 200 bushes were selected at Chambi Tea Estate in Kangra Valley on phenotypic basis during 1992. Their yield record were taken for whole plucking season. On the basis of yield potential only 72 bushes having significant yield potential were retained for further evaluations. Out of these only 10 bushes were having yield potential more than 2.5 and having most of the desirable characters. Among the introduced cultivars, TV 23 was specifically adapted to favourable environments with highest yield potential, whereas T 253 had the general adaptability. For the enhancement of the germplasm, one year old seedlings of about 40 F₁'s among selected and diverse cultivars have been planted in the field during July 1993. The available germplasm are being conserved *in-situ* at Tea Experiment Station of Himachal Pradesh Krishi Vishvavidyalaya, Palampur.

Key words : Tea, *Camellia sinensis*, evaluation, conservation, genetic enhancement

Tea [*Camellia sinensis* (L.) O. Kuntze] is an important cash crop of Kangra and Mandi district in Himachal Pradesh. Its cultivation started in 1850, when China variety (*Camellia sinensis* var. *sinensis*) was planted. There is great importance of preserving tea germplasm primarily due to massive uprooting of seed-grown sections of tea, the seed sources of which no longer exist, and cleaning of villages and jungles for extension of agricultural activities. The situation is further made alarming, as such areas are being replanted although at a slow rate, with few popular vegetative clones developed in recent times, thereby narrowing the genetic base of India tea populations. Once the old seed-grown sections and wild patches of a tea garden which are gold mines for tea genes, are uprooted, they will be lost for ever.

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Due to the wide genetic variability in tea populations created by the indiscriminate early introductions and free hybridization among them, clonal selection to exploit natural variability for the improvement of tea has been advocated (Wight, 1956; Barua, 1963 a; Bezbaruah, 1968, 1969). The bush population even in a single small field of tea shows great variation in growth, branching habit, size, shape, texture and pose of the leaf, as well as in the inherent quality and yield of the bushes. Therefore, the present investigation was carried out for the selection, evaluation, enhancement and conservation of tea germplasm in Kangra Valley.

MATERIAL AND METHODS

The present investigation was carried out in a mature tea plantation at Chambhi Tea Estate in Kangra District during April 1992. Selection was carried out in 10 field comprising of 58, 358 mature bushes. During early part of the season i.e., April 1992, 200 bushes on the basis of early flushing behaviour, branching habit, colour and size of the leaves, pubescence of the leaves and buds were marked. The surface area of each of the selected bushes was determined with the help of two diameters of the bush at the level of plucking table and multiplying the square of the mean diameter by a factor of 0.8 (Venkataramani, 1962; Barua, 1965). The average bush area in the field was obtained by determining the area of several random bushes in the vicinity of each selected bush. The selected bushes were kept under regular plucking from April to October at 7 days interval. The yield record of respective fields was maintained for making comparison. The yield potential of the selected bushes was obtained after dividing the bush yield per unit area by the field yield per unit area (Venkataramani, 1962).

Already introduced five cultivars, namely, Phoobsering 312 (P 312), Tukdah 253 (T 253), TV 9, TV 18 and TV 23 along with Kangra Local (China type) were also evaluated at the Tea Experiment Station of Himachal Pradesh Krishi Vishvavidyalaya, Palampur, which is situated at 1,291 metres above the mean sea level and receives annual precipitation of 250 cm.

RESULTS AND DISCUSSION

Out of the total 200 selected bushes, 72 bushes were having significant yield potential (Table 1), ranging from 1.41 to 3.43. Among the 72 tea bushes having significant yield potential only 10 bushes, number, '1', '2', '52', '53', '118', '119', '128', '130', '162' and '175' were having yield potential more than 2.5 and having most of the desirable characters like number of plucking points, pubescence, resistant to diseases and hails etc. It clearly supports the observations and the views recorded by Venkataramani (1962), Grice (1963), and Barua and Bexbaruah (1989) that screening of 40,000 bushes may produce one elite clone.

Bush number '52' and '130' possess the highest yield potential of 3.43 and 3.00, more number of plucking shoots, light green leaf colour, presence of pubescence respectively. These accessions are orthotropic in nature. Venkataramani and Padamanabhan (1964) also reported that the light green sections are far superior to dark green ones with respect to overall quality and flavour.

Table 1. Selected tea bushes having significant yield potential (Y.P.)

Bush. No.	Y.P.	Bush No.	Y.P.	Bush No.	Y.P.
1	2.51	74	2.31	128	2.87
2	2.54	75	2.32	129	1.68
14	1.42	81	1.63	130	3.00
16	1.75	85	1.49	138	1.67
17	1.41	86	2.17	139	2.26
19	1.56	90	1.82	144	1.76
24	1.56	92	1.75	147	1.43
25	1.65	93	1.56	154	1.54
33	1.57	95	1.64	155	2.45
35	1.60	99	1.49	156	1.72
37	1.60	100	1.82	159	2.05
44	1.69	101	1.43	161	1.55
45	2.06	106	1.89	162	2.69
46	1.54	108	1.99	166	1.48
47	1.86	117	2.07	171	1.74
52	3.43	118	2.97	173	1.60
53	2.57	119	2.83	174	2.42
54	1.84	120	1.62	175	2.50
55	1.57	121	2.24	176	1.67
63	1.65	122	2.21	178	1.57
70	2.24	123	1.79	179	2.13
71	1.49	124	1.85	184	1.44
72	2.01	125	1.99	185	2.35
73	1.83	127	2.48	187	1.52

Minimum population mean significant at : (P 0.05) = 1.41; (p 0.01) = 1.66

All the selected bushes which have significant yield potentials are being conserved *in-situ* at Tea Experiment Station of Himachal Pradesh Krishi Vishvavidyalaya, Palampur, for further use in breeding programme as well as to release the clonal varieties of high yield and quality performance.

In order to classify the different cultivars on the basis of their adaptability, three parameters, namely, productivity (x_i), responsiveness (b_i) and stability ($s^2 d_i$) were estimated (Table 2) as per Eberhart and Russell (1966). TV 23, P

Table 2. Estimates of adaptability parameters for yield with respect to different cultivars studied

Cultivars	x_i	b_i	$s^2 d_i$
Kangra Local	383.70	0.43*	5.50**
P 312	867.60	1.23*	26.00
T 253	856.20	1.17	7.90**
TV 9	847.60	1.06	14.60**
TV 18	651.20	0.85	19.60**
TV 23	1007.10	1.25*	18.10**
General mean	768.90		
SE±	39.50	0.10	

*Significantly different from unity at 5% level

**Significantly different from zero at 5% level

312 and T 253 showed above average performance, and TV 9 had average performance, whereas, Kangra Local and TV 18 had below average performance. The highest yield averaged over environment was observed in TV 23 and the lowest in Kangra Local. It can be seen that the TV 23, P 312 and T 253 gave significantly more than two times yield as compared to Kangra Local, the check, and would be the most promising. With respect to the responsiveness to changing environments, TV 23 and P 312 had regression value (b_i) significantly more than one, indicating that these two genotypes were responsive to favourable environments. Cultivars T 253, TV 9 and TV 18 had b_i value not significantly different from unity, indicating average responsiveness to changing environments. Kangra Local, which had b_i value significantly less than unity, was the least $s^2 d_i$ value and can be considered as adapted to poor environments.

On the basis of three parameters, x_i , b_i and $s^2 d_i$, TV 23 was specifically adapted to favourable environment with highest yield potential. T 253 had the general adaptability as indicated by the above average performance and average responsiveness, whereas Kangra Local was adapted to poor environment with the lowest yield. Kangra Local, P 312 and T 253 are China type, whereas TV 9, TV 18 and TV 23 are of Assam type.

For the enhancement of the tea germplasm, one year old seedlings of about 40 F₁'s among selected and diverse cultivars have been planted in the field during July 1993. The available germplasm are being conserved *in-situ* at Tea Experiment Station of Himachal Pradesh Krishi Vivhavidyalaya, Palampur.

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UTILIZATION OF GERMPLASM FOR EARLINESS AND IMPROVEMENT OF *BRASSICA CAMPESTRIS* L. VAR. YELLOW SARSON

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A total of 132, two way crosses were made from diverse sources of self-compatible yellow sarson with four early accessions of self-incompatible brown seeded toria, for improvement and induction of earliness. The crosses were attempted and F₁, were tested for nine yield attributing traits including earliness. The parents (33 + 4) and their crosses were analysed for genetic parameters (gca, sca, mean value) and further parents (33+ 4) and their crosses (132) were classified for High (H) and Low (L) of their individual attributes over the characters in respect of the significant gca value in positive or negative direction. The studies indicate that the residual variability existing in the germplasm can be exploited for crop improvement. Two way crosses are highly influenced by status of their parents.

Key words : *Brassica*, utilization, earliness, gca, sca, frequency of crosses

Oleiferous brassicae are mainly represented by turnip-rape (*B. campestris*) and mustard (*B. juncea*). Both of these species together called as rapeseed-mustard, and occupy an important position in India. This group of oilseeds is having vast reservoir of genetic variability for various morpho- physiological traits. The slow rate of improvement in rapeseed-mustard in India, could be attributed to various reasons. Genetic uniformity attained by pure line leads to a serious consequences of genetic vulnerability to biotic and abiotic stresses. The scope of heterosis breeding is limited. To avoid the above cited problem, lines/population of short-duration with desirable traits may be evolved.

MATERIALS AND METHODS

The experimental material constituted of two improved strains *B. campestris* var. *yellow sarson viz.*, (YID-1 and YID 3) differing in morphological features

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as well as qualitative and quantitative traits including maturity (110-120 days), were used as a female parents. Four very early (65-95 days) of brown seeded toria (NC-6369; NC-63645; NC-63647 and T-9 renamed as T-1, T-2, T-3, T-4, respectively) were utilized as male parents. Fourteen variable plants from YID-1 (P-1, P-2, P-3, ... P-13, P- 14) were crossed with four male parents (T-1, T-2, T-3, T-4) and thus 56 F_0 , of two way crossed seed were obtained and maintained. Thus, a total of 132 crosses were grown alongwith their parents in randomised block design during 1987-90 at IARI, New Delhi. The data recorded for nine variables such as Height (H); Primary branches (PB); Secondary branch (SB); Siliqua on primary branches (SP/B); Siliqua on sec. branches (S/SB); Seed per siliqua (S/S); Yield per plant (Y/PL); Initial flowering (IF); Complete flowering (CF) were analysed for mean performance, gca effects, sca effects, as per Line x tester analysis (Arunachalam, 1974).

RESULTS AND DISCUSSION

(1) **Variability analysis** : Significant variation was observed among the parents for all the nine traits. The partitioning of variation showed that the female parents also differed among themselves for all the traits. While male parents showed variation for six characters. The mean performance and range of variation for male and female parents showed that the maximum range of variation was observed among female parents for number of siliqua per secondary branch, number of secondary branch while for maximum variation was observed for seeds per plant, siliqua in secondary branch in male parents (Table 1).

Table 1. Mean and range of variability among parents in sarson

		HT	PB	SB	S/PB	S/SB	S/S	Y/PL	IF	CF
Parents	Max.	178.0	14.0	13.5	42.5	15.5	39.5	57.5	50.6	61.5
	Min.	59.0	4.4	1.5	17.0	1.0	13.2	13.5	29.0	42.0
Female	Max.	178.0	14.0	13.5	42.5	15.5	39.5	57.5	50.6	61.0
	Min.	95.0	5.4	1.5	19.1	1.0	18.2	13.8	34.5	42.0
	Mean	138.7	8.7	6.2	28.8	6.5	27.6	33.7	43.8	52.8
Male	Max.	101.0	6.8	19.5	27.7	14.5	16.5	23.5	38.5	52.0
	Min.	59.0	5.8	7.7	17.0	8.1	13.5	13.5	29.0	43.8
	Mean	78.9	6.2	13.5	21.5	11.2	14.7	12.1	34.8	41.8

(2) **G.C.A. estimates** : Adequate variation among the parents for most of the characters was observed. 21 out of 33 female parents and 3 male parents showed high (H) gca status in Fig. 1. The classification on high (H) and low

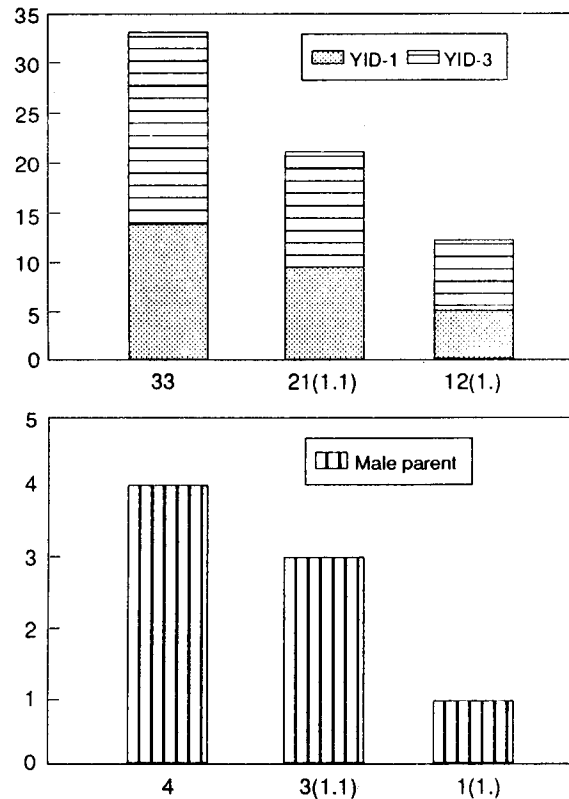


Fig. 1. Frequency of parents, showing their gca status

(L) parental status on the basis of gca effects measures across the characters are useful for relative assessment of potential of parents (Longham, 1961; Bandyopadhyay, 1976; Katiyar, 1978; Das, 1979; Katiyar, 1984 and Bhatnagar and Sharma, 1991). Such a close interrelationship between gca status and average performance of parents did not occur, when all the parents use in producing F_1 were examine individually mean performance over gca status. The presence of residual heterozygosity at certain loci in female parents and in male self-incompatibility could be a valid reason. The finding reported in the present study regarding gca effect and residual heterozygosity in relation to self incompatibility of male parents resembles with earlier workers.

(3) S.C.A. estimates : In general additive and non additive gene effects were found to control all the characters while non-additive pre-dominant for most of the characters. Estimated sca revealed that the presence of non-additive variance for plant height, primary branches, days to flower, yield per plant. Three crosses were identified as a potential hybrid having significant sca effects for five characters. Thus, the higher frequency crosses were given by female

parent YID-3 as compared to YID-1. Out of eight, six crosses belong to same parent (YID-3) showed significant for four characters. So, most of the crosses had shown significant sca effects in desirable direction. Thus, it is clear that female parents (YID-3) was most successful in producing higher number of superior crosses for yield and earliness (Table 2). Similarly, the male parents (T-3 and T-4) were comparatively better for producing the superior crosses. Similar results have been observed by other workers.

Table 2. Frequency of crosses with high(H) and low (L) sca status in different gca classes

gca of parents		sca status of crosses								
		Overall			In YID-1			In YID-3		
Female $\times$ Male	Freq.	T	H	L	T	H	L	T	H	L
H $\times$ H	F	63	37	26	24	15	9	39	27	12
H $\times$ L	F	57	29	28	26	14	12	31	15	16
L $\times$ L	F	12	4	8	6	2	4	6	2	4

(4) Relationship between parental gca status and sca effects : The frequency of crosses with high (H) low (L) sca effects were considered for nine characters.

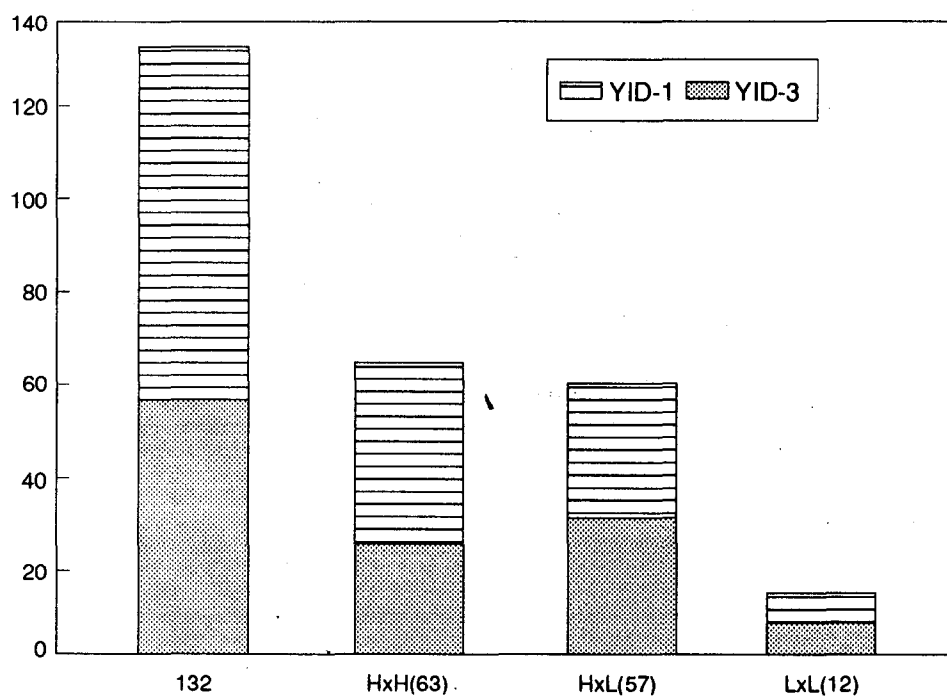


Fig. 2. Frequency of crosses showing their sca status in HxH, HxL, LxL parental categories

These crosses were looked upon their parental *gea*. Out of 132 crosses, 63 belong to High $\times$ High ($H \times H$); 57 crosses of High $\times$ Low ($H \times L$) and 12 crosses of Low $\times$ Low ($L \times L$) parental status (Fig. 2).

The maximum crosses with high (H) *sca* status were found in High $\times$ High ($H \times H$) while Low $\times$ Low ($L \times L$) and High $\times$ Low ($H \times L$) crosses were lowest and intermediate. Superior crosses with higher frequency would be located into $H \times H$ and $H \times L$ categories. The result are quite similar to the findings of earlier reports.

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EFFECT OF METAL STRESS CONDITION ON LIFE PERIOD OF DIFFERENT VARIETIES OF RICE

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In the present investigation, experiments have been designed to study the effects of different concentrations of Cd, Pb and Hg on life periods of 14 different varieties of rice (viz., Annapurna, MW 10, Swarna, IR 52, Ratna, IR 36, Mashuri, Kunti, Parijat, Pusa-2-21, IR 42, Samlai, Pankaj, Assam Aus). Three different concentrations of Cd, Pb and Hg, i.e. 1 ppm, 3 ppm and 5 ppm were used for treatment. Treatment with Cd, Pb and Hg salt solutions started after transplantation of the plants and continues for several times at intervals to cover the period of growth from 45 days to boot leaf stage. Then flowering time and maturity were noted for treated and control plants. It was found that life period was affected, i.e. either increased or decreased in some varieties, but others were not effected.

Key words : Rice, metal stress, life period

Earlier findings revealed that the plants grown in polluted environment accumulate heavy metals like Cu, Cd, Co, Ni, Pb, Hg, Mn etc. The amount of accumulation in the different parts of the plant body is rather higher for each metal than the amount present in the soil due to accumulation through years, and also from the amount present in the irrigated water. It was also found that there is variation in accumulation in different plant parts for the same metal. Experiments with known concentrations of heavy metals revealed that different varieties of rice showed stimulation or retardation or radicle growth depending on the concentration and the varieties used (Mukherji and Ganguly, 1974; Mukherji and Mitra, 1977; Ray, Barman and Khan, 1989; Ray, 1987, 1990, 1991; Ray and Dasgupta, 1991). A series of investigations were conducted to study the effects of heavy metals like Pb, Cd and Hg of known concentrations on growth and yield parameters of different varieties of rice. The accumulation pattern of different heavy metals in different parts of rice plants have been reported earlier (Ray, Barman and Khan; Ray, 1987). In the present paper, the effects of different concentrations of Cd, Pb and Hg on life period of different rice varieties have been presented.

MATERIALS AND METHOD

Fourteen different varieties of rice namely Annapurna, MW 10, Swarna, IR 52, Ratna, IR 36, Mashuri, Kunti, Parijat, Pusa 2-12, IR 42, Samlai, Pankaj, Assam Aus were taken for the investigation. Three different concentrations of Cd, Pb and Hg, i.e. 1 ppm, 3 ppm, 5 ppm, prepared following dilution method, were used. Sets were prepared in triplicate for each concentration of each metal and for respective control. Treatment started after transplantation of the plants and continued for several times at intervals to cover the period of growth till boot leaf stage. Then flowering time and maturity were noted for treated and control plants.

RESULTS AND DISCUSSION

Effect of treatments with different concentrations of Cd, Pb and Hg have been presented in Table 1, 2 & 3.

Table 1 : Effect of treatment with cadmium salt solution on life period of different varieties of rice (*Oryza sativa* L.)

Name of test materials (variety)	Concentration of cadmium (in ppm)	No. of days after sowing					
		Sowing	Transplantation	Establishment	Boot leaf Stage	Range of Flowerin	Maturity
Annapurna	Control	0	27	32	50	56-63	89
	1 ppm.	0	27	32	50	59-66	92
	3 ppm.	0	27	32	47	59-66	92
	5 ppm.	0	27	32	50	59-67	93
MW 10	Control	0	27	32	71	72-86	109
	1 ppm.	0	27	32	71	74-86	110
	3 ppm.	0	27	32	70	75-89	112
	5 ppm.	0	27	32	72	78-92	115
Swarno	Control	0	27	32	50	53-68	90
	1 ppm.	0	27	32	47	50-60	85
	2 ppm.	0	27	32	47	56-65	90
	5 ppm.	0	27	32	50	56-65	90
IR 52	Control	0	27	32	95	97-104	130
	1 ppm.	0	27	32	97	99-105	132
	3 ppm.	0	27	32	92	93-99	126
	5 ppm.	0	27	32	93	95-102	128
Ratna	Control	0	27	32	47	56-64	90
	1 ppm.	0	27	32	53	59 -66	92

(Table 1 contd.)

IR 36	3 ppm.	0	27	32	50	56-65	90
	5 ppm.	0	27	32	56	61-68	94
	Control	0	27	32	78	85-92	110
	1 ppm.	0	27	32	82	87-94	120
Mashuri	3 ppm.	0	27	32	84	86-93	119
	5 ppm.	0	27	32	84	86-93	119
	Control	0	27	32	138	140-146	173
	1 ppm.	0	27	32	139	142-150	176
Kunti	3 ppm.	0	27	32	141	143-151	177
	5 ppm.	0	27	32	138	140-148	174
	Control	0	27	32	110	112-120	146
	1 ppm.	0	27	32	112	114-122	148
Parijat	3 ppm.	0	27	32	114	116-124	150
	5 ppm.	0	27	32	112	114-122	148
	Control	0	27	32	112	114-122	148
	1 ppm.	0	27	32	112	114-123	149
Pusa 2-21	3 ppm.	0	27	32	109	112-120	146
	5 ppm.	0	27	32	110	112-121	147
	Control	0	27	32	75	84-92	117
	1 ppm.	0	27	32	70	78-86	112
IR 42	3 ppm.	0	27	32	72	81-90	115
	5 ppm.	0	27	32	71	81-90	115
	Control	0	27	32	78	81-88	114
	1 ppm.	0	27	32	93	95-103	129
Samlai	3 ppm.	0	27	32	95	97-105	131
	5 ppm.	0	27	32	97	99-108	133
	Control	0	27	32	150	156-163	189
	1 ppm.	0	27	32	148	156-164	190
Pankaj	3 ppm.	0	27	32	149	155-163	189
	5 ppm.	0	27	32	147	152-160	186
	Control	0	27	32	125	127-135	161
	1 ppm.	0	27	32	120	122-130	156
Assam Aus	3 ppm.	0	27	32	90	92-100	126
	5 ppm.	0	27	32	122	124-132	158
	Control	0	27	32	119	122-130	156
	1 ppm.	0	27	32	118	120-127	153
	3 ppm.	0	27	32	115	119-126	152
	5 ppm.	0	27	32	118	121-129	155

Table 2. Effect of treatment with lead salt solution on life period of different varieties of rice (*Oryza sativa* L.)

Name of test materials (variety)	Concentration of lead (in ppm.)	No. of days after sowing					
		Sowing	Transplantation	Establishment	Boot leaf stage	Range of flowering	Maturity
Pusa 2-21	Control	0	26	31	37	45-61	83
	1 ppm.	-	26	31	37	48-63	85
	3 ppm.	-	26	31	39	48-59	83
	5 ppm.	0	26	31	35	37-59	78
MW 10	Control	0	26	31	35	43-59	81
	1 ppm.	0	26	31	35	43-59	81
	3 ppm.	0	26	31	36	44-59	82
	5 ppm.	0	26	31	36	44-61	82
Sita	Control	0	26	31	59	65-74	99
	1 ppm.	0	26	31	59	64-74	99
	3 ppm.	0	26	31	57	64-75	99
	5 ppm.	0	26	31	59	61-76	98
Parijat	Control	0	26	31	49	59-74	96
	1 ppm.	0	26	31	48	53-74	93
	3 ppm.	0	26	31	49	59-76	97
	5 ppm.	0	26	31	48	53-76	94

It has been found that different varieties of rice respond differently in respect of concentration, as well as the metal concerned. Even the same variety behaved differently for different concentrations of the same metal. For instance, Cd delayed flowering and maturity in 3 ppm or 5 ppm or 1 ppm in case of Annapurna, M.W. 10, Ratna, IR 36, IR42. Whereas in case of early flowering and maturity were obtained in case of IR 52 and Pankaj. The other varieties like Mashuri, Kunti, Parijat were not affected significantly. Treatment with lead-salt-solution produced early flowering and maturity in Pusa 2-21 and other three varieties treated were not significantly affected. Treatment with Mercury salt solution induced early flowering and maturity in Sita and Parijat but delayed flowering and maturity in M.W.10.

Table 3. Effect of treatment with mercury salt solution on life period of different varieties of rice (*Oryza sativa* L.)

Name of test materials (variety)	Concentration of mercury (in ppm.)	No. of days after sowing					
		Sowing	Transplantation	Establishment	Boot leaf stage	Range of flowering	Maturity
Pusa 2-21.	Control	0	26	31	36	47-63	85
	1 ppm.	0	26	31	37	48-63	85
	3 ppm.	0	26	31	36	45-61	83
	5 ppm.	0	26	31	36	45-63	84
MW 10	Control	0	26	31	35	36-59	77
	1 ppm.	0	26	31	36	41-63	82
	3 ppm.	0	26	31	36	40-59	79
	5 ppm.	0	26	31	36	42-63	82
Sita	Control	0	26	31	59	65-76	100
	1 ppm.	0	26	31	58	64-76	100
	3 ppm.	0	26	31	57	63-74	98
	5 ppm.	0	26	31	59	64-76	100
Parijat	Control	0	26	31	52	60-74	97
	1 ppm.	0	26	31	49	54-74	94
	3 ppm.	0	26	31	48	55-73	94
	5 ppm.	0	26	31	48	53-71	92

It may be concluded from the results that the response of different varieties of rice with reference to life period differ not only depending on the genotypic difference but also to differences in concentration of metal and also on the kind of heavy metal used. Rice plants are not indifferent to metal stress conditions.

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ABIOTIC STRESS TOLERANCE - A SEARCH IN TRADITIONAL RICE GERMPLASM

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To cater the need of identifying suitable variety for wide range of biotic and abiotic stresses as prevailed in Bay Islands, a massive screening programme were undertaken during 1986-1992 adopting diverse screening strategies. Computing results across years and localities, a set of varieties tolerant to important abiotic stresses viz., excess salt, phosphorous deficiency, aluminium and Iron toxicity were identified from traditional rice germplasm collected from diverse agroclimatic zones.

Key words : Rice, germplasm, abiotic stress, tolerance

Identifying suitable germplasm resources tolerant to various biotic and abiotic stresses have been a major concern in the national as well as international rice research strategy since long back. Day by day the magnitude of such stresses are concentrating due to intensive cropping, cultivation of improved varieties with narrow genetic base, monoculture of variety in specific areas, breakdown of established tolerance level, natural calamities and due to ecological mismanagement. The Andaman and Nicobar group of Islands - a far flung union territory of Indian subcontinent is a potential rice growing area. Being humid tropics and endeavour with unique climatic conditions, the islands are having specific constraints in rice cultivation. Among the abiotic stresses, excess salt stress and phosphorus deficiency in the acid sulphate soils, excess iron and aluminium in the low lying areas were found to be major problem. The present paper deals with the achievements of a study aims at identifying suitable tolerant germplasm for important abiotic stresses in Andamans are detailed below.

MATERIALS AND METHODS

Two hundred seventy five traditional rice germplasm including landraces were collected from Chhotanagpur plateau of Bihar and Maharashtra, Indo-gangetic plains of West Bengal and Uttar Pradesh, hilly terrain of North

Eastern Region, coastal south Bengal and Kerala, were used in this study. Since 1986, the collected materials were recurrently screened across different localities till 1992 with a view to pinpoint suitable donor sources tolerant to prevailing biotic and abiotic stresses in Andamans. Regarding abiotic stress tolerance for screening of the genotypes following strategies were adopted.

A. Screening for excess salt tolerance

1. Under hydroponics

Pre-germinated seeds of the traditional rice germplasm were kept on furrows made on a square styrofoam sheet with a nylon net underneath. In such a way 20 number of entries accommodated on each styrofoam sheet which was kept floated on Hogland solution in a plastic tray ($42 \times 30 \times 6$ cm). The pH of the solution maintained at 5.0 regularly. At 3-4 leaf stage, salt stress was given in the form of NaCl: CaCl_2 (1:1). After salinization at the 7th day, leaf injury symptoms were scored in 0-9 scale and the entries were grouped as tolerant, moderately tolerant and susceptible.

2. *In vivo* screening in cement tanks

Large narrow cement chambers filled with acid sulphate soils in experimental net house were employed in this study. Desired salinity level was maintained regularly with sea water, pH was maintained at 5.0. Observations were recorded at different stages of the crop and finally completed to detect tolerance norms.

3. Field screening

The germplasm were recurrently evaluated in a field adjacent to creek which was frequently inundated with sea water. The average EC and pH varied from 3.0 to 9.0 and 3.0 to 4.8 respectively. Observations were taken at various stages of the crop. In all the approaches, Pokkali, Nona Bokra and IR 26 were used as tolerant and susceptible checks.

B. Screening for phosphorous deficiency tolerance

1. Under hydroponics

Hogland solution was used in the same manner as for salt stress. In control set 10 ppm and in phosphorous deficient set 0.5 ppm of phosphorus were used, pH was maintained regularly at 6.5.

2. *In vivo* screening in wooden tanks

Varieties were directly sown on red lateritic soil (pH 4.5, soil: water = 1:2.5; p = 60 ppm) in narrow long wooden tanks where phosphatic fertilizer was withdrawn and in the control set phosphorous was applied @ 50kg/ha. Observations were recorded and entries were grouped as tolerant and susceptible. In both the approaches Rasi and IR-28 were used as biological check.

C. *Screening of excess Aluminium tolerance*

A. Under hydroponics

Hogland solution with 0, 30 and 60 ppm aluminium in the form of $AlCl_3$ were employed in this study. pH was adjusted regularly at 4.0. On the basis of relative root length in treated and control set, tolerance level were detected. MW 10 was used as biological check.

D. *Screening for excess iron tolerance*

1. *In vivo* screening

Germplasm were screened in fibre glass tanks filled with soil. Iron toxicity created artificially with the addition of $FeCl_3$ and citric acid to attain a level of 400 ppm. pH at 5.0 and Fe stress level were maintained throughout the experiment. Twenty one days old seedlings were transplanted in such tanks in experimental net house. Observations were recorded at maturity.

2. Field screening

Germplasm were evaluated in a field with acid sulphate soil stressed with iron toxicity. Materials were screened recurrently across years and average data used in computing tolerance norms. Mashuri and IR-24 were used as tolerant and susceptible checks. In the aforementioned approaches for observations and interpretations were made as per IRRI standard Evaluation system 1988.

RESULTS AND DISCUSSION

Two hundred and seventy five varieties were screened for mineral stresses (excess salt, iron, aluminium and phosphorous deficiency) related to acid surface soil. Among the varieties tested 20 varieties were found to be tolerant to excess salt (Table 1) and out of those varieties 5 varieties viz., Pokkali, Chettipokkali, Chettivirippu, Cheriopandy and Hamilton were normally grown in salt affected areas.

Table 1. Donors tolerant to different abiotic stress conditions identified in traditional rice varieties

Stress	Traditional variety
Excess Salt ¹	Pokkali, Chettipokkali, Chettivirippu, Cheriopandy, Hamilton
Excess Salt ²	Changpai, Ratirali, Ramsail, Mahajang, Radhunipagal, Phouren, Churnakati, Mirgolo, Mohishadhan, Sectabhog
Iron toxicity (Avoiding type)	Chakhau Amubi, Sectabhog, Ramsail, Ngoba, Black Jonga, Meetmuri, Digio, Sendurjoba, Nania, Chipti, Chinadhan, Basmati.
Iron toxicity	Sirsoria, Thaothabi, Iaphoe, Phouren, Kalma, Framdhan, Charaimukhi
Iron toxicity and excess salt	Pokkali, Damodar, Vatnama, Kurunthakuruka, Maltu, Hamilton, Dhudrice.
Aluminium toxicity	Khailal Kucho, Digio, Haskalma, Gora, Karjat 23, Ajan 146, Mohishadhan, Maltu, Sangsangba, Panvel, Sendursail, Pawana, Nania, Karjat 18, Indrayani, Karhani, Kataribhog, Sectabhog, Kalokeri.
Aluminium toxicity and excess salt	Dhudrice, Sectabhog, Mohishadhan
Phosphorus deficiency	Indrayani, Charaimukhi, Nania, Chindhan, Lalki, Digio, Laloo 14, Punadhan, Daldadhan, Malkujiddhan, Barajapani.
Phosphorus deficiency (Efficient for high P-uptake)	Karjat 23, Jonga, Black gora, Badhkaamkati, White/gora, Sathi, Maltu, Kataribhog, Ratirali.
Phosphorus deficiency and excess salt	Pokkali

1. Normally grow in salt affected areas.

2. Normally grow in normal soils.

It is logical to assume that these varieties were tuned with salt stress due to their cultivation over years, whereas other 15 varieties collected from places not affected with salt stress. This observation indicates null relationship between the tolerant norms and of the geographical origin. For Iron toxicity, 19 varieties were found to be very promising (Table 1). Out of them 12 varieties were of avoiding type i.e. either they escape the critical injury period i.e the flowering phase due to shorter life cycle or could inhibit the diffusion of excess iron through the root system, thereby injurious level of iron could never be achieved. Seven varieties viz., **Sirsoria, Thaothabi, Laiphoe, Phouren, Kalma, Framdhan** and **Charaimukhi** were found true tolerant type. In spite of high iron uptake neither yield was affected nor the extent of bronzing symptoms which reflect physiological injury. Seven varieties viz., **Pokkali,**

Damodar, Vatnama, Kurunthakuruka, Maltu, Hamilton and Dhudrice were found to be tolerant for both iron toxicity and excess salt. (Table 1).

Nineteen varieties were identified as tolerant to aluminium toxicity (Table 1). Furthermore 3 varieties viz., **Dhudrice, Seetabhog and Mohishadhan** were found to be tolerant for both aluminium toxicity and excess salt. In respect of phosphorous deficiency, 11 varieties were found to sustain the yield level with minimum phosphorus while, 9 varieties viz., **Karhat 23, Jonga, Black gora, Badhkalamkati, Whitegora, Sathi, Maltu, Kataribhog, Ratiarali** had the capacity for high uptake of phosphorous indicating their strong efficiency in this aspect. Variety **Pokkali** was identified as tolerant to both phosphorous deficiency and excess salt. (Table 1).

Thirteen varieties were identified for multitolerance and among them 3 varieties viz., **Pokkali, Seetabhog and Digio** (Table 2) had tolerance for three

Table 2. Rice varieties with multi tolerance for abiotic stresses

Variety	Excess Salt stress	Iron toxicity	Aluminium toxicity	Phosphorus deficiency
Indrayani			+	+
Charaimukhi		+		+
Nania		+		+
Chinadhan		+		+
Digio		+	+	+
Kataribhog				
Seetabhog	+	+	+	
Ramsail	+	+		
Ngoba	+	+		
Phouren	+	+		
Ajan 146	+		+	
Mohishadhan	+		+	
Pokkali	+	+		+

+ = Tolerant

stresses and other 10 varieties possessed tolerance for two stresses germplasm were screened for tolerance in respect of excess salt at various growth stages. At 8 ds^{-m} salt stress three different kinds of varieties were identified which

exhibited their tolerance at seedling, vegetative and ripening stage. Varieties mostly failed to show the tolerance at reproductive stage which was also found to be most crucial. With the increment of salt stress such as 12 $\text{ds}^{-\text{m}}$, 6 varieties viz., Frow, Ranga Gellong, Kbathangmew, Napdoi, Lyngri and Adamchini were found to be tolerant at seedling stage and 3 varieties viz. Pokkali, Mahajang and C 14-8 were found tolerant at flowering stage while increasing the stress level to 16 $\text{ds}^{-\text{m}}$, 3 varieties viz. Nonabokra, Pokkali and Sendursail were found to be tolerant at seedling stage and 2 varieties viz. Pokkali and C 14-8 showed their tolerance at flowering stage.

It is concluded that the present set of germplasm offered considerable amount of variability in respect of biotic and abiotic stresses. The identified donors may be used in future breeding programmes to recombine resistance/tolerance characters in high yielding varieties which are well adaptive to the agroclimates of Andamans.

EFFECT OF PACKAGING AND STORAGE TEMPERATURES ON LONGEVITY OF CARROT SEEDS

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Carrot seeds cv Nantes were stored at ambient, 5°C and -20°C. Seeds with seven per cent moisture were packed in paper, glass, polyethylene aluminium foil laminated pouches and viability, vigour and longevity were studied. Seeds remained viable for two years. The process of seed deterioration was faster and greater at ambient storage. The initial viability was maintained at 5°C and -20°C storage. Polyethylene and paper bags were effective in retaining high seed viability at 5°C and suitable for the medium term storage. The aluminium foil laminated bags maintained high viability and seedling vigour at -20°C thus effective for long term conservation of invaluable germplasm.

Key words: Carrot seeds, longevity, temperature, conservation

Carrot (*Daucus carota* L.) cv nantes is an important and choicest vegetable crop in India. It is primarily cultivated through the seeds, which also forms a valuable tool for genetic conservation, owing to simpler nature, practicable and inexpensive operation. High seed quality in terms of vigour and viability is first step towards higher production. Seeds are viable for shorter period under ambient conditions (Agrawal, 1980). The viability of seeds is predominantly dependent on age and nature of seeds (Harrington and Satyati-Harjati, 1966) and method of storage (Popovska *et al.*, 1981). High temperatures and high moistures increase the deterioration process in seeds resulting in loss of germinability as well as vigour (Abdul-Baki and Anderson, 1972). Different kinds of packaging material are available to protect the seeds from high humidity as well as from insects and microorganisms. The experiment was conducted with the view to conserve the viability of carrot seeds for longer period by use of different packaging material at lower temperatures.

MATERIALS AND METHODS

The experiment was conducted with the seeds of carrot cv Nantes. Seeds were dried to 7.0 per cent moisture and packed in different containers viz., kraft paper, glass, polyethylene (200 gauge) and aluminium foil laminated

pouches. These containers were stored at low (5°C), sub-zero (-20°C) and ambient temperatures (16 - 35°C) for two years. Seed viability was expressed in terms of percentage of germination. Seeds were germinated on 'top of paper' at 20-30°C in Cleland's seed germinator. Seedlings were evaluated as per the standard procedures and germination percentage was recorded on normal seedlings. Seedling vigour was compared by means of (coefficient of velocity of germination) shoot length, root length, dry weight and seedling vigour index, which was expressed as a sum of ratio of number of normal seedlings on a particular day of emergence till last count taken.

RESULTS AND DISCUSSION

Seed germinability was significantly affected by the packaging material and storage temperatures. The percentage of germination was significantly reduced under ambient storage. It was 61 per cent after second year of storage (Table 1). Initial percentage of germination was maintained at low (5°C) and

Table 1. Seed viability as influenced by temperatures and containers during storage of carrot seeds

Storage Temp.	Storage Containers	First year % G after		Second year % G after	
		48 Hrs.	Final	48 Hrs.	Final
Ambient	paper	10	75	0	61
	Glass	13	84	2	73
	Poly	22	92	0	70
	Lam	9	87	2	80
5°C	Paper	19	87	17	88
	Glass	22	81	21	81
	Poly	27	90	22	84
	Lam	26	87	25	87
-20°C	Paper	17	76	0	0
	Glass	25	91	21	83
	Poly	19	81	17	80
	Lam	19	89	20	88
CD at 5%		7.4	8.7	5.2	7.6

sub-zero (-) 20°C) temperature. Similarly the emergence of seedlings after 48 hours of sowing was faster and higher in seeds stored at 5°C and -20°C. Amongst different packaging material used, the percentage of germination was higher in aluminium foil pouches stored at ambient conditions. All the storage

containers showed higher percentage of germination at 5°C storage. None of seeds germinated when stored in paper bags at -20°C owing to the chilling injury. The coefficient of germination was higher in seeds stored at 5°C or -20°C than ambient temperatures (Table 2). Similarly shoot length, root length, dry weight and vigour index were greater for the low temperature stored seeds. The decline in these parameters suggests loss of seedling vigour and seeds are heading towards deterioration.

Table 2. Seedling vigour as affected by temperatures and containers during storage of carrot seeds.

Storage Temp.(°C)	Storage Containers	Coeff. of Germination	Shoot Length (cm.)	Root Length	DWT (mg.)	Vigour Index
Ambient	Paper	28.6	0.5	2.4	0.72	17.4
	Glass	29.8	0.7	2.6	0.78	22.4
	Poly	30.4	0.9	3.1	0.60	24.7
	Lam	29.9	0.5	1.9	0.58	21.6
5	Paper	34.4	0.9	1.8	1.34	30.6
	Glass	34.7	1.0	3.1	1.04	30.3
	Poly	34.6	1.2	3.3	1.33	30.6
	Lam	34.5	1.0	3.2	1.07	31.7
-20	Paper	-	-	-	-	-
	Glass	35.2	2.7	2.7	0.82	30.6
	Poly	33.3	3.2	3.2	1.09	27.9
	Lam	33.7	2.7	2.7	1.10	31.3
CD at 5%		1.60	0.33	1.06	0.30	3.10

Carrot seeds exhibit orthodox type of storage behaviour and remain viable for the shorter period especially for 6 months under ambient conditions (Agrawal, 1980). Seed longevity is affected by the relative humidity and temperature of a particular place.

The seeds stored in ambient conditions without any control over relative humidity or temperatures lost their vigour and viability. The seed viability was conserved for two years at 5°C or -20°C without loss of vigour. The process of seed deterioration is rapid under ambient conditions and the seeds exhibit low germination and seedling vigour (Fonseca et al. 1980). The reduction of viability was slower especially at lower temperatures (Harrington, 1972). The retention of viability varies in different containers at -20°C. Packaging acts as a small storage room where it protects seeds from atmospheric humidity.

The aluminium foil pouches were effective in preserving initial viability. The paper containers are not suitable for storage of seeds at sub-zero temperatures. The choice of packaging material depend on temperature and storage period. Hence, inexpensive polyethylene and paper bags can be used for medium term storage of seeds while aluminium foil pouches at -20°C for long term conservation of germplasm.

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EFFECT OF LONG-TERM POLLEN CRYOSTORAGE ON FRUIT, SEED SET AND GERMINATION IN EGGPLANT (*SOLANUM MELONGENA* L.) cv. 'ARKA KUSUMAKAR'

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Fruit set, seed set and germination with 9 year cryostored, eggplant (*Solanum melongena* L.) cv. 'Arka Kusumakar' pollen showed no decline compared with fresh pollen, when pollinations were carried out on emasculated flowers of 'Arka Kusumakar'. Prolonged cryostorage involving the male gamete component obviously, was capable of performing its normal process of fertilization, resulting in fruit and seed set. The average seed number per fruit set with cryostored pollen was higher than (570) that of fresh pollen (423) and germination of seeds set by cryostored pollen was ca. 32 per cent, which was slightly higher than that of fresh pollen (27 per cent) as sample from the seeds obtained. The results clearly indicate the possibility of conserving genes through pollen storage, thereby long-term genetic conservation of characters transmitted through pollen could be successfully accomplished through cryogenic methods.

Key words : Pollen cryostorage, longterm, eggplant

Long-term storage of pollen in cryobanks, is a useful tool of haploid genepool conservation. Pollen occupies less storage space and is presently considered economical for conserving the genepool diversity hitherto wasted to nature. Pollen storage is identified as an integrated component of a crop germplasm conservation programme. Pollen storage strategies are also desirable in vegetable crops to achieve several breeding objectives like heterosis breeding, perpetuation of male sterile lines hybrid seed production etc. which has been well documented (Bajaj, 1987; Towill, 1985; Rajasekharan and Ganeshan, 1994). Limited reports are available pertaining to the effects of pollen fertility, seed recovery and viability. In potato, Pallais *et al* (1985) investigated this effect after storage of pollen at -12°C . Pfahler (1985) studied early seedling growth in maize after storing pollen at 2°C . The present report deals with the effect of long-term cryostorage (9 years) on fruit and seed set and seed germination in eggplant (*S. melongena* L.) cv. 'Arka Kusumakar' (AK)

MATERIALS AND METHODS

The protocols for pollen collection, cryostorage, viability and fertility assessment are discussed in detail elsewhere (Alexander and Ganeshan, 1989). The fertility of long-term cryostored eggplant pollen has been successfully established (Rajasekharan *et al.*, 1993)

Seed production : Seeds were obtained from crosses with 9 year cryostored AK pollen and fresh pollen of the same cultivar on emasculated AK seed parents. A total number of 37 flowers were pollinated with cryostored pollen samples and 46 flowers pollinated with fresh pollen samples. The resulting fruits set were left till maturity and harvested for seed extraction.

Seed germination: Seeds set through 9 year cryostored pollen 'Arka Kusumakar' were germinated (in three replicates) in earthenware seed pans using soilrite as potting mixture. Simultaneously germination of seeds set through fresh 'Arka Kusumakar' pollen (control) were also undertaken for a performance related comparison. Seed germination data were recorded periodically, till transplantation stage.

The seedlings generated through crosses with 9 year cryostored pollen and fresh pollen (Arka Kusumakar) were transplanted to earthenware pots and grown to adult plants, to study flowering behaviour and pollen viability.

The data was analysed statistically using a simple unpaired t-test.

RESULTS AND DISCUSSION

Results on fruit and seed set along with seed germination are presented in table 1a and 1b. It was interesting to note that the 9 year cryostored pollen

Table 1a. Field pollination with 9 year cryostored pollen of 'Arka Kusumakar' (AK)

Parents		No. of flows pollinated	No. of fruit set	Average No. of seeds/fruit
Male	Female			
AK	AK(fresh)	46	41	422.93
AK	AK(cryostored)	37	34	569.50

t - calculated 1.245 (NS)

Table 1b. Germination of seeds set through 9 year cryostored and fresh pollen

	No. of seeds sown	Percentage germination
Fresh (AK × AK)	150	26.66
Cryostored (AK × AK) (9Y)	150	32

was able to induce an equivalent number (average) of seeds per fruit comparable to fresh pollen ($p=0.01$). Seeds set through cryostored pollen recorded 32 percent germination (average of 3 replicates) which was slightly higher than the controls (26.6%). The seedlings generated through cryostored pollen were successfully transplanted and grown to adult plants, which started flowering on proximal dates, along with plants generated through fresh pollen. Flowering proceeded normally and no perceivable phenotypic abnormalities were observed. Pollen viability recorded was on par with controls (data not included).

The foregoing results indicate that prolonged cryostorage of eggplant pollen does not affect fruit set, seed set and seed germination. Seedlings when transplanted produced healthy adult plants which flowered and produced pollen having high viability profiles, comparable to controls. Extensive studies have been carried out on viability of seeds in relation to storage, but there are limited number of reports available on effects of pollen storage on seed viability. Since pollen grains and seeds are very similar in many physiological manifestations, it is generally expected that stored pollen could exhibit a reduction in vigour before it loses viability (Shivanna *et al.*, 1991) which perhaps could be applicable for pollen stored at sub-zero temperatures a considerable decline in viability profiles as indexed by *in vitro* germination, ultimately, controlled pollinations have shown that there was no decline in fruit and seed set (Rajasekharan and Ganeshan, 1994).

In the present study, the seeds sired by cryostored pollen could grow into healthy plants without showing any phenotypic changes. To study the genetic changes in such seed populations (set through cryostored pollen) sensitive procedures like RFLP, RAPD etc. could delineate the alterations in enzyme activity at the seedling stage which could be correlated to lack or malfunctioning of a specific gene sequence coding for a particular enzyme (Alexander AND Ganeshan, 1993).

The results described here have special significance while considering the establishment of 'Pollen cryobanks' for long-term preservation of haploid eggplant germplasm.

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EX-SITU CONSERVATION OF DESICCATION-TOLERANT SEEDS IN GENE BANK

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The National Bureau of Plant Genetic Resources (NBPGR), New Delhi holds the responsibility to conserve germplasm of agri-horticultural crop plants. The long-term Base collection is maintained in built-in cold store vaults of pre-fabricated polyurethane insulated panels running at -20°C . Over 1,44,100 germplasm accessions are stored as Base Collections in National Genebank. These consist of cereals and pseudo cereals (62,423), millets and minor millets (15,783), oilseeds (20,520), pulses (25,527), fibre crops (3,607), vegetables (7,615), medicinal and aromatic plants (179) and improved/released varieties (888) of various crops.

Key words : Germplasm, conservation, genebank, desiccation tolerant seeds

Vigorous efforts have been made in recent years for *ex-situ* conservation of plant genetic resources through the Indian National Plant Genetic Resources System (IN-PGRS) comprising a network for base collections of germplasm of different crops kept under long term storage and linked with numerous crop specific active collections that are maintained at specified locations. National Bureau of Plant Genetic Resources (NBPGR) is the nodal organization for developing, operating and co-ordinating this system. The National Gene bank (NGB), with facilities for long term storage is an integral part of this system. It has the responsibility to maintain germplasm as a base collection for the nation. It also has an active collaboration with crop based institutes of Consultative Group of International Agricultural Research (CGIAR) and is entrusted with regional and global responsibility for conservation of more than a dozen crops by International Plant Genetic Resources Institute (IPGRI).

The establishment of the National Gene Bank started with the commissioning of the first cold storage module of 100m^3 capacity in 1983, comprising two compartments, one operating at 4°C and other at -10°C . Since then four more modules (two with 100m^3 capacity and two with 176m^3 capacity) maintaining -20°C have been added. The total long term storage capacity for over 2,00,000 seed samples has, thus, been created. Consequent upon the

commissioning of 12 new long term storage modules by 1996, the National Gene Bank will have a capacity for long term storage of over one million accessions of crop germplasm.

ACQUISITION OF GERMPLASM

The Indian National Genebank is a Federal facility and the germplasm stored as the base collection comes under the jurisdiction of Government of India. The responsibility for providing the technical guidance and administrative control are vested with the Director NBPGR. Keeping in view the policy, NGB accepts valuable seed stocks from various national and international sources.

The NGB is linked effectively with 30 ICAR Institutes, National Research Centers, All India Co-ordinated Projects and State Agricultural Universities. These centers are designated as National Active germplasm Sites (NAGS) and are responsible for evaluating and maintaining the active collections of specific crops. NAGS form the major source for supplying germplasm of different crops to NGB for storage as base collections.

NGB also gets germplasm accessions of more than a dozen crops from various countries by virtue of the responsibility entrusted by IPGRI for maintenance of global and regional base collections of these crops. The active collaboration between International Agricultural Research Centers (IARCs) located in India and abroad also, results in considerable exchange of germplasm between NBPGR and ICRISAT (India), IRRI (Philippines), CIMMYT (Mexico) and ICARDA (Syria). The NGB regularly gets accessions of pigeon pea from ICRISAT and lentil from ICARDA for maintaining the duplicate, safety base collections.

The Germplasm Advisory Committees, set up for specific crops or group of crops, advise the NGB regarding improving the capability, efficiency and effectiveness of its services. They suggest countries/regions in the world that need to be explored or approached for introduction of new crops/genetic variability to sustain the national crop improvement programmes. Based on the recommendations, bilateral agreements have resulted in germplasm exchange with over 80 countries (Rana, 1995). These accessions eventually find a place in the NGB through the IN-PGR system.

GUIDELINES FOR SENDING SEEDS TO THE GENE BANK

The NGB accepts germplasm accessions from various sources following the guidelines as mentioned below:

(i) Seeds should be well developed, physiologically matured and free from insects and pests. Undersized, shrivelled and immature seeds should be discarded.

(ii) The harvesting under high moisture conditions should be avoided to ensure disease and pests free seeds. Visual inspection and discarding off-types and discoloured seeds is advisable. Fumigated/treated seeds are not accepted.

(iii) Seeds should be dried soon on harvest, preferably in a room at 22°C temperature and 35% RH.

(iv) Accessions of self-pollinated crops should have at least 3,000 seeds and the cross-pollinated twice of that number. Concessions can be made in exceptional cases where seeds are available in limited quantity and for wild relatives.

(v) The germplasm accessions should be packed in good quality paper pouches/muslin cloth bags and wrapped in polythene. Label indicating the unique identification number of the accession should be placed inside and also outside the pouch. The entire seed lot should be packed in either metallic (tin) or cardboard boxes.

(vi) The seed lots should be accompanied by a list of all accessions and must also contain a minimum passport data indicating Name of crop (common, English name); Species/sub species name; Vernacular/Landrace name (if available); Collector No.; Place of collection; National collection number; Population size (No. of seed/weight); Date/year of collection/rejuvenation; Date of flowering; Plant type/habit; Flowering (days/months); Inflorescence type; Fruit characters; Seed characters; Maturity; Morphological marker; data on reaction to diseases/pest/adaptation to stress etc.; and specific local use. In addition, if any detailed evaluation data (based on IPGRI descriptor lists) is available, may also be sent.

(vii) Prior to despatch of the seed material, information including a list of the germplasm, must be sent to the NGB.

Viability testing

The accessions received are subjected to the seed germination test. The ISTA (1976) rules and the recommendations of IPGRI (formerly IBPGR) Advisory Committee are followed to determine the different requirements for light, substrate, temperature, water or any other specific requirement for the different species. The germination test is performed using a minimum of two replicates using 200 seeds (100 seeds per replicate). Generally either rolled towel or filter paper substrates are used. If the accession shows more than 85 per cent viability, it is accepted for further processing. A list of accessions showing less viability is prepared and sent back to the source of supply for sending these accessions again from fresh harvest.

Seed drying and packaging

The accessions qualified for long-term storage are transferred into muslin cloth bags and kept in a seed drying cabinet, maintaining 15°C temperature and 15% RH. The seeds are allowed to equilibrate and within a period of fortnight (depending upon species and initial moisture content) attain a moisture content in the range of 3-7%. However, moisture content is determined following IPGRI guidelines either by the 'low constant temperature oven method' or by 'high constant temperature oven method' to ensure quality control. After equilibration, each accession is packed in a tri-layered aluminium foil pouch and hermetically sealed. Each pouch is labelled indicating the crop, genus, species, accession number, identification number, germination percentage, moisture per cent, storage date and source. They are then arranged serially in plastic baskets and placed in the cold storage modules, maintained at -20° C. The location indicating the module, rack, shelf and basket numbers are provided to the gene bank data base.

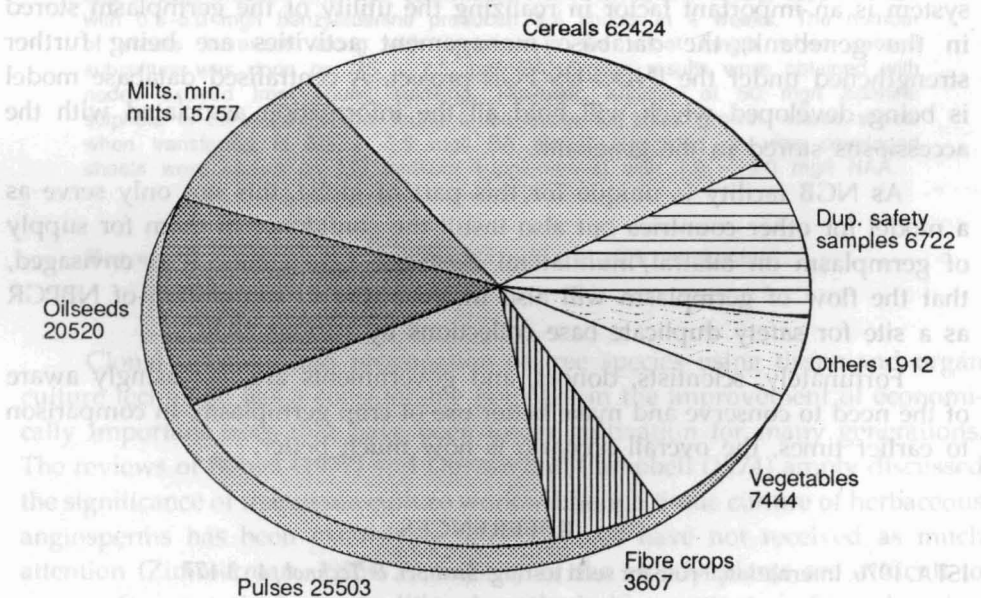
GERMPLASM HOLDINGS IN THE GENE BANK

Figure 1 shows the total proportional picture of base collections maintained in NGB. Presently (as on March 31, 1995), the NGB has a total of 1,43,889 accessions as base collections. It includes the major groups of crops *viz.*, -cereals

Table 1. Base collections in National Genebank kept in long term storage in seed repository maintained at -20°C (As on 31st March, 1995)

Crop Groups	No. of Accessions
Cereals	61,863
Pseudo-cereals	560
Millet & minor millets	15,783
Oilseeds	20,520
Pulses	25,527
Fibre crops	3,607
Vegetables	7,615
Med. & A.P.	179
Spices	67
Others	778
Released varieties	888
Duplicate safety samples	6,722
Total	1,44,109

(61,863), pseudo-cereals (560), millets and minor millets (15,757), oilseeds (20,520), pulses (25,503), fibre crops (3,607), vegetables (7,444), spices and condiments (67) medicinal & aromatic plants (179) and other miscellaneous crops (778). Apart from the released improved varieties (888), safety duplicate samples of pigeon pea (1702) from ICRISAT and lentil (5020) from (ICARDA) (Fig.1) are also conserved in the genebank. The released improved varieties of various crop groups which have been stored in NGB are - cereals (275), millets and minor millets (9131), fibre crops (63), pulses (133) oilseeds (163), narcotics (66), vegetables (55) and one variety each of forage crops (barseem) and medicinal crop (opium). Further details of total accessions of various crops and their sources are given in Table 1. On an average 15,000 - 20,000 accessions of various crops are added every year to the existing collections of NGB. However, it is obvious from Fig. 1 that the germplasm of fibre, vegetable, spices & condiments and medicinal & aromatic crop plants need more attention for their conservation in the genebank.



MONITORING OF SEED VIABILITY IN THE GENE BANK

The aim of NGB is to store good quality seed and maintain viability of the accessions above 85%. The preferred standard for monitoring accessions kept in the base collection is after 10 years of storage. However, in view of the fact that this facility has developed recently, random accessions are monitored periodically after 3-5 years of storage. If the viability is falls below 85%, a request is sent to the NAGS to regenerate seed accessions for replacement in the base collection.

UTILIZATION

The germplasm stored in the NGB is available for crop improvement programmes to research scientists world wide. The request for any accession is first forwarded to the concerned NAGS for providing the material from the active collections. If seeds of any accession is not available in the active collections, the Incharge of the NAGS may obtain seeds from the base collection for multiplication and/or distribution to the research scientists. The NAGS is also responsible for regenerating the seed material for adding it to their active collection and sending a part for the base collection.

DATA MANAGEMENT

At present the information like crop name, botanical name, germination percentage, moisture percentage, date of storage source of material, location in the gene bank and all the accompanying passport data is stored in the form of dBASE files. Since the development of an effective data management system is an important factor in realizing the utility of the germplasm stored in the genebank, the database management activities are being further strengthened under the INDO-US PGR project. A centralised database model is being developed which will hold all the information associated with the accessions stored in the genebank.

As NGB facility is unique for this part of globe, this not only serve as a model for other countries but also instill the confidence in them for supply of germplasm on bilateral/multilateral exchange agreements. It is envisaged, that the flow of germplasm will also increase due to recognition of NBPGR as a site for safety duplicate base collections by various IARCs.

Fortunately, scientists, donors, and governments are increasingly aware of the need to conserve and make better use of crop germplasm. In comparison to earlier times, the overall scenario is now much better.

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IN VITRO PROPAGATION OF NEEM FROM SEEDLING AND MATURE TREE

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Azadirachta indica A. Juss. commonly known as Neem is medicinally and pesticidally important tree. Its seed viability lost for few months which falls off rapidly after two weeks. Thus conventional multiplication through seeds is limited. Present paper described *in vitro* plantlet formation from nodal explant of mature tree and seedling. Nodal explant from mature tree when cultured on Murashige and Skoogs medium (with half concentration of NH_4NO_3 and KNO_3) supplemented with 0.5–5.0 mg/l benzyladenine produced 3-4 shoots in 4 weeks. The number of shoots increased along with increase in the shoot length when second subculture was done on MS + 2.5 mg/l BA. Similar results were obtained with nodes excised from young seedling. However, addition of 50 mg/l Adenine sulphate in the medium was found to be better for shoot growth. These shoots when transferred to MS + 0.5 mg/l BA further elongated. *In vitro* developed shoots were rooted on MS medium supplemented with 1.0 – 3.0 mg/l NAA.

Key words : Neem tree, *Azadirachta indica*, *in-vitro* propagation

Clonal selection and propagation of tree species using tissue and organ culture technique has a considerable potential in the improvement of economically important trees that have been under cultivation for many generations. The reviews of Bonga (1977) and Durzan and Campbell (1974) amply discussed the significance of tree tissue culture work. Although tissue culture of herbaceous angiosperms has been extensively studied, trees have not received as much attention (Zimmerman, 1985). A majority of the woody plants are difficult to propagate vegetatively by traditional methods like cutting, grafting, layering etc. Such methods, although successful in some instances, still have limitations and cannot be applied for all economically valuable species. Regeneration of plantlets is an integral part of any tree modification/improvement programme. It is also important in the cloning of superior or elite trees, as the potential benefits of using clonal planting stock in afforestation or reforestation have been recognized for a long time (Thorpe and Biondi, 1984).

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Azadirachta indica A. Juss. popularly known as Neem is one of the most valuable tree species. The plant is a source of animal feed, fuel, shade, medicine and insecticide. Neem is potentially one of the most suitable and valuable tree species for arid zones. It can grow on a wide range of soil up to pH 10 (Chaturvedi *et al.* 1985). It also occurs in Tropical dry deciduous and thorn forests and in tropical dry evergreen forests. It grows in arid and semi-arid tropical and subtropical zones in the plains and lower foot-hills.

Neem seeds do not retain viability for more than a few months and viability falls off rapidly after two weeks (Dent, 1948). Thus it faces problems in its rapid multiplication. A very little effort has been made for its *in vitro* micropropagation and improvement. Rangaswamy and Promila (1972) reported regeneration of shoots from embryos and decapitated seedlings. Naina *et al.* (1989) obtained transgenic plants whereas Gautam *et al.* 1993 reported development of shoot and roots from anther derived callus of *Azadirachta indica*. In the present report, young axillary buds as well as axillary buds from mature selected elite trees were successfully used for micropropagation of neem.

MATERIALS AND METHODS

Fresh young and juvenile shoots were collected in spring season from selected well grown mature trees. Nodal segments with single axillary buds were used as explants for the induction of multiple shoots. The explants were sterilized with 0.1 per cent mercuric chloride solution for 10-15 minutes and washed three to four times thoroughly with sterile distilled water and cultured on the sterile medium.

Surface sterilizing of nodal segments obtained from field-grown trees was difficult and has certain limitations due to phenolics exudate. Therefore, seedlings were raised aseptically to get explants for direct inoculation. For this, seeds were collected from plus trees as selected by state forest departments. After removal of outer fleshy covering the seeds were thoroughly washed with running tap water first, and then with 1.0 per cent cetavlon solution for 5 minutes. After rinsing with tap water, the seeds were surface-sterilized with 0.1 per cent mercuric chloride solution for 5 minutes followed by 3-4 times washing with sterile distilled water. The seeds were then cultured on agarified basal MS medium and kept for germination. After 5-8 weeks of germination, the nodal segments were excised from these aseptically raised seedlings and cultured on medium containing different growth regulators singly or in combinations. Three different basal media tested were Murashige and Skoog (MS 1962) (half concentration of NH_4NO_3 & KNO_3), Gamborg (B₅ 1968), and Lloyd and McCown (WPM 1981). Cultures were maintained at $25 \pm 1^\circ\text{C}$ with 16 h illumination photon flux density of $30 \mu\text{mol m}^{-2}\text{s}^{-1}$, from white fluorescent tubes.

RESULTS AND DISCUSSION

Germination of seeds

Seed germination and seedling growth was better in MS medium as compared to WPM and B₅ medium. Among the freshly collected seeds, 70-80 per cent of them germinated within 8-12 days. However, the seeds stored for 3 months showed only 40-50 per cent germination and the germination rate declined further with increase in seed storage time. The in vitro seedlings displayed considerable variation in growth rate. For in vitro propagation explants (shoots) were derived from seedling with 5-10 cm or longer shoots. On a hormone free semi-solid or liquid medium, generally a single (very rarely two) unbranched shoot developed from a seed.

Mature axillary bud culture

In starting aseptic culture of the axillary buds from mature aged tree, the main hazard faced was that of exudation of phenolic substances into the medium. A biweekly change of medium and incorporation of 100mg/l activated charcoal, 50mg/l citric acid and ascorbic acid at the initial stage into the medium under different sets of experiments overcame this problem. Also the use of juvenile buds of fresh sprouts of monsoon season collected from trees showed very less phenolic exudation.

Multiplication of shoots

The excised axillary buds from seedling and tree, when cultured on MS basal medium, devoid of growth regulators died after 15-20 days without showing any growth. Incorporation of BA 0.5-5.0 mg/l to the basal medium resulted in multiple shoot formation. The enhanced axillary bud proliferation and shoot growth were better on MS medium than on B₅ or WPM medium. Proliferation of shoot from axillary bud varied on different medium. The frequency of axillary bud break remained very low 30-40 per cent in all the experiments tried. Axillary bud when cultured on MS medium supplemented with 5.0 mg/l BA, 3-4 shoots proliferated. Small thin leaf like structures also proliferated via axillary branching. Addition of low dose of NAA (0.1mg/l) in the medium upto some extent prevented these leafy structures, and helped to develop distinct shoots from axillary buds. The proliferated shoots were excised and were subcultured for shoot multiplication on MS medium supplemented with 5.0 mg/l BA + 0.1 mg/l NAA. On this medium cultured shoots grew and from every node (axillary node) 1-3 shoots originated. A small callus also developed at the base, from where 2-3 shoots formed. At increased concentration of NAA (1.0 mg/l) the shoot formation rate declined with formation of callus at the cut end. The in vitro shoots were subsequently

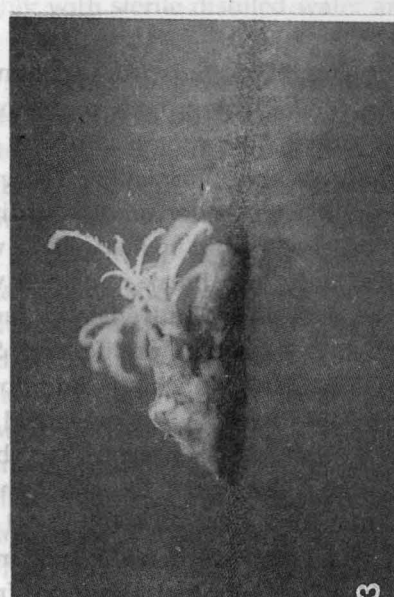
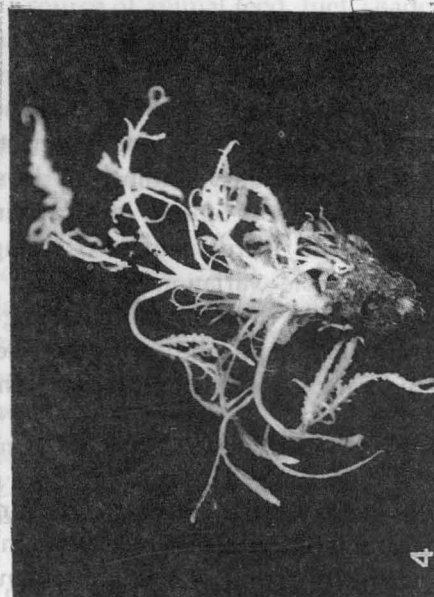
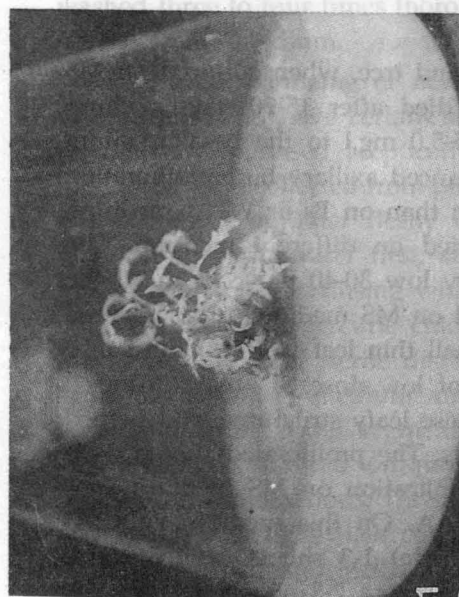
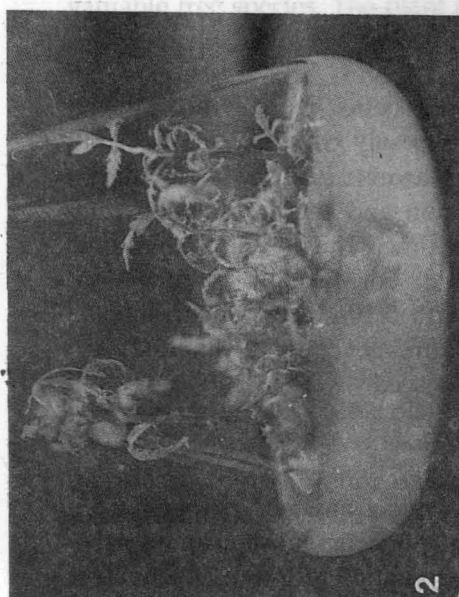


Fig. 1. Excised axillary bud of seedling cultured on MS + 5.0 mg/l BA + 50 mg/l Adenine sulphate, note proliferation of shoots

Fig. 2. Shoot multiplication on MS + 5.0 mg/l BA + 0.1 mg/l NAA supplemented medium

Fig. 3. Initial shoot proliferation from axillary bud of nature tree
Fig. 4. Stage, when proliferated shoots were excised from the axillary buds for shoot multiplications.

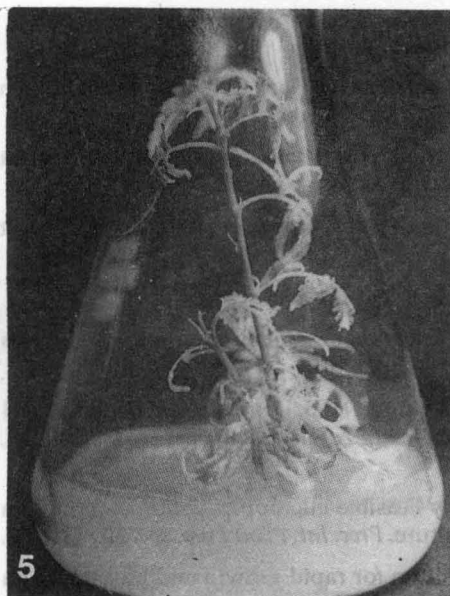


Fig. 5. *In vitro* shoot elongation on MS + 2.5 mg/l BA



Fig. 6. *In vitro* root formation on MS + 1.0 mg/l NAA supplemented media (Plantlet formation)

excised/isolated and sub-cultured on MS + 2.5 mg/l BA for further growth and shoot multiplication. The rate of shoot multiplication was quite low in case of axillary buds of seedlings. An addition of 50 mg/l Adenine sulphate was found to be better for shoot growth and multiplication in this case.

Rooting of shoots

The *in vitro* raised shoots failed to root on a hormone free basal medium, thus various auxins were attempted for rooting trials. All rooting experiments were carried out with modified MS basal medium as it gave best results in subsequent experiments. Of the various auxins treatments, best results were obtained with 1.0 - 2.0 mg/l NAA supplemented MS medium. Generally 2-3 roots emerged from the cultured shoots. In all the experiments small callusing was observed at the base of the shoots.

The present results of micropropagation of neem through tissue culture technique is encouraging as it overcome the plant regeneration problem arising due to rapid loss of the germinability of the seeds. The insecticidal plant constituents (Pradhan et al. 1962) including the terpenoids azadirachtin greatly varied in neem trees. A high valued neem tree can now be multiplied true to its type from above technique as well.

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CONSERVATION AND UTILIZATION OF SUNFLOWER GERMPLASM

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Key words : Sunflower, conservation, utilization, disease resistance

Sunflower is broadly grouped into: (i) Open pollinated population/Hybrid derivatives, (ii) CMS lines, (iii) B lines/Maintainer lines, (iv) Restorer lines, (v) Inbred lines, (vi) Wild species and (vii) CMS sources. Much emphasis has been given for augmentation after the creation of National Bureau of Plant Genetic Resources in 1976, Project Coordinating Unit (Sunflower) in 1974 and onwards. Systematic work on conservation of genetic resources was initiated towards the end of 1983.

Conservation of genetic resources

Through concerted efforts, new germplasm materials have been introduced from different countries through NBPGR to augment genetic resources every year. Number of introductions made so far is presented in Table 1. The accessions are rejuvenated every year in the *kharif* / *rabi* seasons. A cold storage module has been commissioned recently in the project. Characterization and evaluation are carried out over the years for various qualitative and quantitative characters. Promising germplasm, was identified and listed in Table 2. The germplasm was also screened for rust and *Alternaria* at Bangalore and for downy mildew at Latur. A number of germplasm lines/open pollinated populations have been identified as resistant to rust and downy mildew in field (Table 3) as well as in laboratory conditions. Only field resistant types have been identified and presented in Table 3. A catalogue containing characterization and evaluation data of germplasm has been developed. Twenty four accessions of sunflower were subjected to moisture stress at early vegetative phase (40-71 days after sowing) and at late vegetative/early reproductive phase (58-93 days after sowing). Drought Susceptibility Index (DSI) was computed for each genotype. Based on DSI values both for seed yield and Total Dry

Table 1 : Status of germplasm conserved

Germplasm type	No. of accessions
Open pollinated population/hybrid derivatives	1352
CMS lines	41
B lines	54
Restorer lines	48
Inbred lines	225
Wild species	157
CMS sources	3
Total	1880

Table 2 : Promising accessions of sunflower

	No. of Accessions	Value
Earliness (Days to flower)	Co-1.SS-56, Morden A.No. 1541, 1532, M-787-6-2, 1398, M-78-6-1, 1408, 1440	46 to 50
Seed Yield (g/plant)	EC 153103, EC153107 EC 153099, EC153114 EC 153116, EC 143113 EC 153112, EC 50227 EC 89093-2, EC68414 EC 68415, No. 88 No. 179, No. 61 A.No. 1464, 1366, 1460, 1385, 1461, 1402	33 to 51
Oil Content (%)	EC 165743, 87-2R EC 162269, RLC-4-2 EC165745, RLC-4-5 No. 60, BLC-10-4 EC 161261, BLC-15-6 EC 68415 SG 502 SG 581	40 to 47
Biological yield (g/plant)	EC 153096, EC 153113 EC 153099, EC 153114 EC 153103, EC 153115 EC 153111, EC 163813	123 to 178
Plant height (cm)	No. 414 (Bekecs) HA 291 A. No. 1478, M 787-9-2	60 to 70

Matter (TDM) EC 68414 was considered to be drought tolerant under early as well as late stress conditions followed by EC 68415 and MSFH-17. Susceptible CMS lines (253A, 62A and 350A) and tolerant CMS (339A, 352A and 351A) lines were used in developing drought tolerant hybrid by using the good restorer lines (RHA 298, 265, 6D-1, 274 and 855).

Table 3: Genotypes resistant to different diseases

Disease	Genotypes
1. <i>Alternaria</i> leaf spot (moderately resistant)	Acc. No. 714, 35, 43, 147, 167, 179, 180, 194, 216, 251, 284, 315, 340, 351, 353, 358, 426, 430, 431
2. <i>Rust</i> (highly resistant)	Acc. No. 661, 687, 708, 715, 765, 786, 792, 810, 928, 830, 832, 847, 889
3. Combined resistance to rust and leaf spot	Acc. No. 786, 810, 847, 884, 889, 901, 1009, 1020, 1052, 1053, 1058, 1229, 1251
4. <i>Downy Mildew</i> (resistant)	Acc. No. 241, 470, 526, 842, 846, 882, 888, 931, 1234, RHA 278, 334, 344, 345, 346, MRHA-1, MRHA-2

Utilization of genetic resources

Generating new Breeding materials/gene pools

Based on the evaluation results, promising germplasm lines were used to generate material for breeding. Two gene pools - B and R lines were generated using promising maintainer and restorer lines, respectively. These include lines with high oil content, high self fertility and resistance to diseases. The genotypes have been supplied to breeders for developing superior parental lines to be used in heterosis breeding. A gene pool was also constituted to be used as the maintainer source. This gene pool comprised lines with high adaptability, yield, resistance and high oil content.

Development of inbred lines

Inbreeding work is in progress to develop inbred lines using the base population - B line gene pool, R line gene pool, EC 68414, EC 68415 and Morden. Based on the quantitative data, the promising progenies were advanced by selfing. The lines are in F₅ generation.

Diversification of CMS source

At present, only one CMS source (derived from *Helianthus petiolaris*) is being used in the hybrid development programme world over. Research work on diversification of CMS sources have been initiated. Two new CMS sources - CMS PF (*H. petiolaris Fallex*) and CMS I (*H. lenticularis*) are being used in

this programme. Maintainer and Restorer lines have been identified for these sources. The promising maintainer lines have been back-crossed to develop lines in the new CMS background for their use in hybrid development programme in future.

Germplasm supply and accomplishments

Priority has been laid to supply germplasm material to various scientists in the country. Nearly 4000 seed samples of different accessions have been supplied to different indentors. By using germplasm lines supplied by this centre, a number of hybrids have been developed at different locations in the country. Some of the hybrids are released for cultivation. They are LDM-1, LDM-3. In addition, 1000 new hybrids are in testing stages, wherein 20-30 hybrids are significantly superior to the available commercial hybrids.

Future thrust

Priority has been laid in introduction of genetic resources with high oleic acid, high self-fertility and resistance to diseases like downy mildew and rust. Additional CMS and restorer lines, new source of cytoplasmic male sterility also need to be introduced. There is a great need for development of sunflower material with broad genetic base. Introgression of genes from wild species into the cultivated species has been contemplated. In this direction, use of wild species such as *H. argophyllus*, *H. petiolaris*, *H. praecox*, *H. debilis* and others hold promise.

GENETIC RESOURCES CONSERVATION ACTIVITIES AND THEIR UTILIZATION IN NORTH-WEST HIMALAYAS

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Key words : Germplasm, exploration/collection, evaluation, conservation

North-west Himalayas are endowed with very rich plant genetic diversity. Realizing the importance of this vast and valuable plant genetic wealth, the National Bureau of Plant Genetic Resources established a Regional Station at Shimla in the year 1960. Since inception, this regional station is involved in the various activities related to plant genetic resources. The main objectives of the station are (i) exploration and collection of genetic resources of agri-horticultural crops (ii) conservation, multiplication, evaluation, and utilization of the collections (iii) classification and characterization of germplasm collections (iv) preparation of inventories and catalogues of plant genetic resources for breeder use and (v) supply of relevant informations on plant genetic resources and seed/planting material to users. The station is also introducing plant genetic resources of several agri-horticultural crops suited to the north-west Himalayas, especially for the hilly states of India to broaden the existing genetic base. These germplasm lines are characterized/evaluated for its proper utilization.

Exploration and collection

During the last 30 years, the regional station has undertaken several multi-crop/crop specific collection missions to different parts of Himachal Pradesh, Jammu & Kashmir and Uttar Pradesh hills. A great deal of variability was observed and collected in rice, wheat, maize, barley, amaranath, buckwheat, pulses, minor millets, vegetables and various temperate fruits such as *Prunus*, *Malus*, *Pyrus*, *Sorbus*, *Docynia*, *Cydonia*, *Pistacia*, *Vitis*, *Punica*, *Rubus*, *Juglans* and a number of other minor fruit spp. Prominent and rare landraces of different crops collected were *Katheri*, *Hathal*, *Rangi* (cold tolerant), *Monga*,

Basmati, *Ratuwa* (scented types), *Risa*, *Tapta*, *Narkanda* (early types) in paddy; *chidku makki* (multi ears), white *desi makki* (ear length up to 30cm), and *sathoo* (60 days) in maize; *Dharmaurii* (high yielder, longer spike), *Desi Mundul* (awnless), *Mundau*, *Latar* (cold resistant), *Brad Kanak* (drought resistant) in wheat. Chamba and Sirmour districts of Himachal Pradesh were observed to have high genetic diversity of maize. In grain amaranath, three species were found to be predominant throughout the north west Himalayas. *Amaranathus hypochondriacus* and *A. caudatus* were observed in abundance in the high hills, whereas *A. cruentus* was mainly confined to low and mid hills. Exciting variability was observed and collected with respect to various cultivated/wild temperate fruits in the Almora, Nainital, Pauri, Chamoli and Uttar Kashi hills of U.P.; Chamba, Lahaul Spiti, Kinnaur and Shimla districts of Himachal Pradesh. The station has also collected wild relatives of cultivated plants/landraces of crop plants which are under the threat of genetic erosion or at the verge of extinction. These species/areas are : (i) *Cicer microphyllum* and wild *Rosa spp.* from Lahaul & Spiti district (ii) Landraces of rice, wheat, and maize from Karsog, Hamirpur and Chamba respectively, in Himachal Pradesh (iii) Wild pomegranate in Narang valley (Solan) and Shimla (near Mashobra) (iv) Walnut, Chilgoza and Hazelnut from Pangti valley of Chamba (v) *Prunus spp.* and *Sorbus spp.* from Kinnaur and (vi) *Sorbus spp.* from Pangti and Shimla.

Evaluation

The station is at present evaluating, documenting and maintaining germplasm of more than 13,000 collections of various agri- horticultural crops. The major economic groups of crops and number of accessions in each crop are given below.

Pulses : Frenchbean (2800); adzuki bean (70); ricebean (340), urid bean (175); mung bean (125); pea (281) and lentil (530).

Pseudocereals : Amarnath (3063); buckwheat (561); Chenopod (50).

Oilseeds : *Brassica spp.* (330); *Cuphea* (7).

Minor millets : Proso millet (330); little millet (148); finger millet (770); foxtail millet (750); kodo millet (210); barnyard millet (291).

Beverage : Hops (25); chicory (37).

Vegetables : Onion (16); meetha karela (29).

Fruits (i) Pome fruits : Apple (235); pear (33).

(ii) Stone fruits : Apricot (34); sweet cherry (8); European plum (12) peach (38); Japanese plum (10) and almond (15).

- (iii) **Nut fruits** : Walnut (44); pecan (10); hican (1); filbert (6) and pistachio (4).
- (iv) **Soft fruits** : Strawberry (15); currants (1) and raspberry (20).
- (v) **Other fruits** : Pomegranate (9); chinese gooseberry (7); *Feijoa* (2); Chinese ber (3); persimon (3) and olive (6).
- (vi) **Wild fruits** : (20)

Ornamentals : (110)

Besides, station is also maintaining the germplasm of various grasses, fodder, spices & medicinal plants and root/tuber crops.

Documentation

Three catalogues, one each on amaranath, frenchbean, sesame and three monographs/ books entitled "Grain Amarnaths: The Future Food Crop", "Buck wheat in India" and "*Rosa* species" have been published from this regional station.

Achivements/contributions

During evaluation, the promising lines were identified and released for cultivation. This include,

Amarnath : *Annapurna* — a released variety for the hills, average yield 22.3 q/ha, wider adaptability, drought resistant, protein (14.5%) and rich source of lysin (5.5%) and IC 38280. Amarnath also contains some anticholestrol factors so that use of this grain will be regarding to people suffering hypertension etc.

Buckwheat : *Himpriya* — a released variety for the hills, average yield 12.6 q/ha. The tender leaves and shoots are used as leafy vegetable; a flower and green leaves are used for the extraction of rutin (glucoside) (used in medicine).

Frenchbean : PLB-14, PLB-10, EC 10801 (high yielding types)

Adzukibean : EC 87896, EC 87900 (high yielding).

Ricebean : CXM 12P₂-3 (high yielding).

Comfrey : EC 7296 ex U.K. It is very good green fodder for the hills. The grass contains 33 per cent protein and is palatable to all kinds of domestic animals.

Golden timothy : EC 94067 ex Australia (a grass resistant to drought and cold, herbage yield at shimla is about 446 q/ha..

Hops : Late cluster, Colden cluster and Tardif de Bourgoue (use as flavours and preservative in beverages and have occupied a sizable area in Lahaul and Spiti districts of H.P.

Apple : Spur type — Red Delicious (regular bearer), Red Baron (high yielder) and Vered (low chilling).

Pear : Max Red Bartlett (high quality, red colour)

Apricot : Nugget-suitable for mid hills.

Peach : Stark Earliglo (early and good quality), Candor (suitable for mid hills)

Pecan : Mahan (extra large nut and high yield).

Chinese gooseberry (kiwifruit) : Allison ex USA. It is a high yielder and having good quality (high total sugars and ascorbic acid). The propagating material is in great demand in Himachal Pradesh, U.P. hills, Darjeeling (West Bengal), Sikkim and other North-eastern states, of the country.

GENETIC RESOURCES OF ARID LEGUMES IN INDIA

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Key words : Arid legumes, genetic resources, *Cyamopsis tetragonoloba*, *Vigna aconitifolia*, *V. unguiculata*, *Macrotyloma uniflorum*

The cultivated arid legumes have been the main stay in traditional crop production, provide food for man, fodder for animals and raw materials for various industries. These includes four annual crops viz., guar (*Cyamopsis tetragonoloba*), Mothbean (*Vigna aconitifolia*), cowpea (*Vigna unguiculata*) and horsegram (*Macrotyloma uniflorum*). This group of crops is normally grown in the arid and semi-arid regions of the country because the inbuilt potential in them, meet the un-congenial situations like water stresses and dry atmosphere. The natural variability of these arid legumes also is mostly available in the drier belt of the country. In the recent past, good efforts have been made at the NBPCR, New Delhi to collect, evaluate, document and conserve this variability. This paper reviews the present status of the germplasm holding and its utilization of the arid legumes.

Guar (*Cyamopsis tetragonoloba*)

Clusterbean (*Cyamopsis tetragonoloba* (L). Taub.), commonly known as guar, is a drought hardy crop of the arid and semi-arid regions of the Indian continent. It is generally grown for feed, fodder and vegetable purposes, but of late, it has assumed a great industrial importance mainly due to the presence of gum content in its seed. Guar gum is a mucilaginous mixture of galactose and mannose and has diversified industrial uses. Today guar gum and its derivatives are in great demand in the world market and India earns foreign exchange worth Rs. 80 crores annually.

In India, guar is grown as a rainfed crop in the states of Rajasthan, Gujarat, Haryana, Punjab and parts of Uttar Pradesh, Madhya Pradesh and Maharashtra on nearly 2.81 million hectares and produces ca 1.11 million tonnes of guar seed. Work on its improvement was initiated by the erstwhile

Plant Introduction in early sixties on vegetable types and later on collection, evaluation, documentation and utilization of the natural variability. These efforts has resulted in the assemblage of 4727 accessions (Table 1) at the NBPGR. The co-ordinated project on voluntary basis was started during 1977 which later assumed regular status of All India Co-ordinated Research Project on Guar by the ICAR. Under the project, several varieties viz., I.C. 9229/P₃, HG75, HG 258, GAUG 34, Maru Guar, GGI (Late-varieties); Naveen and RGC 936 (Early varieties) and HG 314, PLG 85 and RGC 197 (unbranched varieties) were evolved which suit under different cultivation practices. By adopting these varieties alongwith the improved cultivation practices and plant protection technology (Dabas *et. al.* 1991), the production can be increased on an average from 2-3 q/ha, which at present is very low (about 2.8 q/ha at the national level.

Cowpea (*Vigna unguiculata*)

Cultivated cowpeas are annual herbs with a great range of growth habits and response to photoperiod and great variation also in seed characters. More or less erect, determinate, day-natural types are commonly grown as sole crops for seed or for forage, whereas prostrate indeterminate, short day types are sometimes grown as mixed farming.

Its origin is uncertain, probably in central or tropical African origin where wild races still exist. In India it has been known since vedic times and India and China are considered as secondary centres of origin. Cowpea is valued primarily for its pod as vegetable, seeds as pulse and plant as a valuable feed for livestock. The protein content of the dried mature seeds of cowpea varies from 20-30 per cent. It is also grown as a cover or green manure crop for soil improvement. Work on the improvement of cowpea was initiated during sixties at IARI/NBPGR with more emphasis on development of vegetable type and collection/introduction of germplasm.

NBPGR has built up the germplasm accessions of 3842 through introduction from different countries and collection from within the country. Grain cowpea improvement Project in 1965-66 which subsequently upgraded to Project Directorate, Directorate of Pulses Research and Indian Institute of Pulses Research in 1994. On creation of AICRP on Arid Legumes, the mandate of the improvement of this important pulse has been shifted from DPR to this project in 1991. Systematic and concentrated efforts have been made to develop production technology through multidisciplinary team of research scientists working in different agro-ecological zones of the country. 25-30 per cent production can be increased by utilization of the improved varieties, use of fertilizers and plant protection technology development.

Moth bean (*Vigna aconitifolia*)

Mothbean is native of India and domesticated recently as compared to the other pulses like black gram or green gram. It is mostly grown in India and to a small extent in China. In India, it is an important arid-legume crop cultivated for food to the extent of 1.47 million hectares in Rajasthan, Punjab, Haryana, Madhya Pradesh, Maharashtra, Karnataka, Uttar Pradesh and Bihar where produce 0.51 million tonnes of grain. The area and production of moth bean in the preceeding 20 years indicated that although the area under this in the country has gone down but the total production and productivity are shown an increase. This is attributable to high yielding varieties and use of improved methods of cultivation.

It is an annual, creeping or trailing legume cultivated as a *kharif* crop, sown during June-July and harvested during October-November. It is hardy, drought resistant and can grow on the poorest soils, but it prefers light sandy soil. It is mostly grown as a rainfed crop and can be successfully, cultivated in areas with a well distributed annual rainfall of about 250-500 mm. Varieties like type T for Uttar Pradesh, Jadia, Jwala, JMM 259 and RMO 40 for Rajasthan and Baleshwar 12 and G. Moth I for Gujarat has shown an increase in the production. The production and productivity can be further increased by adopting the production technology and plant protection measures.

Horsegram (*Macrotyloma uniflorum*)

Horsegram popularly known as *kulthi* is a native of India and is distributed throughout the tropical regions of the old World. It is grown all over India as an important pulse crop particularly in Karnataka, Tamil Nadu, Maharashtra, Andhra Pradesh, Orissa, Madhya Pradesh and Bihar. It is generally grown as feed for cattle and seeds as concentrates. Its seed are also consumed by the poorer classes after cooking or frying. It is often grown as a preparatory crop on reclaimed lands. The germplasm collected from various parts of the country is given in Table 1.

Table 1. Germplasm holdings of various arid legumes in National Genebank and active collections

Crop	Genebank	Active collection	
		Total	Centrewise
Guar	1401	4827	Delhi, Jodhpur
Cowpea	2003	3434	Delhi (2461) Thrissur (590), Jodhpur (345) and Bhowali (38).
Mothbean	273	2143	Jodhpur (1978) Amravati (165)
Horsegram	952	1684	Akola (826), Thrissur (734) Jodhpur (48) and Shimla (76).

CLASSIFICATION OF GERMPLASM IN URID BEAN (*VIGNA MUNGO* (L.) HEPPER)

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Key words : Urid bean, *Vigna mungo*, classification, germplasm, variability

India being an important centre of diversity for urid bean, a thrust for germplasm evaluation and exploitation is an urgent requirement. Evaluation of germplasm will provides potential value as a breeding material. Quite often in a germplasm collection, many of the accessions are duplicates and to find unique types for various characters, it becomes difficult unless germplasm is characterised and classified. The ordination techniques like principal component analysis follwed by cluster analysis was found to be a useful tool for getting multicorrelated variables into an other set of uncorrelated variables from which few or all can be utilized for classification of genotypes into homogenous groups or clusters in a geometric space. In this, the between cluster diversity will be maximum and thus the representative types from diverse clusters can be earmarked for different breeding objectives. In view of the above the present studies were taken up with 216 genotypes of uridbean to characterise and classify the set of collection.

The experimental material comprised of 216 germplasm accession obtained from Pulse Breeding Project at Pantnagar. The sowing was done in kharif 1990 at Crop Research Centre, Pantnagar, India (29.5°N La, 29.3°E Lo, 234 m al). All the germplasm accessions were evaluated in an augmented design with three intermittent checks namely Pant U-19, Pant U-30 and Pant U-35 after every 10th row. Each plot consisted of single row of 4 m length with 30 cm. row to row and 10 cm plant to plant spacings. Observations on 27 descriptors were taken as per descriptor list of ICGRI for *Vigna* sp., Among them five quantitative characters (pod length, plant height, 1000 seed weight, pods per plant and yield per plant) are the subject of this paper.

The data obtained for the said 5 variables was analysed for variance and to obtain adjusted means by using methods described by Federer (1956) and elaborated by Federer and Raghav Rao (1975) and Peterson (1985). This analysis gave adjusted values of genotypic means in the form of multivariate matrix on which principal component analysis as given by Hotelling (1933) and Mardia (1971) was applied. For a matrix of r non zero eigen values the r number of principal components were extracted, where $r = 5$ in the present study. These extracted principal components scores obtained from original variables were utilized for Non-hierarchical Euclidean cluster analysis (Beale, 1969; Spark, 1973). The different genotypes were assigned to different clusters on the assumption that the Euclidean distance " D " separating " n " points in a " p " dimensional space are proportional to the dissimilarities between the objects and no object can belong simultaneously to two clusters. For determining the appropriate number of clusters, F-test was applied.

The classificatory analysis gave five principal components. The *eigenvector* and roots are associated with latent roots of observed variables with maximum value 1.90 obtained for eigen vector 1 and 1.25, 0.92, 0.63 and 0.28 for corresponding second to fifth vectors, the maximum variation (%) 38.15 was explained by first vector and 25.09, 18.47, 12.62, and 5.64 by other four vectors, respectively. The obtained five components were utilized for clustering genotypes.

These clusters were arranged in a geometrical space with different inter cluster distances as depicted in Fig.1. The intra cluster distances ranged from

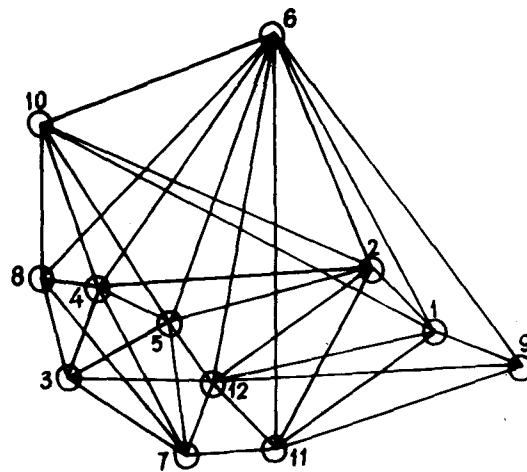


Fig. 1. Cluster diagram showing relative inter cluster distances among germplasm lines

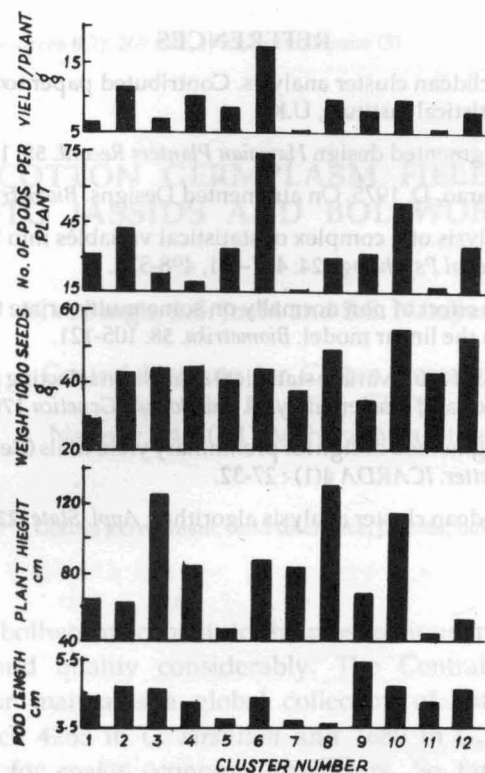


Fig. 2. Cluster mean for different characters

1.2 to 2.63. It was maximum in cluster 6 and minimum in cluster 7. The maximum intercluster distance (4.62) was found between cluster 6 and 11 followed by 6 and 9 (4.51). The minimum distance was observed between cluster 11 and 12 (1.65). The observed distances are indicative of diversity in genotypes as well as their linkage with respect to one another. Although, the diversity studies by utilizing cluster analysis are not reported in urid bean but in other crops like wheat Martinov (1983) showed that cluster analysis allowed genetically related varieties to group together. The clusters having superior genotypes with highest grain yield per plant and pods per plant fell into cluster number 6 while bold seeded genotypes converged to cluster number 10. For longest and shortest plant height genotypes gathered into cluster 9 and 11.

The studies allowed convenient selection of superior clusters for different traits, in the germplasm for distant hybridisation. The procedure also provided a basis for evaluating the role of pedigree in observed association between phenotypic characters.

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USEFUL COTTON GERMPLASM FIELD TOLERANT TO JASSIDS AND BOLLWORMS

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Key words : Cotton germplasm, field tolerance, jassids, bollworms

Jassids and bollworms constitute the most serious insect enemies of cotton affecting yield and quality considerably. The Central Institute for Cotton Research, Nagpur maintains a global collection of cotton genetic resources (Table 1) of which 4268 in *G. hirsutum* and 1680 in *G. arboreum* have earlier been catalogued for major economic characters. So far no systematic effort was made by any one to evaluate a large number of accessions of these two species for the field reaction to jassids and incidence of bollworms including pink (*Pectinophora gossypiella*), spotted (*Earias vittella*) and American bollworm (*Heliothis armigera*) over a continuous period of 3 seasons under field conditions in a systematic manner. In this paper, results of study conducted with 254 accessions of *G. hirsutum* and 201 of *G. arboreum* for screening against jassids and 473 and 201 accessions of *G. hirsutum* and *G. arboreum* respectively for bollworms are discussed.

Table 1. Germplasm holdings in cotton Gene Bank, CICR, Nagpur

Species	Number of accessions		
	Upto 1992	1993	Total
<i>G. hirsutum</i>	4268	1438	5706
<i>G. barbadense</i>	298	620	918
<i>G. arboreum</i>	1680	45	1725
<i>G. herbaceum</i>	450	10	460

A total of 254 and 473 germplasm accessions of *G. hirsutum* and 201 accessions of *G. arboreum* involving breeders working collections were evaluated for 3 consecutive seasons during 1989-1992 at CICR, Nagpur under field conditions (rainfed). The above materials were grown in 3 replications of 10 plants each per replication. Standard procedures for screening for jassids and combined incidence of bollworms on boll and locule basis were followed (Bhat and Jayaswal, 1989; Narayanan, 1991 and Singh and Narayanan, 1993). The data were analysed each year and based on the 3 year overall performances, the germplasm were grouped into various resistance grades.

Table 2. Results of field evaluation for jassid and combined bollworms incidence in elite *G. hirsutum* and *G. arboreum* germplasm.

Pest	Species	Total number of accs.	Number of accessions			
			HR	MR	MS	HS
Jassids	Hirsutum	254	74	154	22	4
	Arboreum	201	201	-	-	-
			Number of accessions			
			Mean bollworms incidence percent			
			0-10.0	10.1-20.0	20.1-30.0	30.1 & above
Boll worms (Combined incidence)						
Locule basis						
	Hirsutum	473	144	100	67	162
	Arboreum	201	179	20	2	-
			Mean bollworms incidence percent			
			0-20.0	20.1-40.0	40.1-60.0	60.1 & above
Boll basis						
	Hirsutum	473	111	133	97	132
	Arboreum	201	174	23	4	

HR = Highly resistant; MR = Moderately resistant; MS = Moderately susceptible; HS = Highly susceptible

The results of field evaluation for jassids and combined bollworms incidence are presented in Table 2. Based on the 3 years mean performance,

the germplasm accessions were listed under resistant and susceptible categories (Table 3).

Table 3. Elite germplasm accessions with field tolerance to jassid and bollworms

Jassids

G. hirsutum:

Fairly resistant

Cocker 100 staple, EL 592, DC 534-3, 86-la-1, 561, Blight Master, Hirsutum Tashkent, B 1007, 68-G-6, JK 266, Sobhagya, A 72-62, Acala SJ 5, CB 2472-3, Deviraj.

Moderately susceptible

Meade 9030 D, Texas 1050, 9030-8-5, AR 27, PH 36A, DS 61, B 61- 2307, PKV 053, PKV 802, G. Cot. 12, M 4, DHY 286.

G. arboreum:

Highly resistant

AC 27, 30797, 30805, H 234, H 442, AKH 2, Vira 6, Desi 6, Million Dollar, BDN 6377, Rozi 6, AK 235, Naked Seed, Chinese spotless, Malvensis, AC 3662, G 153, Cocanada 5, B-11, Chandroda, P 642 NLL.

Bollworms

G. hirsutum :

Fairly resistant

Coker 100 Staple, DCI 108, JK 259, 68-G-6, DS 59, JK 297-621, Buri NL, G. Cot. 12, PKV 804, 9030-8-5, Meade 9030 D, Reba B 50, KW 61-276, Lankart 57.

Moderately susceptible

Acalaglandless, Acala 69/5, Bikaneri Narma (Frego), M-19 cy, PD 695.

G. arboreum :

Fairly resistant

AC 27, AC 36, 30811, 30805, AC 28, BJ-6, LD 132, 30820, 30816, B- 15-3-0 MLL, H 446, H 73, LD 135, 7735, JL 10 BLL, 79/BH-53, 30820 NLL, AKH 5, G 27.

Moderately susceptible

Lohit, Chinese Spotless, Lohit Red, G 153, B-11, P 562 NLL, Sanguineum BL/RF, AC 3294, Malvensis, Sanguineum G 29, 79/BH 53.

Jassids

It may be seen from the table that out of 254 accessions screened, 74 were highly resistant while 154 recorded moderate resistance grade and 22 were medium susceptible whereas, only 4 accessions exhibited high susceptibility to jassids in the tetraploid species *G. hirsutum*. In the case of 'desi' cotton (*G. arboreum*) all the 201 accessions were found highly resistant against jassids.

Bollworms

In case of combined bollworms incidence recorded on locule basis in *G. hirsutum*, 144, 100 and 67 accessions fell under 0-10.0, 10.1-20.0 and 20.1-30.0 per cent bollworm incidence categories respectively, while 162 accessions recorded bollworm incidence of 30.1 per cent and above. In case of *G. arboreum*, 179, 20 and 2 accessions were represented in the three categories of 0-10.0, 10.1-20.0 and 20.1-30.0 per cent bollworm incidence, whereas none of the accessions fell in the category of 30.1 per cent and above.

The combined bollworms incidence recorded on boll basis also showed similar trend as in the case of incidence of bollworm on locule basis. It is seen from the table that out of 473 *G. hirsutum* accessions studied, 111 and 133 fell in the categories of 0-20.0 and 20.1-40.0 respectively while 97 and 132 accessions were grouped under 40.1-60.0 and 60.1 per cent and above categories. In case of 201 *G. arboreum* accessions 174 and 23 accessions fell in the first two categories of bollworm incidence whereas only 4 were grouped into third category of 40.1-60.0 per cent while none of the accessions showed higher incidence of bollworms under 60.1 per cent and above category.

From the above, it is evident that there are considerable germplasm lines which are showing field tolerance/resistance towards combined bollworms incidence and jassids in the national gene pool of cotton available at CICR, Nagpur. These accessions can be further screened/tested under artificial cage conditions so as to confirm their reactions against the jassids and bollworms complex and thereby could be utilized in breeding programmes to develop suitable resistant/tolerant cultivars for commercial cultivation.

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SYSTEMATIC EVALUATION, DOCUMENTATION AND UTILIZATION OF COTTON GERMPLASM — A SUCCESS STORY

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Key words : Cotton germplasm, evaluation, documentation, utilization

Germplasm holds the key for crop improvement. In cotton, both traditional varieties and hybrid cottons are commercially cultivated in India. Breeding of improved cultivars and development of hybrids represent a continuous process for ensuring successive increases in crop production. Two successful achievements through the most scientific and effective utilisation of genetic resources at CICR, Nagpur leading to release of a *hirsutum* cultivar CNH 36 and an intra- *hirsutum* hybrid CICR HH 1 (Kirti) are reported in this paper, particularly highlighting their characteristics.

Based on diallel analysis and other means of heterosis evaluation, two specific accessions were identified as potential parents for heterosis breeding. These two, namely CP 15/2 (Sel.) and Bikaneri Narma (Sel.) were crossed by conventional hand emasculation and hand pollination technique and the hybrid systematically tested at CICR and in All India Coordinated Cotton Improvement Project, multilocation trials. Again with the help of pathologists, three bacterial blight resistant/immune germplasm were selected and a large number of crosses utilizing the 3 donors for bacterial blight resistance with several agronomic types and elite germplasm were screened continuously through five filial generations with some selected inter-crossing in F3. This effort resulted in identification of 19 multiracial, bacterial blight resistant selections/cultures.

These materials were also added to the genebank. A few of these elite cultures were further purified and tested for seed-cotton yield, bacterial blight resistance and fibre quality at CICR and AICCIP trials at several locations. The efforts to developing a superior medium staple hybrid cotton with early maturity, high pest escape and high yield potential over the existing long

duration hybrid resulted in the release of a new hybrid CICR HH 1, popularly named as KIRTI, for Marathwada region of Maharashtra state. The detailed

Table 1. Important characteristics of CICR HH 1 (Kirti)

Yield potential (q/ha) (Seed-cotton)	15-25
Boll weight (g)	4.0
Seed index (g)	10.0
Lint index (g)	5.7
Plant height (cm)	110-115
Maturity (days)	160
Seed oil (%)	22.6
Bacterial blight grade	MR
Jassid grade	MR
Ginning Outturn (%)	35.0
2.5 % span length (mm)	25.8
Fibre fineness (mv)	4.2
Fibre strength (g/t) ('O' gauge)	42.9
Spinning potential (HSC)	40s Counts
Yarn tenacity (corrected)	
40s CSP	2272
50s CSP	2130
Region suitable	Marathwada (M.S.)
Expected potential coverage (lakh hectares)	1.0
Potential expected contribution to additional annual production (tons of seed-cotton)	20,000

characters and potential of the hybrid are presented in Table 1. In the next five years, its cultivation can spread and thereafter contribute to an additional production of 20,000 tons of seed-cotton per year. The second endeavour resulted in the release of a superior medium staple, high yielding and early maturing *hirsutum* variety designated as CNH 36 for irrigated tracts of Maharashtra and Gujarat. The attributes of CNH 36 is documented in Table 2 alongwith its potential for increasing the cotton production to the extent of 40,000 tons seed cotton per annum. The merit of these two improved types have been presented and discussed in detail by Singh *et. al.*, 1993). In conclusion, the success in developing two cultivars indicate the critical role of systematic

Table 2. Important characteristics of CNH 36

Yield potential (irrigated)	25-30 (I)
(Seed-Cotton) (q/ha) (Rainfed)	12-15 (R)
Boll weight (g)	3.2
Seed index (g)	7.7
Lint index (g)	4.4
Plant height (cm)	105-120
Maturity (days)	145-150
Seed oil (%)	22.3
Bacterial blight grade	Mod. resistant
Jssid grade	Mod. resistant
Ginning Outturn (%)	35.0
2.5 % Span length (mm)	26.3
Fibre fineness (mv)	4.0
Fibre strength (g/t) ('O' gauge)	47.3
Spinning potential (HSC)	40s
Region suitable	Irrigated tracts of Maharashtra and Gujarat
Expected potential coverage (lakh hectares)	2.0
Potential expected contribution to additional annual production (tons of seed-cotton)	40,000

evaluation, documentation as well as planned and effective utilization of genetic resources in cotton.

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RICE BEAN — A NEW CROP FOR TRIBALS OF BIHAR PLATEAU

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Key words: Ricebean, evaluation

Rice bean, popularly known as 'Raj moong', has proved to be the highest yielding *kharif* pulse in this region. On account of its high yield and high degree of resistance to viral and bacterial diseases in comparison to other *kharif* pulses as well as its profuse pod-bearing and bold-seeded character, rice bean may prove to be more popular and acceptable to the local farmers than moong and urid. Moreover, due to the hardness of its seed-coat, grain damage by storage pests is negligible or almost nil. A need was, therefore, felt to evaluate rice bean varieties obtained from various parts of the country to test their suitability for this region.

Evaluation trials were conducted in a randomised block design with 21 varieties in *kharif* 1990, with 22 varieties in *kharif* 1991 and with 24 varieties in *kharif* 1992. Out of these, 16 varieties were common to all the three years. Each plot was of 3×4 m, 10 rows, 30 cm apart and 4 m long. Fertilizer @ 40 kg N and 40 kg P₂O₅/ha was basally applied before sowing.

In the combined analysis of three years yield data (Table 1), RBL -13 recorded highest mean yield of 1486 Kg/ha followed by RBL-6 (C) 1339 kg/ha; the third highest mean yield was obtained by the variety RBL-100 (1272 kg/ha). It can be seen from the table, that the yield obtained during 1990 were very low; in the year 1991 the yields were better, but true potentiality of the varieties appeared only in the year 1992. In individual years, variety RBL-3 (868 kg/ha) ranking number 3 was at par with the highest yielding variety RBL-4 (899 kg/ha) in 1990. In the year 1991, the highest yield was obtained by the variety RBL-13 (1410 kg/ha) followed by RBL-35 (1290 kg/ha) both being at par. In the year 1992, the yield figures showed much higher yield than the previous years. Highest yield was obtained by the variety RBL-35 (2264 kg/ha) followed by, and at par with, RBL-13 (2181 kg/ha) RBL-13 is the best variety for this region.

Table 1. Combined analysis of three years' yield data on ricebean

Sl. No.	Variety	Yield (kg/ha)			Mean yield (kg/ha)	Overall rank
		1990	1991	1992		
1.	RBL-1(c)	629	-	2056	-	-
2.	RBL-2	409	-	-	-	-
3.	RBL-3	418	1024	1792	1078.0	-
4.	RBL-4	899	1234	1681	1271.3	-
5.	RBL-5	766	406	1347	906.3	-
6.	RBL-6(C)	874	1103	2042	1339.6	II
7.	RBL-7	686	1220	1389	1098.3	-
8.	RBL-8	800	1251	1681	1244.0	-
9.	RBL-9	412	-	-	-	-
10.	RBL -10	645	1068	1778	1163.6	-
11.	RBL-13*	868	1410	2181	1486.3	I
12.	RBL-35	241	1290	2264	1265.0	-
13.	RBL-36	499	1047	1597	1047.6	-
14.	RBL-38	340	-	-	-	-
15.	RBL-48	720	252	-	-	-
16.	RBL-50	822	330	1319	820.3	-
17.	RBL-51	535	1063	2042	1213.0	-
18.	RBL-52	375	1047	1778	1066.6	-
19.	RBL-70	554	990	2069	1204.3	-
20.	RBL-100*	797	1076	1944	1272.3	III
21.	RBL-121	398	991	1375	954.6	-
22.	RBL-26	-	1133	1472	-	-
23.	RBL-69	-	1106	2375	-	-
24.	RBL-122	-	944	1694	-	-
25.	RBL-23	-	847	1403	-	-
26.	RBL-40	-	844	1778	-	-
S.E. (Mean)		73	109	69	143	
C.D. at 5% level		310.93	310	195.25	412	
C.V.%		17.74	19.94	6.73	21.5	

The average yield of moong and urid in this region are much lower than that of rice bean, being only 5-6 q/ha, whereas the average yield of rice bean has been shown in the trials to be as high as 12-14 q/ha. Moong is harvested earlier, in 60-65 days and urid in 80-90 days, while rice bean can be harvested within 75-90 days, not too late if we get 200 per cent higher yield over the above named traditional pulses crops.

RICE BEAN : GERMPLASM EVALUATION UNDER TEMPERATE CONDITIONS

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Key words : Ricebean, evaluation, stability analysis

Ricebean [*Vigna umbellata* (Thunb.) Ohwi & Ohashi] has considerable high potential for grain yield. The seed protein varies from 18 to 23 per cent. Collection of germplasm can be of use to increase the available genetic variability which can be effectively used either by crossing with currently used germplasm or by selecting for local conditions. High genetic variation exists in Indian collections for pod and seed characters. Ricebean seeds possess remarkable storage quality without much being infested by bruchids.

Germplasm evaluation and stability analysis

The evaluation of 300 indigenous and exotic germplasm collections of ricebean for 14 economically important characters during 1985-92 led to identification of some promising accessions as mentioned below:

Bold and Heavy Seeds	:	IC-18453, IC-12436 (100 seed wt = 8.84 g)
Early maturity	:	IC-18454 (129 days)
Long pods	:	IC-12436 (10.50 cm)
High yielding & stable lines	:	R-49, RB 40

The crop is highly sensitive to environmental fluctuations. Hence, an experiment was also conducted to work out the extent of $G \times E$ interaction to isolate high yielding stable genotypes that may be used either as a variety or as a donor parent in a breeding programme. The 11 genotypes of rice bean viz RB-4, RB- 56, $C \times M_8 P_2$, RB-40, RB-49, $C \times M_{12} P_3$, RB-26, RB-39, RB-17, RB-53, RB-32 were grown under randomized block design with 3 replications during the rainy season of 1988-91. Data were recorded on 5 random plants

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Table 1. Estimates of mean and stability parameters in 11 genotypes of ricebean

Line	Clusters/plant			Pod length(cm)			Pods/plant			Yield/plant (g)		
	Mean	bi	S ² di	Mean	bi	S ² di	Mean	bi	S ² di	Mean	bi	S ² di
'RB 4'	12.10 ^{abc}	1.05 [†]	-0.78	0.09	0.09 [†]	-0.15	47.58cde	1.16 [†]	71.82 ^{††}	17.73bc	1.13 [†]	-2.32
'RB 56'	12.54 ^a	1.00 [†]	0.16	9.08 ^{bc}	1.10 [†]	-0.20	52.28ab	1.14 [†]	-19.55	19.33ab	1.39	-3.58
'C×M ₁₂ P ₃	11.00 ^{cd}	0.90 [†]	-0.48	9.01 ^{bcd}	1.02 [†]	-0.22	46.03def	0.65	-6.05	16.70 ^{cd}	0.87 [†]	5.70 ^{††}
'RB 40'	12.68 ^a	0.89 [†]	0.96	9.33 ^{ab}	1.10 [†]	0.14	51.98ab	1/27	-9.70	20.40 ^a	1.12 [†]	-3.69
'RB 49'	12.06 ^{abc}	1.03 [†]	-3.27	9.60 ^a	0.94 [†]	-0.029	48.18bcd	1.14 [†]	14.16	19.89a	1.14 [†]	-1.97
C×M ₈ P ₂	12.65 ^a	1.27	1.72	9.06 ^{bc}	0.85 [†]	1.49 ^{††}	51.23abc	1.59	105.75 ^{††}	20.68a	0.87 [†]	6.04 ^{††}
'RB 26'	12.13 ^{ab}	1.01 [†]	0.65	8.82 ^{cd}	1.11 [†]	-0.02	50.28abcd	1.01 [†]	-7.89	10.29ab	0.48	-2.94
'RB 39'	12.76 ^a	1.19 [†]	1.40	9.09 ^{bc}	1.07 [†]	-0.05	52.63a	1.09 [†]	53.92	17.61c	1.10 [†]	14.94 ^{††}
'RB 17'	11.39 ^{bcd}	0.50	0.80	8.57 ^d	0.89 [†]	-0.26	42.40f	0.37	24.48	15.67 ^d	0.88 [†]	-3.65
'RB 53'	12.20 ^{ab}	1.26	1.56	8.94 ^{bcd}	0.63	0.69 ^{††}	48.25bcd	1.07 [†]	34.81	18.20	1.09 [†]	8.92 ^{††}
'RB 32'	10.58 ^d	0.91 [†]	0.62	9.20 ^{abc}	1.39	-0.15	43.25 ^{ef}	0.51	-14.60	16.85	0.91 [†]	-2.14
Mean	12.02		9.20		48.55		18.40					
r(x, bi)	0.54		0.24		0.63		0.21					
r(x, S ² di)	0.21		-0.05		0.17		-0.10					
r(b, S ² di)	0.16		-0.46		0.50		-0.12					

Figures for mean followed by same letter are not significantly different from each other, according to Duncan's Multiple Range Test at P = 0.05
r, Correlation coefficient; bi, regression coefficient; S² deviation from regression

for clusters per plant, pods per plant, pod length, yield per plant at maturity. Average data of 5 plants was utilized for statistical analysis. The stability parameters were worked out. Environment (year) were analysis of variance revealed that significant differences existed among genotypes under each environment for clusters per plant, pods per plant, pod length, and yield per plant. The pooled analysis of variance also revealed significant differences among genotypes and environments indicating the presence of genetic variability among the genotypes. Highly significant mean squares due to environment + (G $\times$ E) interactions suggested that the genotypes interacted considerably with environmental conditions. A major portion of these interactions could be attributed to the linear component, indicating that the prediction of seed yield was possible in the environments. Though the pooled deviations were not significant for all the characters, the genotypes C $\times$ M₈P₂ showed significant deviation from regression for all the characters except for clusters/plant. It indicates that both (linear) and non-predictable (non-linear) components contributed significantly to the differences in stability among genotypes. Considering all the characters simultaneously, the genotypes RB-49 and RB-40 appeared promising and could either be used as a variety perse or as a donor in hybridization programme for breeding high yielding stable varieties. The co-relation coefficients (r) among 3 parameters (mean, b_i and Sd_i) indicated no significant association among these parameters (Table 1) indicating the involvement of different genetic system in the control of these 4 parameters. Hence, all the 3 parameters may be taken into account while breeding for stable varieties of ricebean. The simple use of mean values as suggested in other crops (Sanghi and Kandalkar, 1983) may not be useful in ricebean.

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VARIATION AND CHARACTER ASSOCIATION IN CLUSTERBEAN

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Key words: Clusterbean, variation, correlation coefficient

Clusterbean (*Cyamopsis tetragonoloba* (L.) Taub.) is mainly grown for fodder either pure or in mixture with other non-leguminous forages to improve the nutritional quality of fodder due to its higher protein content. An assessment of the variability in the germplasm collected is required to judge its potential as base material for genetic improvement. The direct selection for complex character, such as green fodder yield is not effective. For making a suitable selection indices for improving herbage quantity, a knowledge of association of simply inherited characters is required.

A total of 40 accessions collected from arid and semi-arid tract of north India were grown during 1992. The observations on days to flowering, plant height, number of nodes, branch numbers, leaf numbers, green fodder yield, dry matter yield and leaf-stem ratio on dry matter basis were made. The extent of variation among accessions for stem girth, number of nodes, branch numbers and leaf numbers per plant was worked out according to Barah *et al.* (1981). The correlation coefficients analysis was performed according to Singh and Chaudhary (1979). The association analysis (Table 1) indicated that the green fodder yield was positively correlated at phenotypic level with days to flowering while dry matter yield with leaf stem ratio, number of leaves per plant, number of nodes per plant and plant height. Similar observations were reported by Chaudhary and Lodhi (1980) and Rao and Paroda (1975). The leaf-stem ratio on dry matter basis also positively associated with all characters except green fodder yield.

There was considerable variation among accessions for stem- girth, nodes, branch number and leaf numbers/plant. Mean of all characters are plotted against their respective variances in Fig. 1. Mean stem girth for most of accessions varied between 0.50-0.82 cm although the highest stem-girth from

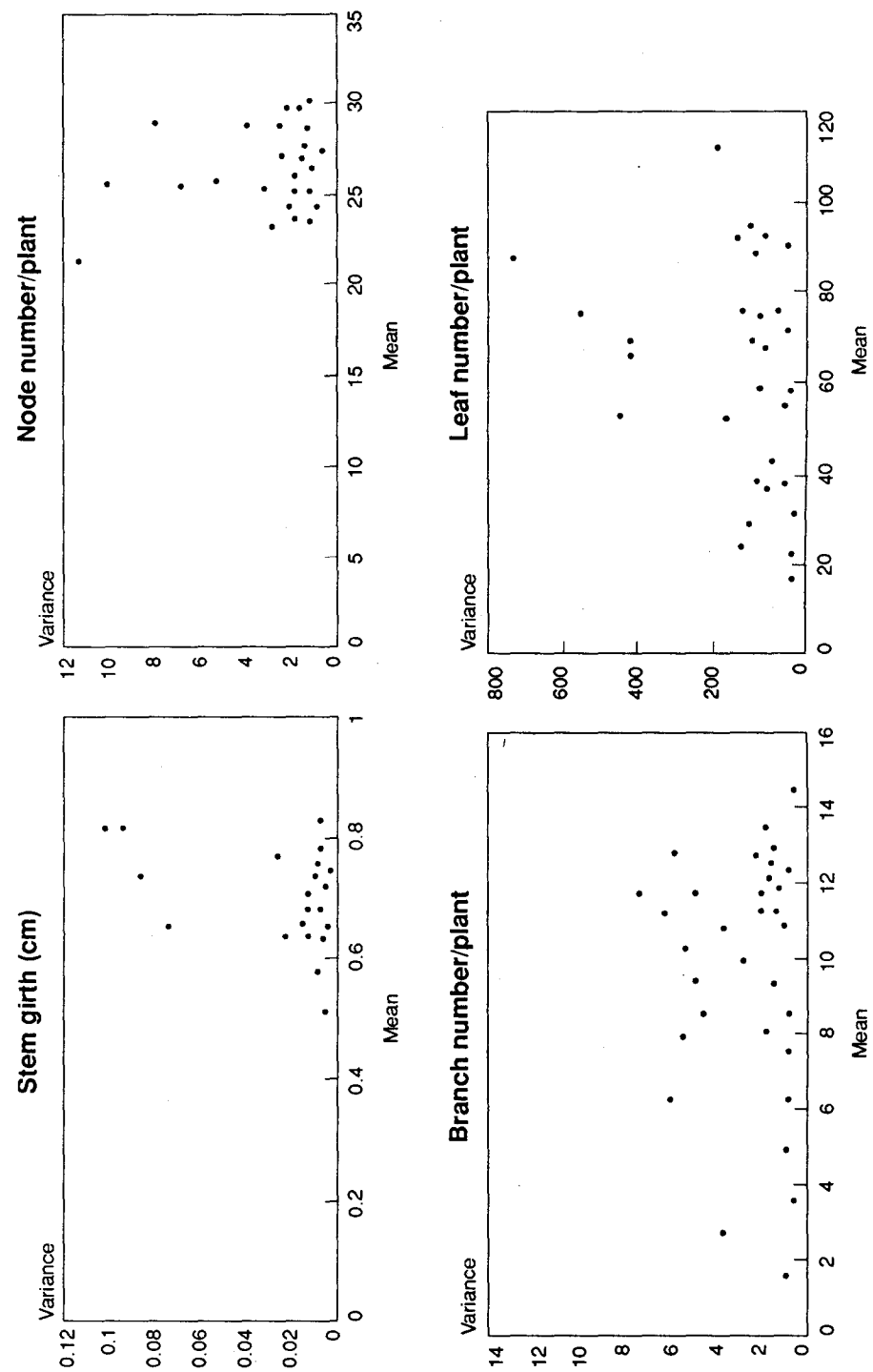


Fig. 1. Variation in cluster bean accessions for different growth parameters

Table 1. Phenotypic correlations coefficients between characters of cluster bean

	Plant height	Nodes/ plant	Bran- ches/ plant	Leaf No.	Green fodder yield	Dry matter yield	Leaf: stem ratio
Days to flowering	0.12	-0.37*	0.22	0.07	0.22	-0.02	0.06
Plant height		0.05**	0.06	0.16	-0.29	0.54**	0.47**
Number of nodes/plant			0.18	0.38*	-0.37*	0.63**	0.42**
Number of branches/plant				0.84*	-0.01	0.47**	0.59**
Number of leaves/plant					-0.17	0.71**	0.74**
Green fodder yield						-0.31*	-0.20
Dry matter yield							0.73**

*, ** Significant at 5% and 1% level respectively.

individual plant was 1.10 cm. The nodes, branch numbers and leaf numbers/plant ranged from 24.20 to 30.53, 1.00 to 14.40 and 18.80 to 110.16; respectively. The variances for stem girth among collections varied from 4-6 times of mean values. The intravarietal variability is generally more conspicuous in respect of branching pattern ranging from unbranched to profuse branched types with various intermediate forms varying in height of plants, leafiness and branching pattern. The branched types generally produce small leaflets. The single stemmed types are generally tall with large and more leaves giving high herbage quantity.

The flexible breeding system and the wide range of variability among collections provides ample opportunity for selection of material with high herbage quantity on the basis of leaf-stem ratio and early maturity.

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PATH COEFFICIENT ANALYSIS IN LENTIL

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Key words : Lentil, genotypes, path coefficient analysis, phenotypic index

Lentil is an important pulse crop widely grown in India during winter season under limited moisture and rainfed condition. A knowledge of the association of quantitative characters, contributing towards yield will be of immense practical interest to the plant breeder to ensure efficient selections for desirable plant type. Accordingly, the present study was taken up using path-coefficient analysis to collect the information on yield and its component traits in lentil to ensure better prediction and gain during selection for ideal plant type.

Thirty six diverse genotypes of lentil (*Lens esculantus* L.) were grown in a randomized block design in three replications. Each genotype in a replication had 2 row of 5m length with 30 × 10 cm spacing. Data were recorded on randomly selected 10 competitive plants in each replication for seven quantitative and one qualitative traits (Table 1). The mean values of each trait was used for statistical analysis. The correlation and path coefficients were obtained according to the procedure proposed by Al-Jibouri *et al.* (1959) and Dewey and Lu (1959).

In the present study, grain yield showed highly significant and positive correlations with number of clusters per plant, number of pods per plant, number of primary branches per plant, plant height and days to flowering and are in accordance with earlier reports in lentil (Balyan and Singh, 1986; Baidya *et al.*, 1988; Ramgiri *et al.*, 1989; Biswas and Das, 1990; Kumar and Bajpai, 1992) grain yield appeared to be weak but positively correlated with 100 grain weight and protein content. However, increase in number of pod clusters per plant, number of pods per plant and number of primary branches per plant may increase the grain yield in lentil. The path coefficient analysis using yield as dependent variable and other characters as independent variables

was carried out (Table 1). Number of pod clusters per plant, number of pods per plant and number of primary

Table 1. Path coefficient analysis for grain yield and its component traits in lentil

Characters	Correla- tion with yield per plant	days to flowe- ring	Plant height (cm)	No. of primary bran- ches	No. of pods/ plant	No. of pod clusters/ plant	100 grain weight (g)	Protein content
Days to flowering	0.3251**	-0.0269	-0.0047	-0.0536	-0.1350	0.1691	-0.0489	-0.0153
Plant height (cm)	0.3957**	-0.0006	-0.2013	0.0384	0.1796	0.0355	0.0328	-0.0085
No. of primary branches plant	0.6582**	0.0094	0.0508	0.1520	0.2435	0.2781	-0.0151	0.0411
No. of pods/ plant	0.7684**	0.0067	-0.1071	0.0684	0.5407	0.2779	-0.0028	-0.0154
No. of pods cluster/plant	0.8526**	0.0064	-0.1020	0.0602	0.2143	0.7012	-0.283	0.0008
100 grain weight (g)	0.2929	0.0175	0.0881	-0.0307	0.0204	0.2643	-0.0750	0.0083
Protein content	0.0033	0.0053	-0.0223	-0.0811	0.1084	-0.0074	0.0081	-0.0070

**P = 0.01 Residual effect : 0.1838

Underlined figures denote direct effects

branches per plant showed considerable direct and positive effect towards grain yield. Other studies (Nanda and Pandya, 1980; Sarwar *et al.*, 1984; Elassa *et al.*, 1987; Pandey *et al.*, 1992) substantiate this finding. Results further revealed that days to flowering had negative direct effect on grain yield but it contribute indirectly through number of pod clusters per plant. Similarly plant height had negative direct effect but indirectly it contributes positively through all the characters except days to maturity and protein content. Number of primary branches per plant were more effective indirectly through number of pod clusters per plant and number of pods per plant. Indirect effects of number of pods per plant through number of pod clusters per plants was high in comparison to other characters. Number of pod clusters per plant contributed maximum towards grain yield directly and indirectly through number of pods per plant. It is noteworthy that these two traits were closely associated with grain yield per plant, hence, it is desirable to give more emphasis while selecting an ideal plant type to ensure high yield in lentil crop. In the present study 100 grain weight and protein content had non significant association

with yield directly but indirectly through number of pod clusters per plant and number of pods per plant contributed towards yield.

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VARIABILITY IN PHYSICAL CHARACTERS OF WILD APRICOT (*PRUNUS ARMENIACA* L.)

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Key words : Apricot, variability

The scattered trees of wild apricot (*Prunus armeniaca* L) have been found growing in hilly areas of India having elevation above 1500m. But in Kinnaur district of Himachal Pradesh, which has dry climate, the wild apricot trees are growing in every village in abundance. The wild apricot has great significance to tribal people because the fruits has multi-purpose like table, extraction of liquor, oil from its kernel, feed to animals, preparation of chutney, jam, squash etc. The quality of fruit is better due to dry temperate climate. It has generated good amount of variability and some trees produce fruits as good as comparable to the commercial cultivars. Keeping in view the importance of this fruit in hilly areas of India particularly in Kinnaur, the present studies were undertaken to mark trees which produce good quality apricot for further multiplication.

The present studies were carried out during 1990 and 1991. The data were collected on fruit weight, length, diameter, volume, stone weight, kernel weight, flesh weight and flesh/stone ratio. Twenty fruits were randomly selected at maturity stage for recording data on each character. The data were analysed statistically and presented in table 1.

The distinct variation was obtained for physical characters of wild apricot in the present studies. Markov (1940) reported that average fruit weighed between 8 to 15g but occasional fruit weight was recorded upto 26g and some even had weight upto 35 to 40 g. Majority of the fruits have less flesh than the cultivated apricots but in certain forms the proportion of flesh to stone is higher than in the cultivated apricot. Lal and Sharma (1979) reported variation in fruit under mid hill conditions. Sharma and Sharma (1990) reported variation in fruit weight from, 13.0 to 24.92g, length from 2.86 to 3.42 cm, diameter from 2.77 to 3.51 and volume from 14.12 to 24.0 ml in some low

chilling apricot cultivars. Gulcan (1988) reported that fruit weight varied from 14 to 93g in a study of 56 cultivars. In a comparison of 5 local and 3 introduced varieties mean fruit weight varied from 17.2 to 33.2g in local varieties and 24.7 to 50.1g in the introductions (Shokhumorova and Gachechiladze, 1987). Sharma (1973) obtained stone from 1.08 to 3.49g, pulp from 11.18 to 21.34g and kernel from 0.64 to 1.70g in some Asian varieties of apricot.

Table 1. Variation in physical characters of wild apricot

	Mean	Range	Standard deviation	Standard error	Co-efficient of variation
Fruit weight(g)	11.31	4.0-29.3	3.217	0.449	28.39
Fruit length(cm)	2.68	1.9-3.6	0.356	0.049	13.36
Fruit diameter(cm)	2.70	1.9-3.5	0.289	0.040	10.80
Fruit volume(cc)	10.88	2.1-27.5	2.923	0.407	27.12
Stone weight(g)	1.48	0.5-2.9	0.342	0.048	23.09
Kernel weight(g)	0.40	0.2-0.7	0.072	0.010	18.09
Flesh weight(g)	9.79	3.5-21.6	2.948	0.406	29.91
Flesh/Stone ratio	6.79	2.7-15.5	1.610	0.225	24.12

In the present studies the variation in respect of physical characters of fruits may be attributed to the genetic differences in the trees due to propagation by seeds and variation from other workers may be due to agroclimatic conditions where the studies have been undertaken. In these studies the better quality of apricot produced by some of the seedlings may be due to superior genotypes in addition to favourable climatic conditions of Kinnaur.

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EVALUATION OF AMARANTH GERMPLASM FOR FODDER

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Key words : Amaranth, germplasm, evaluation, fodder

One hundred ninety exotic and indigenous accessions of amaranth (100 from NBPGR, Shimla; 51 from NBPGR, Delhi; 15 from NBRI, Lucknow; 10 from NBPGR, Akola and 14 from local markets and other agencies) were assembled. This germplasm was grown at fodder research farm of Punjab Agricultural University during different months (March to October) in 1992 and 1993. A replicated yield trial constituting of twelve entries was conducted during April 1993.

Wide range of variability was observed for all the quantitative traits studied (Table 1). From the present germplasm, green fodder yield upto 46

Table 1. Variability for various agronomic and morphological characters

Character	Range
Days to germination	6-12
Days to flower	30-140
Numbr of branches	1-38
Number of leaves	24-325
Plant height (cm)	7-295
Leaf length (cm)	3.1-22.0
Leaf width (cm)	1.8-11.2
Green fodder yield (t/ha)	13.0-46.0

t/ha has been obtained. Exceptionally high fodder yields of 234 t/ha from Bangladesh and 225 t/ha from China have been reported by Hamid *et al.* (1989) and Shaoxian and Hongliang (1989), respectively. Uros *et al.* (1987) suggested the possible use of amarnath as a forage plant. Maximum number of branches per plant upto 38, plant height upto 285 cm, leaf length of 22 cm, leaf width of 10 cm and number of leaves upto 325 have been recorded in the germplasm. Hauptli and Jain (1987) showed a wide range of flowering responses, a maximum leaf length of 26.4 cm, leaf width of 12.4 cm and plant height of 245.3 cm. Tucker (1986) reported a leaf area of 4000-6000 cm² per plant. Batta *et al.* (1993) reported ample amount of variability for quantitative traits in 169 amarnath collections.

Perusal of Table 2 showed that variation among different genotypes was significant for all the characters. High heritability alongwith high genetic advance and coefficient of variability were observed for leaf length and leaf width. It might be due to additive gene effects. Hauptli and Jain (1984) showed significant inter population differences for the quantitative traits. Joshi (1986) reported high heritability and expected genetic advance for plant height in a study on twenty genotypes of amaranth. A number of promising strains suitable for fodder yield and component traits have been identified (Table 3). These outstanding lines will be utilized as potential parents. Response to cutting has shown that N-45 and LC-6 genotypes can provide fodder in more than one cutting. In sowing during march to May, there was severe damage due to insect pests. Late sowings in and after October produced low fodder yields. Hence May and June months were found to be suitable for raising fodder crop and July-August were suitable for seed production of amaranth.

Table 2. Genetic parameters of amarnath genotypes

Character	Treatment Mean- Squares	Heritability (%)	GA(%) Mean	PCV (%)	GCV (%)
Green fodder yield	10379.0**	46.3	37.9	39.7	27.0
Plant height	1504.1**	89.9	28.2	28.2	26.7
Days to flower	520.7**	92.6	25.9	25.9	25.0
Number of branches	186.2**	85.5	42.3	42.3	39.1
Number of leaves	4405.8**	62.0	53.1	53.1	41.8
Leaf length	101.2**	93.1	57.9	57.9	55.8
Leaf width	19.3**	89.5	60.1	60.1	56.9

Table 3. Promising fodder genotypes of amaranth

IC-35445	AV-45
IC-17947	AV-64
EC-13958	BDJ-18
EC-120051	93-p-63
EC-223636	LC-4
K-436	LC-6

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EVALUATION OF CROP GERMPLASM IN CENTRAL INDIA : CURRENT STATUS

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Key words : Genetic resources, evaluation, crop plants

At present, nearly 30,000 accessions are being maintained at Akola as active collections of various crops, viz., pigeonpea (2380), Chickpea (1482), wingedbean (241), lentil (651), kulthi (1050), Lathyrus (135), soybean (2402), linseed (710), safflower (1933), sesame (5773), groundnut (624), niger (396), castor (244), amarnath (1146), sorghum (177), kodo millet (529), proso millet (401), little millet (502), barnyard millet (528), foxtali millet (1365), finger millet (4321), and okra (2236). The Satellite Centre at Amravati maintains the working collections of 4859 accessions including 3700 accessions of different agricultural crops, viz., mungbean (2834), mothbean (165), uridbean (107), lablabbean (449), ricebean (112) and yambean (33). The horticultural crops maintained are sweet-potato (278), papaya (20), grapes (60), custard apple (41), pomegranate (35), ber (20), citrus species (5) chillies (700), *Simarouba glauca* and other 20 economic crop plants.

The germplasm holdings were characterized for various qualitative and quantitative traits as per the norms of IPGRI descriptors (Table 1). The most promising germplasm in various crops were identified for further testing. Several germplasm lines were also tested in different adaptive trials under All India Co-ordinated Research Projects, viz., AKSS-65, AMSS-34, AKSS-80, AMSS-41 in Soybean; EC-38821-B, EC-38995-A and EC-114273-B in wingedbean; IC-49618, IC-5564, IC-35696, IC-21930 in amaranth; EC-114273-B of wingedbean has been released as AKWB-1 for commercial cultivation in Karnataka and Maharashtra as vegetable. On the basis of preliminary evaluation and consistency in performance, some elite genotypes have been identified and presented in Table 1. However, the donor types identified in various crops for various attributes are presented in Table 2.

Table 1. List of promising accessions identified

Crop group	Crop name	Accessions evaluated	Characters evaluated	Promising accessions
Oilseeds	Sesame	5773	34	IC 41977, IC 43224, NIC 8212, NIC 7716, NIC 8200, NIC 7785, NIC 7780 EC 89112, IC 4911, IC 23316, NIC 43102, EC 346172, EC 346198, EC 346231
	Safflower	1933	20	EC 181533, EC 181128, IC 119864, IC 119866, EC 303268, EC 181803 EC 182162, EC 182080, EC 182078, EC 182119, EC 182068, EC 181641.
	Groundnut	624	18	EC 36973, EC 21045, EC 20979, EC 11419, IC 53181, IC 95858, EC 21034
	Niger	396	18	EC 282996, IC 74794, UC 74989, IC 856, IC 15795, IC 16398, IC 53561 IC 15798, IC 119912, IC 119933, IC 119934
	Castor	244	19	EC 168489, IC 47569, C 43696, IC 43694, IC 43705, IC 47259, IC 119811, IC 119812, IC 119814.
	Linseed	710	19	EC 236, EC 1413, EC 4177, EC 41762, IC 59250, IC 59252, IC 61309, IC 61318, IC 61321, IC 61291, IC 62335, IC 63578, IC 96612
	Soybean	2402	25	EC 93403, EC 39025, EC 95808, EC 11741-A, EC 134041, EC 34146-B, EC 93741, EC 251372, EC 251484, EC 251527, EC 274674, EC 274675, EC 309535, EC 257977.
Pulses	Pigeonpea	2383	19	IC 32927, IC 23955, IC 34543, IC 56061, IC 73285, IC 73801, IC 110232, IC 117487, IC 117504, IC 117567, IC 117568.
	Chickpea	1482	18	EC 2199, EC 9449, EC 95044, EC 95191, IC 198633, EC 222975, EC 267470, EC 267504, IC 117829, IC 117865, IC 117758, EC 267256, EC 267307.
	Kulthi	1050	19	IC 9627, IC 56140, IC 56143, IC 56145, IC 18455, IC 26135, IC 26137, IC 43506, IC 110286, IC 110871, IC 120770, IC 120808, IC 120833
	Lentil	651	18	C 60965, IC 60968, IC 62505, IC 57762, IC 62511, IC 33920, IC 53239, IC 78422, EC 223212, EC 223215.

(Table 1 contd.)

	Mungbean	2834	55	IC 8654-4, EC 24130, PLM 306, PLM 240, PLM 277, PLM 311, PLM 175.
	Wingedbean	241	33	Vegetable type : EC 114273-B, EC 38995-A, EC 38957, EC 38825, EC 178271, EC 178331, EC 178275, EC 178298, EC 178313. Grain type: EC 27886, EC 178303, EC 26942, IC 95240.
	Khesari	150	11	IC 120453, IC 120458, IC 120455, IC 120472, IC 120495, IC 120500, IC 120501, IC 120510, IC 120520, IC 120523.
Millets	Finger millet	4321	10	IE 3144, IE 31, EKR 219, GE 743, GE 983, IE 3464, IE 3143, IC 120380, GE 4354, GE 4363, GE 4342, GE 77, GE 452, GE 582
	Foxtail millet	1365	10	ISE 941, ISE 905, ISE 781, ISE 1363, ISE 426, ISE 1135, ISE 989, ISE 1013, ISE 1042, ISE 1077, IC 120148.
	Barnyard millet	528	10	IEC 288, IC 28445, IC 41788, IEC 157, IEC 562, IEC 565, IC 28435, IEC 104, IEC 170, IEC 331.
	Little millet	502	10	IPMR 388, IPMR 421, IPMR 433, IPMR 728, IPMR 742, IPMR 750, IPMR 862, IPMR 872, IC 120395, IC 120353.
	Proso millet	401	10	IPM 79, IPM 264, IPM 121, IPM 136, IPM 2162, IPM 2618, IPM 2629, IPM 2644, IPM 2700, IC 120356.
	Kodo millet	529	10	IPS 199, IPS 270, IPS 681, IPS 3417, IC 52471, IPS 669, IPS 585, IPS 79, IPS 346, IPS 570, IPS 325, IPS 135.
Pseudo cereal	Amarnath	1146	15	IC 35661, IC 35696, IC 35624, IC 35681, IC 95638, IC 21947, IC 38243, IC 38267, IC 95505, IC 120867, IC 120588, EC 284348
Vegetables	Okra	2236	54	EC 169341, EC 169357, EC 169358, EC 305635, EC 305639, EC 305655, EC 305675, EC 305737, EC 305738, EC 306735, EC 306751, EC 306736, EC 306725, EC 305691.
	Chillies	700	15	BDJ 2254, EC 103820-1, IC 18882
Fruit crops	Papaya	20	10	EC 109088, EC 109089, EC 109090, EC 26495
	Grapes	51	12	EC 38478, EC 38557, EC 26914
Tuber crops	Sweet potato	278	10	EC 5889, EC 13468-A, EC 13469, Pusa lal.

Table 2. Donor types identified in various crops

Crop	Characters	Accessions
Soybean	Four seeded pods	EC 172665, EC 172665-A, EC 250581, EC 251528.
	Bold seeds (20-30 g)	EC 301884, EC 39755, EC 232053, EC 257977, EC 257978, EC 301883, P1366, IC 118163
	Resisit. to B.P.	Bragg, EC 34094, EC 95806, EC 106991, EC 106992, EC 106998
	Multiple resistant (BP, SM, PB)	EC 95796, EC 107415, EC 172575, EC 172596, EC 251405, G 1526, G 2202, IC 118086, IC 118096, IC 118101, IC 18383.
	Defoliation resistant	EC 106991, EC 106992, EC 305353.
	Shattering resistant	EC 172575, EC 172630, EC 172648, EC 172659, EC 232044, EC 232048, EC 251411, EC 251418, EC 251457, EC 251478
	High seed germinability/longevity	IC 1182622, EC 241949, EC 241920, IC 202, IC 574, IC 14680, IC 19729, IC 24072, IC 81820, IC 118335, IC 117873, IC 118576, G 2524, IC 118110, EC 39495, EC 172587, EC 99991, EC 172638, EC 172654, EC 251369, EC 251418, EC 251459, EC 241771, EC 274673, EC 241412
	Photoinsensitivity	EC 14483, EC 38137, EC 117633, EC 289099, EC 291391, IC 118237, IC 118238, IC 118240
	Vegetable type	EC 250575, EC 250576, EC 301881, EC 301884, P 1366, IC 118163
	High oil content (23-25%)	EC 95809, EC 39703, EC 76736, EC 16694, EC 37050, EC 37939, EC 95277, EC 95796, EC 102612, EC 107407, EC 110676.
Chickpea	Bold seeds (40-60g)	EC 222917, EC 222978, EC 222991, EC 222992, EC 223125, EC 267224, EC 267424, EC 22307, EC 267318, EC 267489
	Twin pods	EC 267451, EC 267158, EC 267425.
	High pods	EC 219962, EC 220083, EC 267206, EC 267256, EC 267289, EC 267489
	High nodulation	EC 198544, EC 198705, EC 220046, EC 223459, EC 223485, EC 267112, EC 267227, EC 267279
	Earliness	IC 105322, IC 105327, IC 117511, IC 117568, IC 112421, NIC 12771.
Pigeonpea	High pod number	IC 110232, IC 110261, IC 117465, IC 117468, IC 117504, IC 117560, IC 117592.
	Long pods	IC 117504, IC 117511, IC 117557, IC 117560, IC 117577, IC 117581, IC 117585.
	High branches	IC 110323, IC 117464, IC 117468, IC 117502, IC 117530, IC 117567.
	Tall types	IC 110232, IC 110261, IC 117504, IC 117480.
Safflower	High seeds/capitulum	JL 1518, JL 1519, JL 1429

(Table 2 contd.)

	Bold seeds (5-7 g)	JL 1515, JL 896, EC 100523, JL 1339, JL 158, JL 160, JL 1370, JL 128, IC 6114
	High oil content (42-43%)	EC 100508, JL 1516, JL 1518, JL 1429, PC 100507, PI 343774, JL 1342, JL 1002, JL 151, Tara
Linseed	Earliness	EC 526, EC 1395, EC 14621, EC 41650, IC 61280, IC 61320, IC 96609
	Resist. to powdery mildew	EC 41495, EC 41767, IC 53288, IC 96513, IC 96514, IC 96532
	High oil content (46-47%)	EC 12538, IC 59008, IC 61306, IC 61322, IC 96506, IC 96745, IC 96646, IC 96649, IC 96749, IC 96663, IC 96751, IC 96666, IC 96752, IC 96680, IC 10544
Horsegram	Earliness	IC 49289, IC 105489, IC 120774, IC 120777, IC 120828, IC 120845.
	Long pods	IC 11387, IC 11405, IC 94591, IC 120837, IC 120825, NIC 11402.
	High pods	IC 105820, IC 120774, IC 120777, IC 120816, IC 120833, IC 120837
Lentil	Earliness	IC 27695, IC 53234, IC 53239, IC 60377, IC 60698, IC 95655, EC 223229
	Multiple seeds	IC 62508, IC 62509, IC 62558, IC 73120, IC 73122, IC 78498
	Bold seeds	EC 223212, EC 223220, EC 267596, EC 26730, EC 267709
	High pods	IC 33920, IC 53239, IC 78422, IC 78472, IC 78476, IC 78578
Okra	Earliness	EC 305611, EC 305612, EC 305639, EC 305616, EC 305609, EC 316053
	Long fruits	EC 305681, EC 305708, EC 305740, EC 316050, EC 316069, EC 316080
	Short fruits	EC 305741, EC 305739, EC 306701, EC 306736, EC 306743
	Less seeded fruits	EC 329371, EC 329366, NIC 9362, NIC 9376, NIC 9387, NIC 9487, NIC 10316
	Resist. to YMV	EC 305612, EC 305635, EC 305652, EC 305672, EC 305685, EC 306736
	High bearing	EC 305635, EC 305639, EC 305665, EC 306730, EC 306735, EC 305738
Sesame	Earliness	IC 96079, IC 96080, IC 96075, IC 96199, IC 54044, EC 178378
	High bearing	IC 43041, IC 43172, IC 52526, IC 96125, EC 13384, EC 132832
	Single culmed	EC 132132, IC 54004, IC 54006, IC 54016, IC 54025, IC 54054
	Basal branched	EC 132827, EC 133844, IC 41923, IC 41946, IC 31843.

Several crop catalogues were published viz., frenchbean (Patel *et al.*, 1981), Soybean (Bhatia *et al.*, 1983), sesame (Umesh Chandra *et al.*, 1984), Okra Part

II (Thomas et al., 1991), okra Part III (Bisht et al., 1993), sesame (Loknathan et al., 1993), soybean (Verma et al., 1993), linseed (Verma et al., 1993), safflower, (Patel et al., 1995) and kulthi (Patel et al., 1995).

Maintenance of wild species:

Okra	<i>Abelmoschus ficulneus</i> , <i>A. callei</i> , <i>A. moschatus</i> , <i>A. manihot</i> , <i>A. tuberculatus</i>
Safflower	<i>Carthamus</i> , <i>lanatus</i> sub spp. <i>turkestanicus</i> , <i>C. lanatus</i> , <i>C. oxyacantha</i>
Soybean	<i>Glycine soja</i> , <i>G. tomentella</i> , <i>G. tabacina</i> , <i>G. canescens</i>
Sesamum	<i>Sesamum alatum</i> , <i>S. radiatum</i> , <i>S. indicum</i> (black seeded wild), <i>S. mulayanum</i>

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MORPHO-PHYSIOLOGICAL EVALUATION OF TURNIP

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Key words : Turnip, characterization, fertilization value, pollen fertility

Although morphological characteristics of some Indian varietal populations of turnip are known to some extent (Williams, 1985; Shrivastava, 1992), they are not well studied. Therefore, one of the objectives of the present work was to characterize and evaluate seven populations of turnip on the basis of their morphophysiological characteristics. The populations which constituted the material for present investigation are : Blue White (BW), Rose Red (RR), Purple Top White (PT), Moddle White (MW), Golden Ball (GB), Early Snow Ball (SB), and Green Globe (GG). To make comparative study the plants were raised from the seeds in controlled condition in rows at a distance of 35-40 cm during September-April, 1988-1989 in the field at Hazaribag. Following characteristics were taken into consideration : per cent seed germination (PSG), seedling morphology which included the mean hypocotyl length (MHL), mean cotyledon area (MCA) and relative width of cotyledon (RWC %): number of leaves/plant (MNL), lobes/leaf (MNLB), number of branches/plant (MNB), plant height (Ph), days to flower, mean number of stomata/unit area (MNT), number of chloroplasts/guard cell (MNC), mean number of ovules/pistil (MNO), mean number of seeds/siliquae (MNS), fertilization value (FV %) and pollen fertility.

PSG is based on 1000 seeds in each population. MHL was obtained from measurement of 100 randomly selected seedlings after the appearance of the first true leaf. At the same time, length and width of the cotyledons were also measured with the help of a divider and a scale in order to calculate MCA. MNLB was computed by counting the number of lobes in ten leaves from each of 25 plants. To score MNB number of secondary branches developing from the main axis was counted. Days to flower were scored as appearance of first flower from sowing. Total 625 pistils, (25 from each plants of 25 plants

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in each population were dissected out carefully to score MNO. MNS was scored by counting the number of seeds in 250 siliquae (10 from each plant of the 25 plants). The ratio of MNS to MNO gave FV. For pollen fertility, technique of John Ferreira (1985) was used considering about 1000 pollen grains in each population.

The populations showed inter-population variation in various characters. Studied (Table 1). Turnip is suitable for genetical study of the seedling characters (Prasad & Shrivastava, 1993 b) which are quite sharp and distinct in this species. The seedling counts give better genetic ratio than the adult plant counts due to lesser effect of the environment on such characters. The data of present investigation demonstrated that the populations of turnip differed considerably among themselves in PSC, MHL, MCA and RWC due to their genotypic peculiarities. The populations having greater MHL had smaller MCA and vice-versa (Prasad, 1993 a). This indicated that MHL is negatively correlated with MCA. Whether hypocotyl length has any correlation with root size in turnip is not known. However, SB, GB and PT characterized by the larger roots also had the longer hypocotyl (Shrivastava, 1992).

Our results also demonstrated that different populations of turnip vary among themselves in the vegetative attributes like MNL, MNLB, MNT, MNC, Ph and MNB. Whether these parameters have any relation with the components of fertility in turnip is not known.

The populations differed in fertility components as well. It is remarkable that FV in all the population is below 50%. The seed set in turnip appears to be a genotypic function of the (Prasad & Shrivastav, 1993c). The pollen fertility in these populations also showed significant intervarietal differences. In contrast to the fertilization value, pollen fertility in all the populations is quite high, above 84.0 per cent. Some sort of parallelism does exist between pollen fertility and meiotic chromosome behaviour (Shrivastava, 1992) but this can hardly be generalised. However, in radish a correlation between pollen sterility and meiotic chromosome abnormalities have been noted (Dayal, 1978). Nwankiti (1970) is of the opinion that all types of chromosome abnormalities are not related with pollen sterility.

Thus the present study shows that the populations of turnip vary genotypically among themselves in a number of morphophysiological attributes. Heterosis has been a phenomenon of great interest to plant breeders and the degree of heterosis is closely associated with genetic diversity of the parental forms and, therefore, intervarietal hybridization becomes more significant from the viewpoint of effective exploitation of additive and non-additive genetic variability.

Table 1. Variations in morpho-physiological traits in the varietal populations of turnip

Characteristics	BW Mean $\pm$ SE	RR Mean $\pm$ SE	PT Mean $\pm$ SE	MW Mean $\pm$ SE	CB Mean $\pm$ SE	SB Mean $\pm$ SE	GC Mean $\pm$ SE
1. % Seed Germination (PSG)	52.0 $\pm$ 1.57	73.3 $\pm$ 1.39	56.1 $\pm$ 1.57	61.1 $\pm$ 1.47	70.2 $\pm$ 1.44	57.9 $\pm$ 1.56	63.0 $\pm$ 1.52
2. mean Hypocotyl length (MHL) (mm)	55.8 $\pm$ 1.17	35.2 $\pm$ 0.76	59.4 $\pm$ 0.96	28.6 $\pm$ 0.86	63.9 $\pm$ 1.07	63.9 $\pm$ 1.04	28.7 $\pm$ 0.84
3. Mean Cotyledon area (MCA) mm ²	46.7 $\pm$ 0.02	82.5 $\pm$ 0.03	58.5 $\pm$ 0.02	79.6 $\pm$ 0.04	51.8 $\pm$ 0.02	53.8 $\pm$ 0.02	82.5 $\pm$ 0.03
4. Relative width of cotyledons (RWC) %	143.0 $\pm$ 1.92	154. $\pm$ 2.85	163.3 $\pm$ 2.08	130.8 $\pm$ 3.91	126.6 $\pm$ 1.96	131.2 $\pm$ 2.21	146.7 $\pm$ 3.42
5. Mean No. of leaves/plant (MNL)	13.0 $\pm$ 0.89	9.4 $\pm$ 0.76	10.6 $\pm$ 0.58	11.2 $\pm$ 0.58	10.4 $\pm$ 0.62	10.2 $\pm$ 0.59	10.8 $\pm$ 0.72
6. No. of lobes/leaf (MNLB)	16.6 $\pm$ 0.96	9.6 $\pm$ 0.62	11.2 $\pm$ 0.58	12.0 $\pm$ 0.69	13.4 $\pm$ 0.73	11.4 $\pm$ 0.66	12.0 $\pm$ 0.69
7. Mean No. of branches/plant (MNB)	1.6 $\pm$ 1.14	11.4 $\pm$ 0.77	11.2 $\pm$ 0.64	9.0 $\pm$ 0.34	11.0 $\pm$ 0.85	9.2 $\pm$ 0.44	-
8. Plant height (Ph) (cm)	109.6 $\pm$ 4.81	105.6 $\pm$ 4.60	82.4 $\pm$ 6.0	80.8 $\pm$ 4.59	85.6 $\pm$ 4.45	68.8 $\pm$ 4.53	-
9. Days to flower	80	72	73	137	181	176	Did not flower even after 180 days
10. No. of stomata/unit area (MNT)	15.5 $\pm$ 0.98	16.3 $\pm$ 0.48	15.9 - 0.57	28.0 $\pm$ 0.82	12.6 $\pm$ 0.41	20.6 $\pm$ 0.65	15.6 $\pm$ 0.37
11. No. of chloroplasts/guard cell (MNG)	4.4 $\pm$ 0.10	3.9 $\pm$ 0.10	3.7 $\pm$ 0.10	3.2 $\pm$ 0.08	3.5 $\pm$ 0.11	3.3 $\pm$ 0.10	3.6 $\pm$ 0.11
12. No. of ovules/pistil (MNO)	23.1 $\pm$ 0.24	22.1 $\pm$ 0.31	21.3 $\pm$ 0.23	22.7 $\pm$ 0.30	27.3 $\pm$ 0.23	16.5 $\pm$ 0.29	-
13. No. of seeds/siliquae (MNS)	5.3 $\pm$ 0.23	7.8 $\pm$ 0.41	7.9 $\pm$ 0.28	8.9 $\pm$ 0.22	11.6 $\pm$ 0.24	5.2 $\pm$ 0.22	-
14. Fertilization value (FV %)	23.5 $\pm$ 1.34	36.9 $\pm$ 1.52	37.9 $\pm$ 1.52	40.7 $\pm$ 1.55	41.7 $\pm$ 1.55	31.3 $\pm$ 1.47	-
15. Pollen Fertility (%)	85.5 $\pm$ 1.10	90.8 $\pm$ 0.91	87.8 $\pm$ 1.03	84.2 $\pm$ 1.15	85.6 $\pm$ 1.11	83.4 $\pm$ 1.17	-

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INTERCEPTIONS OF PLANT PATHOGENIC FUNGI ON IMPORTED SEED MATERIAL FROM 1989 TO 1992

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The accelerated movement of germplasm is necessary for utilisation in crop management programme by international, national and private organisations. But there has been an inherent risk of introduction of serious exotic plant pests and pathogens into the country. To minimize the chances of such inadvertent introduction, constant vigil has to be maintained, therefore, it is absolutely necessary to subject all introduced seed/planting material to strict quarantine examination using the available standard and sensitive detection techniques.

Hyderabad Plant Quarantine Regional Station of the National Bureau of Plant Genetic Resources is catering the quarantine needs of South India. The present note gives details about the pathogenic fungi intercepted during 1989-1992. To detect associated fungi, the seed material was first visually examined under illuminated magnifier and subsequently representative samples were plated on three layers of moistened blotter papers in plastic Petri plates. The plates were incubated at 20°C ($\pm 1^\circ\text{C}$) under 12 hours of alternate light and darkness for 8 days (ISTA, 1976). The plates were then observed under stereoscopic microscope for identification of associated fungi. The intercepted exotic fungi alongwith thier host crops and source countries are listed in Table 1.

A persual of literature showed that *Botryodiplodia theobromae*, *Botrytis cinerea*, and *Pestalotia* sp. on *Atylosia scarabioides*, *Colletotricum lini* on sorghum, *Drechslera maydis* on chickpea have not been reported on these crops. This clearly indicates that some of the seed borne fungi of quarantine importance could also be carried through non-host crops and get established. During seed health testing care must be taken to look not only for the pathogens reported on a specific crop but also for other pathogens of quarantine importance.

Table 1. Important plant pathogenic fungi intercepted in imported seed material

<i>Fungi intercepted</i>	<i>Crop (Source)</i>
<i>Acremonium</i> sp.	Maize (USA)
<i>Ascochyta rabiei</i> (Pass.) Labrousse	Chickpea (Myanmar)
<i>Botryodiplodia theobromae</i> Pat.	<i>Atylosia</i> sp. (Sri Lanka), Pigeonpea (Sri Lanka), Chickpea (Myanmar)
<i>Botrytis cinerea</i> Pers. ex Perb.	Indian paspalum (Philippines) <i>Atylosia</i> sp. (Sri Lanka) Sorghum (philippines) <i>Setaria</i> sp. (Philippines)
<i>Claviceps fusiformis</i> Loveless	Pearl millet (Zimbabwe)
<i>Colletotrichum</i> sp.	Pigeonpea (Togo)
<i>C. graminicola</i> (Ces.) Wils.	Sorghum (UK, Namibia, Togo, Mexico, Rwanda, Zimbabwe)
<i>C.lini</i> (Westend) Tochinai	Sorghum (Mexico)
<i>Drechslera maydis</i> (Nisik.) Subram. and Jain	Sorghum (USA, Philippines, Central African Republic), Pearlmillet (Togo, USA), <i>Pennisetum glaucum</i> (USA), Chickpea (USSR), <i>Pennisetum</i> sp. (UK), Sudangrass (USA)
<i>D. nodulosa</i> (Berk. and Curt.) Subram. and Jain	Finger millet (Nepal)
<i>D. borghicola</i> (Lefevre and Sherwin) Richardson and Fraser	Sorghum (Mexico)
<i>D. sorokiniana</i> (Sacc.) Subram and Jain	Sorghum (Zimbabwe)
<i>Fusarium moniliforme</i> Sheld.	Maize (USA)
<i>F. oxysporum</i> Schlecht. extr.	Pigeonpea (Sri Lanka)
<i>F. solani</i> (Mart.) Sacc.	Sorghum (Zimbabwe)
<i>Gleocercospora sorghi</i> Bain and Edg. Deighton	Sorghum (USA)
<i>Macrophomina phaseolina</i> (Tassi) Goid.	Okra (USA) Pigeonpea (Togo) Groundnut (Niger) Sorghum (Philippines)
<i>Periconia</i> sp.	
<i>Pestilotia</i> sp.	<i>Atylosia</i> sp. (Sri Lanka)
<i>Phoma</i> sp.	Chickpea (Pakistan)
<i>Phomopsis</i> sp.	Pigeonpea (indonesia)
<i>Pyricularia grisea</i> Sacc.	Finger millet (Nepal)
<i>Rhizoctonia solani</i> Kuhn	Pigeonpea (UK)
<i>Tolyposporium penicillariae</i> Bref.	Pearlmillet (USA, Namibia)

Although some of the fungi intercepted are known to occur in India, there is a risk of introducing new and more virulent races and biotypes of such fungi. New races and biotypes have been reported in *Ascochyta rabiei*, *Colletotrichum graminicola*, *Drechslera oryzae*, *D. maydis*, *D. sorokiniana*, *Fusarium oxysporum*, and *Macrophomina phaseolina*.

Since many of the pathogens intercepted are of quarantine importance and pose problems to our agriculture, strict quarantine measures and proper salvaging treatments were followed before release of such infected seed material (Chakrabarty and Prasada Rao, 1989).

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QUARANTINE PROCESSING OF EXOTIC PLANTING MATERIAL IN INDIA

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One of the methods of crop protection is to prevent the pests/pathogens from entering into the areas in which the host plants are growing so that the chances of attack are eliminated. This method of exclusion is enforced through certain legal measures commonly known as *Quarantine*. Knowledge and methodology of exclusion are utilised and practised by a legally constituted authority to prevent the entry and spread of injurious crop pests/pathogens in public interest. Quarantine regulations are of comparatively recent origin. The adoption of such steps by different countries of the world has arisen out of the realisation that the crops have suffered extensive damages, often sudden in nature, not by the indigenous pests or pathogen but by exotic ones which gained entry along with introduced planting materials. Instances may be cited of the introduction of downy mildew of grapevine (*Plasmopara viticola*) into France from USA which was responsible for the destruction of grapevines. Blight disease of chestnut (*Endothia parasitica*) introduced into the USA from Europe completely wiped out chestnut plants. In India leaf rust of coffee (*Hemileia vastatrix*) introduced from Sri Lanka in 1776; flag smut of wheat (*Urocystis tritici*) introduced from Australia; bunchy top of banana introduced from Sri Lanka in 1940 causing serious damage to dwarf Cavendish varieties in different parts of India, wart of potato (*Synchytrium endobioticum*) introduced from Netherlands in 1952; onion smut (*Urocystis cepulae*) and sunflower downy mildew (*Plasmopara halstedii*) introduced recently are examples showing how many destructive diseases have entered into this country and have established themselves causing extensive damage.

Plant quarantine regulations in order to be effective have to be based on sound scientific principles. The biology and ecology of the organism against

which quarantine measure is proposed to be enforced should be known. Besides it has to be determined whether:

1. in the absence of any quarantine measure, the organism is likely to be introduced into the country;
2. in the event of its introduction whether the organism is likely to be established and cause damage of any consequence;
3. quarantine regulations can be framed on scientific lines and enforced satisfactorily and
4. it is economical to introduce the legislative measure in terms of benefit likely to be derived.

National Bureau of Plant Genetic Resources (NBPGR), being the apex body for exchange of germplasm for research purposes, has greater responsibilities to avoid any introduction of exotic diseases. Plant materials imported from all over the world, once arrived, come to NBPGR- Joint Inspection Laboratory after accessioning of the seed samples (through Germplasm Exchange Division). The samples received in the laboratory are first entered in a register with pertinent informations *viz.*, IQ (import Quarantine) number, number of samples, host, source country, name and address of the person sending sample, name and address of the consignee and procedures adopted, dates, interceptions and remarks with regard to the seed health testing. Every effort is made to start testing samples on the day of receipt, so that the changes in the quality of seed are minimised. However, it is very important to note the presence of *Phytosanitary certificate*, a document necessary to be present along with the seed materials. Each contracting Government should make arrangements for the issue of Phytosanitary Certificate in accordance with the plant protection regulations of other contracting Governments, and in conformity with the provisions laid down.

Pests/pathogens are constantly associated with a plant disease which may be grouped in various ways. The diseases are soil-borne or seed-borne when they perpetuate and spread through the agency of soil or seed (or any propagating material). During the absence of an active host plant, pests/pathogens survive through one or more of the following means: soil, pests/pathogens; seed-borne pests/pathogens and alternate or weed hosts and off-season crops. Various procedures adopted/employed for the detection of different pests/pathogens are listed below:

Techniques for detection of pests and pathogens during quarantine processing

Fungal pathogens

1. Inspection of dry seed with unaided eye, hand lens or under low power stereoscopic microscope.

2. Microscopic examination of suspensions obtained by seed washings.
3. Incubation tests:
 - a. Blotter method
 - b. Agar plate method
4. Examination of symptoms developed on seedlings :
 - a. Roll-Towel method
 - b. Water agar seedling symptom method (Khare *et al.*, 1977)
 - c. Sand/soil method
5. Growing on tests carried out in green house, environment controlled chambers or in field
6. Specific methods :
 - a. Oxgall agar method (Mathur and Lee, 1978)
 - b. Peptone-PCNB agar method
 - c. Guaiacol-agar medium method
 - d. Embryo count method
 - e. NaOH soak method (Agarwal and Verma, 1983; Agarwal and Srivastava, 1981)
 - f. Biochemical tests (Gordon and Webster, 1982)
 - g. Serological tests

Bacterial pathogens

1. Visual examination
2. Plant inoculation (Thyr. 1969; Saettler, 1971)
3. Incubation tests
 - a. Blotter tests
 - b. Paper towel method
 - c. Agar planting method (Lundsgaard, 1973)
 - i. Direct plating (Randhawa and Schaad, 1984)
 - ii. Plating with seed washing
 - iii. Plating after seed maceration
4. Growing on test
 - a. In water-agar
 - b. In green house
5. Specific tests
 - a. Phage plaque method or phage sensitivity test
 - b. Serological techniques
 - i. Agglutination test (Duveiller *et al.*, 1988)
 - ii. Immunofluorescence test
 - iii. Immunodiffusion (direct double diffusion; Ouchterlony double diffusion)
 - iv. Enzyme Linked Immunosorbent Assay (ELISA)

Viruses

1. Visual examination of seeds
2. Grow-out test
3. Infectivity test
4. Staining of inclusion bodies
5. Electronmicroscopy

6. Serological tests
 - a. Agglutination test
 - b. Latex agglutination test
 - c. Agar diffusion test
 - d. ELISA.
7. Immuno Sorbent Electron Microscopy (ISEM)
8. Complementary DNA (cDNA) probes

Insect pests

1. Visual examination with unaided eye, hand lens or under low power stereoscopic microscope
2. X-ray radiography (Milner *et al.*, 1950; Wadhi *et al.*, 1967)
3. Transparency and staining technique (Kaura, 1959; Verma, 1986)
4. Acoustical method (Brain, 1924)
5. Chemical methods
6. Detention

Nematodes

1. Direct examination of plant materials
 - a. Visual observations
 - b. Microscopic observations
 - c. Seed soaking and teasing and soaking of vegetative propagates in water
 - d. Staining technique
 - e. Examination of accompanying soil
2. Detection of nematodes in Post-Entry Quarantine Nursery

Salvaging of the infected germplasm

The principles of salvaging the infected germplasm are same as those of controlling the plant diseases except that the tolerance limit for any pathogen in quarantine is zero and efforts are made to eliminate the pathogen. Various physical and chemical methods which are adopted for disinfecting the germplasm are listed below.

Fungal pathogens

1. Mechanical separation
2. Spirit wash
3. Acid wash
4. Hot water treatment
5. Chemical treatment
6. Post-entry quarantine growing

Bacterial pathogens

1. Roguing-out infected plants
2. Hot water treatment

3. Dry heat treatment
4. Chemical treatment

Viruses

1. Roguing-out infected plants showing viral symptoms in grow out test.

Insect pests

1. Fumigation
2. X-ray Radiography
3. Chemical dip/spray
4. Mechanical cleaning
5. Cold/heat treatments

Nematodes

1. Mechanical seed cleaning
2. Disinfection of planting material by heat
 - a. Use of microwaves
 - b. Hot water treatment
3. Nematicidal dip treatment

The planting material found free from insect pests and pathogens and or salvaged through various ways are then sent and made available to the respective indentors. However, the planting materials found to be infested/infected by pests/pathogens not known to occur in India are rejected and incinerated.

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