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RICE GENETIC RESOURCES PROGRAMME IN THE PLATEAU REGION OF BIHAR

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Rich diversity in rice exists in the plateau region of Bihar owing to diverse growing situations and low coverage under modern high yielding varieties. There is an urgent need to collect and conserve this rich wealth of diversity before genetic erosion depletes this useful genepool. This paper presents an account of current status of genetic resource programme in the region and suggests intensification of coordinated efforts in collection, *in situ* and *ex situ* conservation, evaluation, cataloguing and utilization.

Key words : Rice genetic resources, plateau region Bihar, collection, evaluation, conservation, utilization

There is rich diversity in rice agroecology in the plateau region of Bihar (22.0-22.5° N latitude; 83.95-88°E longitude; 140-1200 m above msl) having 29.2 per cent of the rice area of the state. The region is also endowed with enormous genetic diversity in traditional rice cultivars owing to low coverage under high yielding varieties. Further, the area is largely inhabited by tribals in the inaccessible areas which are not exposed to modern agriculture and hence possess wide array of native types and wild genetic resources. Concerted efforts should be made to conserve the rice genetic diversity in native land races, primitive cultivars and their wild relatives occurring in the region before this wealth is eroded. This paper presents current status of rice genetic resource activities in the region.

Three research centres - Central Rainfed Upland Rice Research Station (CRURRS), Hazaribag, a unit of Central Rice Research Institute, Cuttack; National Bureau of Plant Genetic Resources (NBPGR), Base Centre, Ranchi and Birsā Agricultural University (BAU), Kanke, Ranchi - have active rice genetic resources programme in the plateau region of Bihar.

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GERMPLASM COLLECTIONS

Indigenous Collections : One hundred and nine landraces were collected from 25 blocks of five districts in collaboration with NBPGR, New Delhi, in 1985 (Chauhan *et al.*, 1989) followed by collection trips during 1987-1991. Fifty upland rice cultivars were also collected from Almora and adjoining areas in western Uttar Pradesh. The NBPGR Base Centre at Ranchi extensively surveyed Bihar, eastern Uttar Pradesh and adjoining areas of Orissa during 1988-1993 and collected 796 accessions, of which 171 were ecotypes of *Oryza nivara* (110), *O. rufipogon* (36), *O. spontanea* (14), and hybrids of *O. nivara/O. spontanea* (9) and *O. rufipogon/O. nivara* (1). BAU is maintaining a collection of 591 accessions. The area surveyed the predominant landraces in different agroecologies are presented in Table 1 & 2.

Table 1. Details of the rice germplasm collection trips

Period	Area surveyed			Collections (No)
	Blocks (No)	Districts		
Oct.-Nov. 1985	25	Hazaribag, Giridih, Gumla, Lohardagga, Ranchi	109	
Sept. 1987	5	Hazaribag, Giridih	28	
Oct. 1987	2	Hazaribag	7	
Oct. 1988	-	Ranchi, Hazaribag and North Bihar	6	
Nov. 1988	-	Bolangir (Orissa)	130	
Nov. 1989	9	Ranchi, Gumla, Singhbhum	28	
Dec. 1989	-	Palamau, Ranchi, Hazaribag, South Bihar and Eastern UP	119	
Dec. 1989-Jan. 1990	-	Lohardagga, Palamau, Gumla, Ranchi, Singhbhum, Hazaribag, Purulia (WB)	170	
Nov.-Dec. 1990	-	North Bihar	111	
Sep.-Oct. 1991	-	Ranchi, Dumka, Sahebganj, Godda, Giridih, Hazaribag, Gumla, Singhbhum, Palamau, Lohardagga	86	
Nov. 1991	9	Eastern UP;	67	
	-	Giridh, Godda, Dumka		
Nov. 1992	-	Eastern UP	112	
Sep.-Oct. 1993	-	Ranchi, Hazaribag, South and North Bihar	21	

Exotic collections : Traditional and improved cultivars from South and South East Asia, Latin America and West Africa were received from the International Rice Research Institute, Philippines. These accessions are mostly

of rainfed upland type and constitute a very useful genepool specifically for drought tolerance, blast resistance and root characteristics since many of them are the known donors for these characteristics. At CRURRS, 124 accessions are being maintained. No distinct classification of exotic and indigenous collections is available at BAU although they are having some improved exotics received through international testing programmes. The accessions at NBPGR are exclusively indigenous including wild ecotypes.

Currently, a total of 2091 accessions are in stock at the three centres representing traditional, exotic and improved types for upland, medium- and

Table 2 : Important traditional cultivars of rice in the plateau region

Agroecology	Land type	Cultivars
Upland	Tanr II & III	Black gora, White gora, Brown gora
Medium land	Don III	Dudhi, Dighio, Karhani, Dehule, Asumarto, Marto
	Don II	Tilasar, Dudhras, Ratgoli, Chandragrahi, Lalki, Jonga, Nevair, Chapasair, Areba, Khoya
Lowland	Don I	Sikkinanhia, Panidubki, Bherakaber, Dudjkander, Nardha, Haskalma, Kalamdani, Tulsimanjari, Mainasar, Sarna, Ramsar, Birendrasar, Nakjawain, Dhusra, Mehra, Nauhia

lowlands. The accessions are prefixed with HRC (Hazaribag Rice Collections) at CRURRS, Acc (Accessions) at BAU and NIC (National Indigenous Collections) at NBPGR.

EVALUATION, CHARACTERIZATION AND CATALOGUING

Systematic evaluation, proper documentation and dissemination of findings provide the bridge between conservation and potential use. Accomplishments at the three centres are presented in Table 3.

Table 3. Evaluation status of rice genetic resources in the plateau region

Character	Accessions (No)
Agromorphological	425
Quality	259
Blast	748
Brown spot	205
Bacterial leaf blight	307
Sheath rot	131
Termites	60
Gundhi bug	50
Leaf folder	50

Agromorphological characters : One hundred and eighty one gora collections (traditional upland cultivars) of plateau region have been extensively studied for pigment distribution in plant parts, quality, physiological and agro-morphological characters (Chauhan *et al.*, 1993; Singh, 1993). The accessions HRC28, 621 and 625 were identified as donors for grain weight, panicle length and kernel colour respectively (Sinha *et al.*, 1990). Singh (1993) selected eight accessions Goradhan 1 (Acc 18), Goradhan 8 (Acc 25), Jarang gora 1 (Acc 33), Karanga gora 2 (Acc 35), Lalmati gora 1 (Acc 37), Karanga gora 1 (Acc 34), Naud gora 1 (Acc 40) and Nanhi gora 1 (Acc 41)- as valuable sources for several genetic markers and agronomic characters. The pattern of *in situ* morphological variation for panicle length, type, branching pattern, grains per panicle, grain weight, apiculus colour, sterile glume colour, awning, husk colour, grain size per shape and aroma were studied in 109 traditional cultivars of medium and lowlands. Several potential donors for grain number, grain weight and panicle characteristics were identified (Chauhan *et al.*, 1989). At NBPCR, 83 upland rice accessions were evaluated for pigment and agromorphological characters and the variation in flowering, plant height, panicle length, branches per panicle, spikelets per panicle and leaf length was studied in 52 ecotypes of *Oryza nivara* and *Oryza rufipogon*.

Table 4. Promising accessions of rice for specific quality characters

Character	Accessions
High grain weight (>30 g) Aroma	Raria (268), Sathi 34-36 (35), Ramdi, Rukaminibhog, Raskadam (29), Improved Raskadam (30)
Long slender grains (L = > 6.61 mm) (L: B = > 3.0*)	Brown gora (407, 409), Kalamdani (212), Sukhvel-20 (490)
High milling out-turn (> 70%)	Kalamdani (212), Chandragrahi (606) PTB 10(421), Raria (268), Aus 454 (465)
Intermediate amylose content & gelatinization temperature	Sudha (432), Kalamdani (212), Pakiraj (197), Brown gora (298), White gora (303), Brown gora (371)
High water uptake (> 350 ml)	Raria (268), Dahia (264), Dudhras (271), Nauhia (287), Ramkel (272)
High volume expansion (> 4)	Raria (268), Jonga White (140), Gora (274), Dudhras (271), Lalki (605), Chandragrahi (606)
Kernel elongation (> 1.9)	Sudha (432), White gora (308, 318, 320), Jhulaka (580)

*Length and breadth based on milled rice

Numbers in parentheses are HRC Nos.

Quality characteristics : Chauhan *et al.*, (1990, 1991) evaluated 135 accessions comprising rainfed upland (traditional, 25; gora collections, 57) and

medium/lowlands (53) for 12 physico-chemical and cooking quality components. About 50 per cent of the cultivars had short, bold and red kernels. Sixteen genotypes exhibited desirable combination of intermediate amylose content and gelatinization temperature. A few traditional cultivars possessing desirable quality characters were identified which could be used as donors for quality improvement (Table 4).

Tomar *et al.* (1990) classified 124 indigenous cultivars from Bolangir district of Orissa and based on 12 quality traits, grouped them into 16 clusters. Variar *et al.* (1990) and Shukla *et al.* (1991) reported that Salumpikit, Khao vano veri and Bhattadhan possess many desirable quality characteristics in addition to blast resistance, while Kalamdani, Raria, Ramkel, Tilasar and Lalki showed good cooking quality traits besides BB resistance. Efforts were also made to identify duplicates in a collection of 57 gora rices using physico-chemical characters and phenol test at CRURRS. Only 25 accessions appeared to be distinct cultivars based on grain colour, size/shape, amylose indicated that Brown- and Black gora collections were highly variable as compared to white gora collections.

DISEASES AND PESTS

Blast : Six hundred ninety eight indigenous (449) and exotic (249) accessions were phase-evaluated (each accession atleast for two seasons) in outdoor blast nurseries as per Standard Evaluation System (SES) for rice. Results indicated that only 7.2 per cent had complete resistance and 20.5% had partial resistance. The distribution of blast resistance genes was skewed in favour of the exotic (Fig. 1). Among indigenous types, the cultivars grown under uplands (Bhattadhan, Kalakeri, N 22, Dular) were less susceptible than those of medium/lowlands. Resistance in these indigenous upland 'aus' cultivars and a number of exotic cultivars like Moroberekan, IAC 25, Dourado prescose, Iguape cateto and Salumpikit were reported to be stable (Variar *et al.*, 1990). Resistance in upland rice accessions and improved germplasm was classified based on lesion types and disease progress. Three groups were recognised. Group I had complete resistance represented hypersensitive flecks or no infection symptoms. Group II had partial resistance to leaf blast. The genotypes of this group take up infection slowly, have few scattered susceptible lesions (type 4, SES, <2% Diseased Leaf Area (DLA) in the nursery but they succumbed to neck blast. Group III comprised 'aus' cultivars of the region which take up infection early, have 5-10 per cent DLA at tillering, rapid recovery and adult plant resistance. The donors identified with different types of resistance (Table 5) are being utilized in the breeding programme to combine non-infection resistance with slow blasting resistance and adult plant resistance. At BAU, 50 gora rices were field evaluated for blast resistance and some of them showed tolerance.

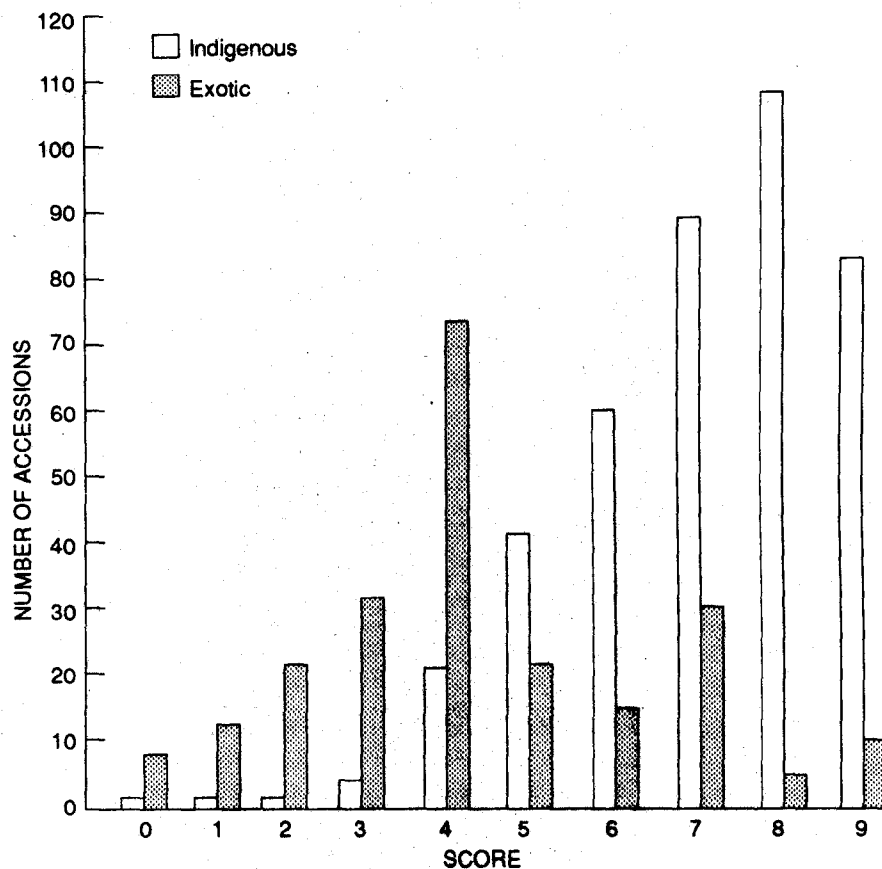


Fig. 1. Frequency distribution of rice germplasm for leaf blast reaction (n = 698)

Bacterial blight : Using clip inoculation method (Kauffman *et al.*, 1973) and SES, 257 accessions of diverse rice ecology were evaluated and 13.6% were observed to be resistant as compared to T (N)1. The cultivars showing high level of tolerance were Agnisal (HRC699), Kalamdani (HRC 711), Jhilidhan (HRC 703), Chapasair (HRC 712), Nanhia (HRC 726), Jugudi (HRC 733), Tilasar (NIC 105470), Goyen (NIC 105665) and Jarli (NIC 105682).

Other diseases : Twenty four brown spot tolerant accessions were identified at CRURRS from 155 accessions, the highly resistant were Jingsar, Rangi, Kalamkathi, Deeptisal (NIC 105758) and Badnasal (NIC 105783) and at BAU Goradhan 2 (Acc 19), Gora 2 (Acc 31), Gora 3 (Acc 33), Karanga gora 2 (Acc 35) and Naud gora 1 (Acc 40) were observed to be resistant to brown spot under field conditions. Screening of 131 traditional cultivars under natural growing conditions results into identification of Sain (NIC 105539), Jarli (NIC 105682), Bogna (NIC 105687), Gopalbhog (HRC 716) and Dudhiras (HRC 724) as resistant to sheath rot.

Table 5. Donors for blast resistance

Group	Lesion type	DLA (%) *		PBS (%) **	Accessions
		(Nursery) (40 DAS)	(Field) (DAS)	(20 DAF)	
I	0	0	0	0	Moroberekan (482), IACX 25 (478), MI 48 (483) IRAT 112 (172), Iguape cateto (294), Tres marias (484)
II	3,4	2	0	5-15	Aditya, Akashi (452), Annada (443), Heera, Kalyani II, Rasi (438), Vandana
III	4	5-10	5	1-5	Brown gora (392), Black gora (342), Bhattadhan (19), Kalakeri (17), N 22 (4), ARC 11775 (429)

*DLA Diseased Leaf Area ** PBS Panicle Blast Severity

Number in parentheses are HRC numbers.

Insects : Sinha and Prasad (1992) reported variation in susceptibility to termites in 60 genotypes and observed that N 22, Lalnakanda 41, CR 143-2-2 and RR 50-3 were free from termite infestation while the susceptible check IRAT 112 recorded 98 per cent seedling mortality. Variar *et al.* (1993) reported from a study of 35 traditional and improved upland germplasm that tropical upland japonicas (OS 6, Moroberekan, Kinandong Patong, IRAT 112 and IAC 25, IAC 1131 and IAC 1246) were highly susceptible to termite infestation. Fifty gora collections were also field evaluated at BAU, Ranchi for gandhibug and leaf folder incidence.

Efforts have been made to systematically analyse the accessions for quality and multiple resistance which led to the identification of five potential donors for use in the breeding programme (Table 6).

Table 6. Characteristics of multiple disease resistant donors

Donor	BS	ShR	BLB	Height (cm)	50% flw (d)	1000-g.wt (g)	Length (mm)	L:B
42-34 (HRC 702)	1	1	2	111	95	24.5	6.2	2.6
Jhilidhan (HRC 703)	1	2	3	117	97	22.5	6.2	2.7
Chapsair (HRC 712)	2	1	2	114	98	25.5	6.0	2.7
Samunderdhan (NIC 105750)	2	2	3	114	103	30.0	5.9	2.3
Chandrakanati (NIC 105751)	2	1	2	118	96	30.0	6.4	2.7

UTILIZATION

Several of the landraces and traditional cultivars have been utilized in the varietal improvement programme at CRURRS, Hazaribag and BAU, Ranchi. Of the seventeen traditional cultivars used in the development of 303 crosses at CRURRS, the most frequently used were N 22 (13 crosses), Kalakeri (12 crosses), Lalnakanda 41 (11 crosses) and Black gora (10 crosses). In many other crosses their derivatives were used. At BAU the gora rices have been extensively used. Seven varieties have been released till date for rainfed upland and medium lands and several elite breeding lines are at various stages of testing under Directorate of Rice Research, Hyderabad (Table 7).

Table 7. Promising breeding lines and varieties evolved utilizing indigenous genetic resources

Variety/ lines	Origin	Parentage	Stature	50% flw (days)	Grain type	Blast (0-9)	Land type
Varieties							
Birsadhan 101	BAU	Fine gora/IET 2832	SD	50	M	3	upland
Birsadhan 102	BAU	Pure line sel. from gora (BR 23-19)	T	60	M	6	upland
Birsadhan 103	BAU	Fine gora/IET 2832	SD	55	M	3	upland
Birsadhan 104	BAU	-do-	SD	55	SB	5	upland
Birsadhan 201	BAU	T (N) 1/Br gora 23-19	SD	80	M	6	med-land
Birsadhan 202	BAU	Jaya/BR 34	T	95	M	5	med-land
Vandana	CRURRS	C 22/kalakeri	T	60	M	5	upland
Elite breeding lines							
BAU 120-19	BAU	N 22/CR 245-1	T	48	M	3	upland
BAU 146-16-3	BAU	Mut. gora/IAC 25	SD	66	LB	3	upland
BAU 148-30	BAU	17 Bala/Bl/gora// OS 6/ch 1039	SD	58	SB	2	upland
BAU 149-2	BAU	16 Bala/Bl.gora// OS 6/Ch 1039	SD	53	SB	0	upland
BAU 149-34	BAU	-do-	SD	65	LS	5	upland
BAU 4045-8	BAU	Fine gora/IET 2832	SD	65	SB	5	upland
RR 151-3	CRURRS	N 22/C 22	T	55	LB	8	upland
RR 174-1	CRURRS	RR 51-1//CR 143-2-2/ Kalakeri	T	59	M	1	upland
RR 203-2	CRURRS	Wh. gora/Kalnga III	T	58	LS	1	upland
RR 203-16	CRURRS	-do-	T	58	LB	1	upland

FUTURE NEEDS

The progress of collection and evaluation is rather slow and only a modest collection from the limited geographic area could be made. Collection trips were restricted to easily accessible areas, while a large reservoir of wild types are fast depleting in the remote localities. The major thrust of collections was on medium and lowland ecologies comprising mostly late maturing types while early maturing upland types are yet to be collected from vast unexplored area. Therefore, there is need for intensification of the efforts.

Coordination and collaboration among the three centres should be strengthened. A time bound, detailed plan of the area to be explored coinciding with different maturity periods of the rice crop should be drawn and the progress should be reviewed regularly. The existing and new collections should be assigned a common accession number for database development.

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DIVERSITY OF CUCUMBER AND MELONS FROM RAJASTHAN

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An exploration was undertaken in south-west, west, south-east and central parts of Rajasthan and wide range of variability was observed/collected particularly in cucumber, snapmelon, *Kachri* and snake cucumber. A total of 399 collections were made. Jodhpur, Nagaur and Bikaner areas were veritable 'goldmine' of snapmelons. The germplasm were highly variable for fruit characters and widely distributed (including in the sand-dunes habitats). *Kachri* (*Cucumis collosus*) melons were uniformly distributed throughout Rajasthan. Locally adapted landraces in Cucumber (Sawanariya, Balamkakdi) had more variation in Sirohi (Abu) and Shekhavati areas for fruit shape, fruit skin colour, fruit skin mottling, colour of stripes, fruit skin glossiness, fruit length/width, weight and stem-end/blossom-end fruit shape, flesh texture and flesh colour.

Key words : Cucumber, melons, diversity, exploration/collection

Out of 6 species of *Cucumis* in India, *Cucumis sativus* and *C. melo* are widely cultivated. Cytological studies revealed that the species under this genus belongs to two distinct geographically isolated groups i.e., Asiatic and African group. Species bearing chromosome number $2n = 14$ are all of Himalayan origin while species of $2n = 24$ are basically originated from tropical and south Africa. Therefore it is presumed that Cucumber (*Cucumis sativus*) is thought to have originated in India where its wild relative (*C. hardwickii*) of chromosome number $2n = 14$ are presently found. The species being cultivated since 3000 years (de Condolle, 1982) all over India, has two forms - creeping one, cultivated in the field during hot season and climbing form, cultivated during rainy season. Morphologically they differ in fruit size. The closely related wild species *C. hystrix* Chakr. also grown wild in Meghalaya state (of India) which may however be a weedy form of a cultigen. This can be a valuable material for breeding purpose with the cultivated cucumber, since they are well adapted to wild habitat at 900-1500 m altitude and resistant to several diseases/pests. Wild related types of *C. sativus* exhibit diversity in the Himalayas in *C. hardwickii* and *C. trigonus*. *C. hardwickii* - small bitter cucumber with sparse and stiff spines has been found wild in the foothills

of Himalayas. Many landraces were under-represented in the national germplasm collection to reasonably match the potential genetic diversity available and hence, an exploration mission (October-November 1992) was organised to collect and conserve the available diversity in cucumber and melons from Rajasthan (India) before their possible erosion due to several factors including destruction of habitat. A total of 399 collections were made (Table 1) and rich diversity in cucumber, melons (*Cucumis melo* var. *momordica* and *C. callosus*) were sampled from Rajasthan.

Table 1. Diversity collected in *Cucumis* species and other crops

Crops	Botanical Name	No. of germplasm collected
Cucumber	<i>Cucumis sativus</i>	110
Snapmelon	<i>Cucumis melo</i> var. <i>momordica</i>	194
Muskmelon	<i>Cucumis melo</i>	04
Snake cucumber	<i>C. melo</i> var. <i>utilissimus</i>	08
Kachri	<i>Cucumis callosus</i>	83
Total germplasm collected		: 399

PHYSIOGRAPHY AND AGRO-CLIMATE

In Rajasthan (69° 10'- 78° 10'E and 23° 5'- 30°N), in the southern half, mostly hard rocks are found. The alluvium as well as the blown-sand-covered regions support potable aquifers. The fluctuations in water level are less in northern than the southern part. In south-eastern region, the water table is generally within 15m of depth but in north-western part, it is deeper (30-100m). The rainfall pattern is highly influenced by timing, duration and intensity of north-east and south-east monsoons and the topographic and geographic features. The predominantly dry conditions and extremes of other climatic components that characterize these regions support a poor flora.

GERMPLASM COLLECTION

North-western (Jodhpur, Pali, Nagaur, Bikaner and Sriganganagar districts), eastern/central (Sikar Jaipur and Tonk districts), south east (Bhilwara and Chittaurgarh) and south-western (Udaipur, Sirohi and Jalor districts) of Rajasthan, India were surveyed for collection of cucumber and melons germplasm. A total of 399 collections were made from 72 sites Table 1. Due to paucity of time, some of the areas could not be covered. However, it was possible to move across from north to south covering east and west along plain and mountainous areas. The collection route map (Fig. 1) indicates the areas followed during the trip and the concentrations of available germplasm espe-

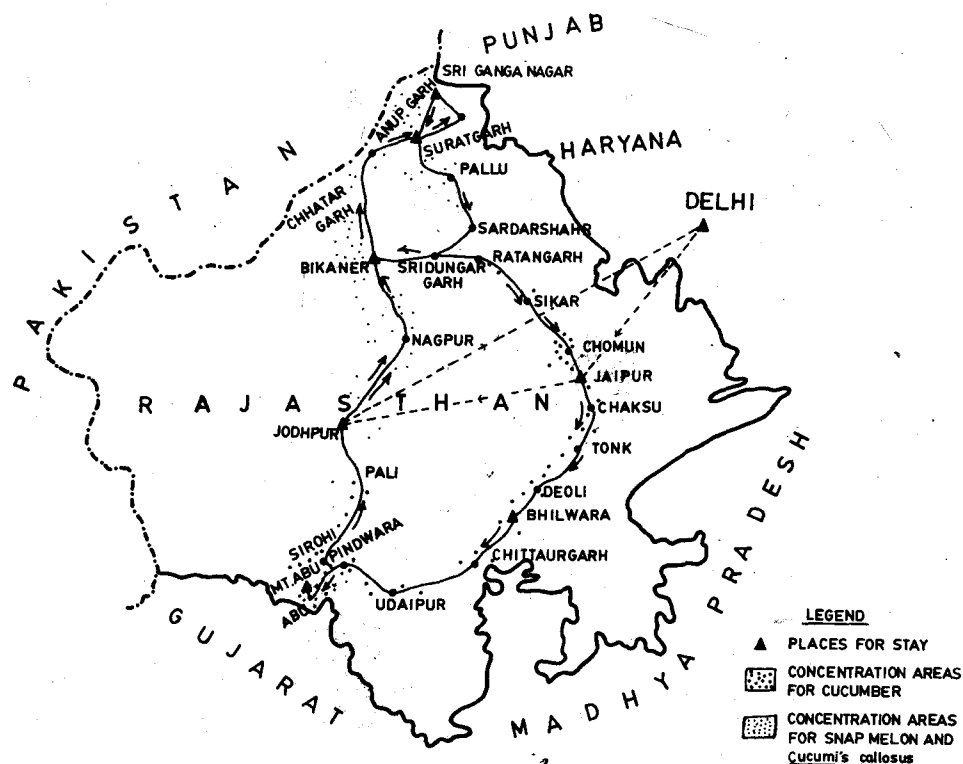


Fig. 1. Exploration route map for collection of cucumber and melon germplasm from parts of Rajasthan

cially for locally adapted landraces in cucumber, snapmelon and *Cucumis callosus*. The sites were selected at every 15-20 km. based on the availability of the target species in the pockets specified and other areas, preferably with some fallow land, cultivated lands/abandoned land/edges of agricultural fields/protected/disturbed areas. The sampling sites were selected in different climatic zones so as to collect large range of variation, Population samples were taken and passport data recorded. Some morphological and other important data on fruit characters were also recorded. Ripe seed were extracted from 4-5 fruits in each accession. Herbarium specimens were prepared for some samples collected.

EXTENT OF DIVERSITY COLLECTED

The arid region of Rajasthan is endowed with rich genetic diversity in snapmelon and *Cucumis callosus*. The landrace variability is of considerable

interest, as it is atuned to dry conditions and adapted under agro-ecological niches with acute water stresses. The extreme dry climate is characterized by high solar radiation, seasonally and diurnally fluctuating temperatures and erratic low annual rainfall which varies from year to year without following any trend. The desert is characterised by wind blown sand dunes of various types besides the occurrence of saline and sporadic aquatic habitats. Melons (Snapmelon) and *Cucumis callosus* have tremendous diversity. Mostly monoecious types were observed in snapmelon. The germplasm varied in plant growth habit (bushy/intermediate/prostrate type), in ovary pubescence (short/intermediate/long), fruit shape (globular/oblate/elliptical/ovate/elongated), fruit ribs (generally absent but occasionally superficial to deep ridging), fruit skin colour (green, whitish yellow, yellow, orange, brown and grey), secondary fruit skin colour (yellow, orange, green and pink occasionally), fruit skin texture (smooth/grainy/with spines/with warts), in design produced by secondary colour (speckled/spotted/striped/streaked), in blossom scar-generally obscure but occasionally conspicuous, fruit length (2.5 - 34.0 cm.), fruit width (2.5-13.0 cm.), fruit weight (6.8-149.2g) and in flesh colour (white, yellow, orange), flesh texture (smooth/grainy type) and seed coat colour generally white but occasionally brown in colour.

Cucumber germplasm has concentration in south-west, south east and central part of Rajasthan. Locally adapted landraces 'Sawanariya' from Sikar, Laxmangarh, Shekhawati areas and Chomun areas of Jaipur (from Purohit ki Dhandi, Nauri ki Dhandi villages) and "Balamkakdi" from Tonk, Deoli, Kir ka Kheda (Chittaurharh district), Abu Road, Mungthala, Phongur, Ghorla, Sanar, Kui, Khejra, Uplagarh, Amba, Sagna, Dotara etc. (Sirohi district) have been collected. Amazing diversity in fruit (shape, size and colour) were observed. Germplasm collected varied in plant habit (bushy to prostrate), in sex type (monoecious generally to gynomonoecious/andromonoecious), fruit shape (elliptical, elongated/oblong/globular/stem- end tapered/blossom- end tapered), fruit skin colour, (yellowish white/light green/medium green/dark green/yellow with uneven colour dark green colour at stem-end portion and light green with whitish splashes on other parts of the fruit), fruit skin mottling (generally absent), colour of stripes (absent/white/green/yellow), in fruit skin glossyness (dull/glossy), fruit length (15-46.2 cm), fruit width (7.2 cm. - 30.0 cm.), fruit weight (110-4900 g), in stem- end fruit shape/blossom- end fruit shape (depressed/flattened/rounded/pointed), flesh texture (smooth/grainy/soft), flesh colour (white/greenish white/green) and in seed coat colour (white/tan/yellow).

Since aim of the collection mission was to collect several landraces in cucumber and melons specifically, it is highly likely that the variability collected in these two crops from sites differing in pH, altitude, rainfall type, and vegetation components, would provide a basis to determine the ecologically

and geographically related genetic variability when these collections are evaluated morphologically, chemically and on molecular marker basis. It is hoped that some of these collections would be of use as straight introductions or as parents in the hybridization programme.

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DIVERSITY IN MARVEL GRASS GERMPLASM

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A wide diversity in 91 collections of Marvel grass (*Dichanthium annulatum*) from gangetic plains of Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka and Andhra Pradesh was assessed for their habit, forage yield and regrowth potential. The forage yield was higher in accessions from gangetic plains of Uttar Pradesh. The winter regrowth potential in accessions from Maharashtra, Karnataka and Andhra Pradesh was higher, while the North Indian accessions proved better in their regrowth during summer. Tiller dynamics played an important role in grouping accessions for high forage yield and classifying them for their suitability and adaptability to varying agroclimatic regions. The extent of variability for morphological characters viz., tiller height, leaf length, leaf width, circumference and tussock weight was considerable for utilization of these accessions in breeding programme.

Key words : Marvel grass, *Dichanthium annulatum*, germplasm, diversity

Marvel grass (*Dichanthium annulatum* L. (Stapf) is the most prominent native grass species forming an important component of one of the largest grass covers *Sehima-Dichanthium* of India. It is also fairly distributed in almost all other grass covers of the country. (Dabadghao and Shankarnarayan, 1973). It shows ecological plasticity to the extent that its distribution ranges from peninsular region upto Northern plains, inclusive of Gujarat, Haryana, Punjab and the sub-temperate hills (1500 m above msl) (Arora *et. al.*, 1975; Kanodia, 1987). In the present studies, an attempt has been made to document the diversity in habit, forage yield, regrowth potential and tiller dynamics of the germplasm collected from different parts of the country.

MATERIALS AND METHODS

Ninety one collections from a range of sites and ecological situations of gangetic plains of Uttar Pradesh, Madhya Pradesh, Maharashtra, Karnataka and Andhra Pradesh, were raised in nursery in 1989 and later transplanted in to the field of sandy loam (*Rakar*) soil at C.R. Farm, Jhansi (latitude 25° 27'N, longitude 78° 25'E, normal rainfall 958 mm). For single plant evaluation, five plants of each collection from different locations were planted in each plot of 5m × 6m where row to row and plant to plant distance was 70 cm.

All the plots were under rainfed conditions and no fertilizer or irrigation was applied, except one irrigation during establishment phase. The data recorded for the habit, forage yield during monsoon season and regrowth harvest during winter and summer, were documented in accordance to the forage grass descriptors (Tyler *et al.*, 1985). Seven harvests made over a period of two years were one each during monsoon, winter and summer (October, January and April respectively) every year and one additional harvest of summer early monsoon growth during second year. The extent of variability in other growth characters. i.e. tiller weight, leaf length, leaf width, tussock circumference were also recorded. The tillering capacity and number of tillers per kg harvest of green fodder of monsoon, winter and summer seasons formed the basis of tiller dynamics for classifying the accessions for their suitability and adaptability to varying agroclimatic regions.

RESULTS AND DISCUSSION

Marvel grass exhibited wide diversity in habit of the species - erect, semi erect and prostrate type. All the forms are represented by collections of different regions/states of the country, however erect forms were more frequent in south Indian accessions (Table 1). The varying habit of this species adapted

Table 1 : Statewise diversity in habit of *D. annulatum* accessions

State/No. of accessions	Erect	Semi-erect	Prostrate	Total
U.P.	02	05	04	11
M.P.	00	04	16	20
Maharashtra	02	02	00	04
Karnataka	02	06	02	10
A.P.	25	12	09	46
Total	29	24	38	91

to different ecological situations provides reason for its wide distribution in most of the grass covers of the country (Dabadghao and Shankarnarayan, 1973; Skerman and Riveros, 1990). The green forage yield of accessions from gangetic plains of Uttar Pradesh was highest after seven cuts over a period of two years (Table 2). This showed that accessions from northern plains are more productive in comparison to those from southern states. This may be attributed to the isoclimatic environment of evaluation and region of collection of the accessions. The winter regrowth after two cut harvest provided higher forage yield in accessions from Maharashtra, Karnataka and Andhra Pradesh, while the north Indian accessions proved better in their regrowth irrespective of the site and location of collection and gave highest green forage yield. The

lowering temperature during winter season caused growth inhibition, while rising temperature of summer favoured regeneration growth of northern

Table 2 : Green forage yield and regrowth potential in 91 accessions of *D. annulatum*

State	Green forage yield (kg/tussock)-period 2 years				
	Yield 1st cut	Total yield 7 cuts	Monsoon regrowth 3 cuts	Winter regrowth 2 cuts	Summer regrowth 2 cuts
U.P.	1.94	4.85	3.15	0.73	0.93
M.P.	1.47	3.67	2.38	0.56	0.73
Maharashtra	1.54	3.85	2.50	0.71	0.64
Karnataka	1.33	3.32	2.15	0.66	0.51
Andhra Pradesh	1.37	3.42	2.22	0.68	0.52

accessions. Conversely, the south Indian accessions remained productive in winter also. A wide range of variation in other growth parameters was found amongst accessions for tiller height, leaf length, leaf width, tussock circumference and tiller weight, which was documented in Table 3 for the utilization of accessions in breeding programme.

Table 3 : Range of variability in growth characters of *D. annulatum* (91 accessions)

Character	Range			
	1	2	3	4
Tiller height (cm)	78.0-120.0 (36)	120.1-160.0 (29)	160.1-200.0 (14)	200.1-245.5 (12)
Leaf length (cm)	8.7-25.0 (26)	25.1-40.0 (24)	40.1-55.0 (28)	55.1-67.5 (13)
Leaf width (cm)	0.3-0.5 (11)	0.6-0.7 (29)	0.8-0.9 (26)	1.0-1.1 (25)
Tussock circumference (cm)	30.25-42.0 (47)	42.1-54.0 (20)	54.1-66.0 (14)	66.1-83.2 (10)
Tiller weight (g)	0.30-0.60 (24)	0.61-0.90 (18)	0.91-1.20 (26)	1.21-1.56 (23)

Figures in parenthesis indicate number of accessions

There was considerable variation in tiller number per plant in different seasons ranging from 101-205 in monsoon through 265-576 in winter to 287-377

in summer. In general tiller number increased in winter from monsoon season of the establishment year and decreased sharply in summer of subsequent year. But this trend was more conspicuous in accessions from southern India. However the increase in number of tiller was reported throughout the year by Chatterjee and Singh (1968). The tillering capacity was higher in accessions exhibited both winter and summer regrowth after monsoon harvest. The tillering behaviour, therefore, was an important attribute determining the ecotypic development of the species. This was in confirmation of the reports on *Panicum* and *Heteropogon* by Richards *et al.*, 1986.

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EXPLOITATION OF AROMATIC RICE GERMPLASM FOR YIELD AND QUALITY*

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One hundred and twenty genotypes of aromatic rice collected from diverse geographical sources were evaluated in replicated plots under transplanted conditions during *Kharif* 1990 for agronomic and quality traits. Most of the aromatic rices originating in the Indian sub-continent were good donors for quality components but poor agronomic types. On the other hand, collections from Philippines, China, Indonesia and Thailand were good donors for agronomic traits. Few donors for biotic stresses were also identified. The promising donors are being exploited in basmati breeding programmes.

Key words : *Oryza* species, aromatic rice, germplasm, yield, quality

A large number of aromatic rice varieties are grown and consumed in many countries of south-east Asia. The cultivation of these varieties is limited to specific pockets depending upon the climatic conditions and requirements of the local consumers. Being agronomically poor and susceptible to various biotic stresses, these have remained unexploited in the breeding programmes. With increasing emphasis on quality improvement of high yielding rice varieties, the exploitation of this group of rices has become essential. The present study, therefore was undertaken to assess the variability present in some of the indigenous and exotic aromatic rice germplasm collections for possible utilization as donors.

MATERIALS AND METHODS

The experimental material comprising 120 genotypes of aromatic rice collected from diverse geographical sources (Bangladesh-2; China-5; India-33; Indonesia-4; Iran-2; IRRI-14; Myanmar-2; Nepal-1; Pakistan-46; Philippines-8; Thailand-1 and Vietnam-2) were grown in a randomized complete block design in two replications during *kharif* 1990 at the Crop Research Centre, G.B. Pant

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University of Agriculture & Technology, Pantnagar under irrigated conditions in two row plots of 3 m length. Row to row distance was kept at 25 cm, while plants in a row were spaced at 15 cm apart. One month old seedlings were transplanted in well puddled field @ one seedling per hill. The crop was grown under good management conditions and all the recommended package of practices for basmati group of varieties were followed. Data were recorded on five randomly selected plants in each replication to study days to 50 per cent flowering, plant height (cm), number of effective tillers per plant, panicle length (cm), number of grains per panicle, spikelet fertility (%), panicle exertion (scored on 1-9 scale), 1000-grain weight (g) and grain yield per plant (g).

For the study of quality components, the grain samples were dried to a moisture level ranging between 12-14 per cent and observations were recorded on hulling recovery (%), milling recovery (%), kernel L/B ratio, chalkiness of endosperm (scored on 0-9 scale), amylose content (%), alkali digestion value (scored on 1-7 scale), water uptake number, volume expansion gel consistency and presence of aroma (scored on 0-3 scale) as per the Standard Evaluation System for Rice (IRRI, 1988). The standard statistical methods were used to estimate various parameters.

RESULTS AND DISCUSSION

The analysis of variance of means for different characters showed highly significant differences among genotypes. The range of treatment means presented in Table 1 alongwith the general mean for various agronomic traits gives an idea of the extent of variability present in the germplasm. A wide range of variability was observed for flowering duration. The germplasm included a mutant line of basmati 370 which flowered in 92 days and some photosensitive landraces which took as long as 157 days to flower. The plant height ranged from 74.4 cm to 176.0 cm and most of the lines were tall as evidenced by the general population mean of 132.7 cm. Dwarf and early cultures possessing basmati grain do not exist in the germplasm. Number of tillers per plant ranged from 3.2 to 17.5. However, majority of the cultures screened were low tillering type and very few could be exploited in breeding programmes aimed at increasing tiller number. The spikelet fertility ranged from 18.3 per cent to 97.0 per cent with a general mean of 81.0 per cent while the number of filled grains per panicle ranged from 20.0 to 165.0 with a general mean of 105.2. Delayed flowering exposed the crop to lower atmospheric temperatures and was mainly responsible for reduced fertility of the spikelets. Decrease in fertility percentage with increasing length of cooling treatment has been reported by Satake and Koike (1983). Panicle length in the germplasm ranged from 20.6 cm to 39.6 cm and there were many genotypes which possessed significantly longer panicles than Basmati 370 and T3 (Table 1). In general, short panicles

showed poor panicle exertion. However, some genotypes like Basmati 136, Basmati 6113, Basmati 436 and Basmati 6129 showed poor exertion inspite of long panicles. The magnitude

Table 1. Range, mean and promising cultures for agronomic traits

Character	Range	Mean	Promising cultures
Days to 50% flowering	92.0-157.5	114.9	Basmati 208, Basmati 334, Ayepyaung, Dwarf Basmati, Mussatrene
Plant height (cm)	74.4 - 176.1	132.7	Guinata, Kinandang Pula, Kalimunchh Mutant, Kunsan-Woo-Shah-Gon, Balugyun, Macunting, Dwarf Basmati
Number of tillers/plant	3.2-17.5	8.3	Basmati 370, Sitasail, Basmati 208, Basmati 372, Basmati 376, Basmati, Surkh 81-15, Mikhudeb, Ayepyaung, Sipala, New Sabarmati, Kasturi, Dwarf Basmati
Panicle length (cm)	20.6 - 39.4	30.1	Basmati 122, Basmati 372, Basmati 410, Basmati 6113, Pageleoh, N-12, Type 3
Number of filled grains/ panicle	20.0 - 265.0	105.2	Kinandang Pula, Basmati 123, Basmati 376, Lakchhmivilas, Badshahbhog
Spikelet fertility (%)	18.3 - 97.0	81.0	Kinandang Pula, Dinorado, Palawan, Yi-Lu-Hsiang
Panicle exertion score (1-9 scale)	1.0-8.0	3.7	Basmati 370, Type 3, Sitasail, Basmati 123, Basmati 138, Basmati 372, Basmati 376, Basmati 613
1000-grain weight (g)	8.3-31.6	19.8	Kinandang patong, Milfor 6-2, Tarome, Cembocelak, New Sabarmati, Palawan, Ku 76-1
Grain yield/ plant (g)	2.7-59.9	16.8	Bindli, Sitasail, Basmati 123, Basmati 376, Yi-Lu-Hsiang, New Sabarmati

of variability was very high in case of grain yield per plant as indicated by the range (2.7- 59.9 g). The highest yielding genotype Basmati 376 produced as many as 17.5 productive tillers per plant and longer (35.6 cm) panicles. Its spikelet fertility (84.1%) was better than the spikelet fertility of Basmati 370 (73.5%), T3 (79.7%) and Pusa Basmati 1 (80.7%) and 1000 grain weight *at par* with Basmati 370. The main defect of this genotype was tallness which made it prone to lodging.

The range of treatment means and the promising cultures for different quality traits are given in Table 2. Perusal of this table shows that hulling

Table 2. Range, mean and promising cultures for quality traits

Character	Range	Mean	Promising cultures
Hulling recovery (%)	65.4-81.8	76.0	Yi-Lu-Hsiang, Kinandang Pula, Samudrawati, Bong Cay, Multani
Milling recovery (%)	63.3-78.9	72.5	Bong Cay, Samudrawati, Kala Joha, New Sabarmati
Kernel length/breadth ratio	2.02-4.6	3.5	Multani, Basmati 370, Karnal Local, Basmati 5854, Basmati 6131, Basmati 5888, Basmati Naham 381
Chalkiness of endosperm (score 0-9 scale)	0.00-9.0	3.5	Kasturi, Pusa Basmati 1
Amylose content (%)	6.8-35.9	22.1	Kasturi, T3, Basmati 370, Basmati 107, Basmati 113, Basmati 122, Basmati 375A, Basmati 405
Alkali digestion value (score : 1-7 scale)	1.1-6.0	3.6	Basmati 5853, Bong Cay, Balugyun, Sipala, Basmati 122, Basmati 6311, Basmati 136
Water uptake number	110.0-442.5	255.6	Azucena, Kinandang Pula, Basmati 6316, Kunsan-Woo-Shah-Gon, Basmati 5854, Basmati 375
Volume expansion	2.2-6.4	4.0	Kinandang Pula, Basmati 370, Kunsan-Woo-Shah-Gon, Azucena, N12, Dwarf basmati
Gel consistency	26.5-100.0	56.5	Azucena, Basmati 334, Basmati C 622, Basmati 5853, Basmati 6311, Kasturi, Basmati Naham 381
Aroma (score: 0-3 scale)	0.0-3.0	1.5	Milfor 6-2, Basmati 93A, Basmati 123, Basmati 5853, Basmati Surkh 81-15, Xiang-Geng-Dao

and milling recovery showed a wide range of variation in the germplasm evaluated. Though, these traits are highly influenced by the weather conditions during grain formation, moisture content at the time of hulling, the method of drying and miller used (Govindaswami and Ghosh, 1968), there were many genotypes in the germplasm which gave significantly higher milling out-turn than Basmati 370 and T3. Kernel length/breadth (L/B) ratio is one of the important parameters deciding shape of the kernel, but majority of the lines contained less than 20% opaque areas. A few genotypes also possessed clear

endosperm free from opaque areas and could be used as donors. Majority of the cultures had intermediate amylose a desirable trait for basmati rices. The gelatinization temperature, water uptake number and volume expansion are important parameters of rice cooking quality. All the three traits showed wide range of variation and promising donors are listed in Table 2. High natural variation for volume expansion has also been reported by Sood and Siddiq (1980). The variation for gel consistency was quite high and varieties with hard (< 40 mm), medium (41-61 mm) and soft (> 61 m) gel were observed. The characteristics of cooked rices are frequently assessed with the presence of aroma. With few exceptions, majority of the germplasm evaluated was aromatic.

The evaluation of the germplasm indicated presence of high natural variability for different agronomic traits and quality components and some of the identified donors are already being exploited in the basmati breeding programme at Pantnagar.

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SCREENING OF RICE GERMPLASM FOR HIGHER YIELDS AND PEST RESISTANCE

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The Andaman and Nicobar group of Islands (4 to 6°N lat. and 92 to 94°E long.) with about 3000 mm rainfall has typical hot and humid climate favourable for growing rice as well as pests multiplication. Rice is grown in about 12,000 ha. With an average yield of 2 t/ha, probably the low yield is due to the age old practice of growing long duration varieties coupled with pest incidence. It is estimated that by 2000 AD, the requirement of rice will be 69,000 tonnes for an expected population of 4.5 lakhs. This target has to be achieved in rice cultivable area with the high yielding short duration and pest resistant varieties. This paper gives details on the evaluation studies carried out. 1817 cultures were screened in a phased manner from 1984 to 1992-93 procured from different agroclimatic zones. Twenty four high yielding accessions with resistant to sheath blight, and blast and bacterial blight, were isolated. Accessions with resistance to the specific diseases were also identified.

Key words : Rice, germplasm, yield, pest resistance

The Andaman and Nicobar groups of islands in addition to its natural beauty have strategic importance for the nation. It lies in the Bay of Bengal between 4-6°N latitude and 92 to 94°E longitude. It has true maritime climate with least variation in maximum and minimum temperature throughout the year (Fig-1) The agricultural history starts in these Island around 1790, however, major agricultural activity started with the arrival of Lord Mayo in 1870. Till 1931, only about 18,000 hectare of land was cleared of the forest. Major clearing of land was taken up during post independence period for settlement of refugees from East Pakistan, repatriates from Sri Lanka and Myanmar. With these people, their staple food rice must have arrived and cultivation started. During 1942-44 when these Islands were under Japanese occupation, some rice varieties from lower Myanmar have also been introduced. The Karan tribes of Burmese origin brought some traditional varieties of Rice like Pe-Wah, Pe -tha etc. Out of 40,000 ha cultivable, land the rice occupies an area of 12000 ha and cultivated in different environments like upland, lowlands, saline and sandy soil conditions as rainfed. Though the Islands average rainfall is 3000 mm per year spread over in a period of 6-8 months the average yield

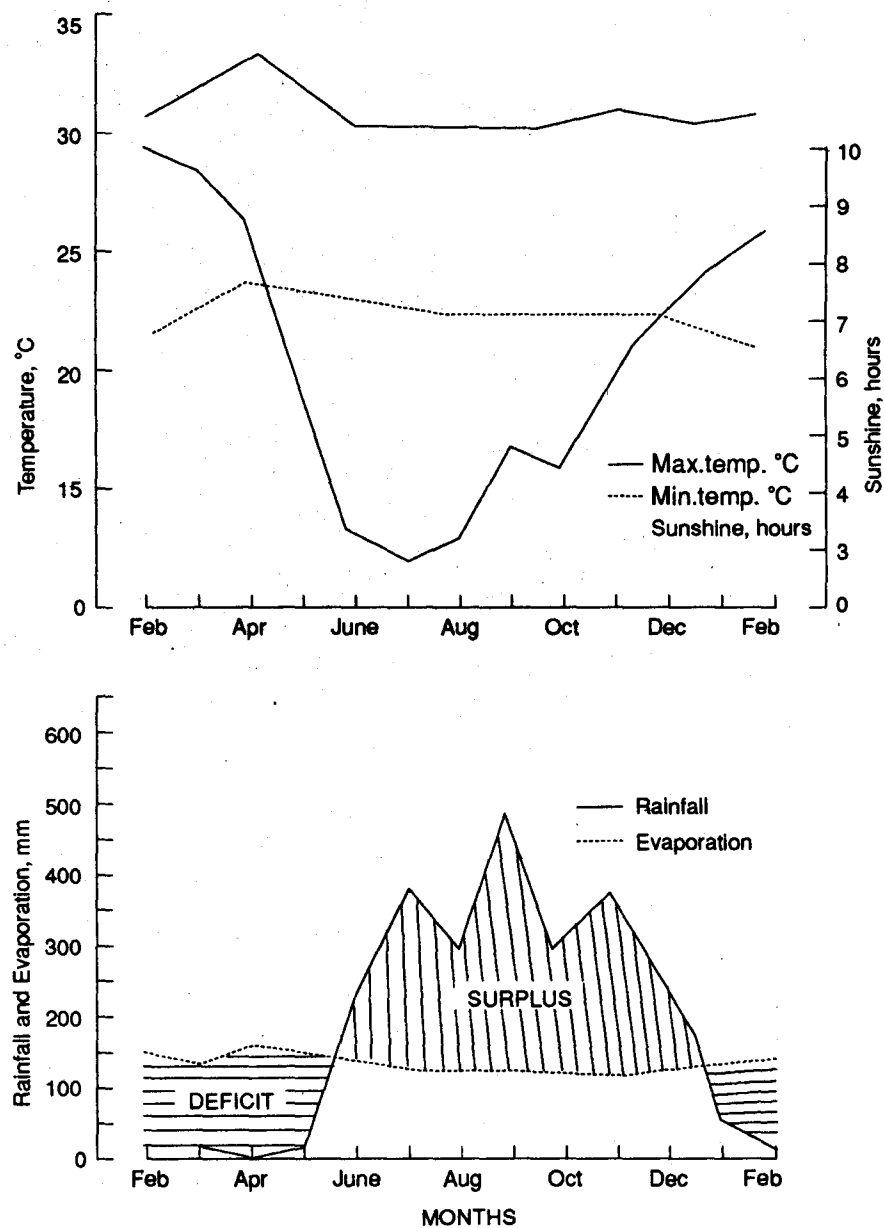


Fig. 1. Rainfall, O.P. evaporation, temperature and sunshine hours at Port Blair (average of 3 yrs.)

is 2t/ha with a single crop of rice between June to December. Several constraint are responsible for low production. The most important among them are fragmented holdings, non-availability of inputs, poor mechanization, poor inherent fertility (Fe-toxicity), weed growth, disease (Blast, sheath blight and bacterial blight) insects (stem borer, gundhi bug) attack. Due to these factors,

double cropping with high yielding varieties are not precipitating to farmers level. To overcome some of these problem and to encourage double cropping, Central Agricultural Research Institute, Port Blair has started screening and breeding rice varieties suitable for these islands.

MATERIALS AND METHODS

Experiment No. 1: Screening of rice germplasm

All the varieties received during that year were grown in R.B.D. in a plot of five lines with 1.5m long. All recommended agronomical practices were followed with a fertilizer dose 90:60:60 N.P.K where N was given in three splits. All biometrical observations and disease score were recorded. Most promising lines with resistance to common major diseases were selected for further trials.

Experiment No. 2: Yield and yield attributes

Most promising lines with initial higher yields and good grain quality in each maturity groups were grown in R.B.D. with the recommended agronomical practices and standard spacing. All other biometrical observation like days to flowering, plant height, panicle length, ear bearing tiller per hill, number of grains per panicle, test weight and yield were recorded. The disease incidence were recorded as per the IRRI standard evaluation system. (IRRI, 1980).

Experiment No. 3: Large scale yield trial

The five best performers have been selected for this study. They were grown in plot of 0.3 h at different location (Middle Andaman and South Andaman) in the farmers field under the Lab to Land project and national demonstration programme for yielding ability. All agronomic practices with proper spacings were followed. Data on yield was recommended farmer wise, year wise and mean of these are presented in Table 3. Twenty one day old seedlings were transplanted at 15 × 10 cm spacing for early and 20 × 10 cm for medium and late duration varieties in each experiment. To protect the crop from insect attack the recommended insecticides were used as and when required.

RESULTS AND DISCUSSIONS

Out of 1817 genotypes screened in a split over the years 50 were found resistant to blast, 59 to sheath blight and 41 to bacterial blight. The resistance varied from moderate to high (Table 1). Ansari *et al.* (1985), (1989) found some of these varieties resistant to blast and sheath blight in Andaman conditions under natural field infection. Five genotypes viz C 1136-3, I 18350-

Table 1. Performance of most promising genotypes

Variety/genotype	Duration	Days to 50% flowering	Plant height	Panicle length	Earbering tillers/ hill	No. of grains/ panicle	Test weight	Yield qt/ha	Sheath Blight	Reaction to pest	Blast
Thaaching Sen-yu	Early	76	99.3	24.29	5.69	59.69	23.18	36.03	MS	R	R
BG-1203	"	78	99.4	23.15	6.22	65.96	21.73	51.0	R	MS	R
SP 681032	"	78	104.3	22.64	5.48	64.16	24.00	31.91	R	MS	R
IR31805-20-2-3-1	"	78	103.3	23.63	6.76	58.86	20.47	42.02	R	MS	R
IR33249-47-3-2-2	"	74	96.1	23.17	7.50	57.13	24.01	39.50	R	MS	R
IR SO4044-57-2-2-3	"	74	89.2	22.20	5.38	59.2	24.38	47.13	R	MS	R
IR41996-118-2-1-3	"	73.0	101.0	23.58	6.40	67.43	23.97	40.34	R	MS	R
RP1442-2-2-3-5-1	"	76	90.4	22.78	6.37	40.75	23.95	31.25	R	R	R
BG 7312	"	79	105.7	23.07	5.74	62.53	25.30	45.33	R	MS	R
IR 50404-54-2-2-3	"	74	97.0	24.15	6.00	60.70	23.30	44.90	-	-	-
AT-77-1	"	77	93.9	24.12	5.22	51.70	24.61	48.42	-	-	-
C 1136-3	"	70	95.3	22.30	5.70	60.36	25.53	36.81	R	R	R
IR 318851-6-3-3-2	Medium	88	92.5	24.35	5.73	76.27	25.55	44.2	R	R	R
IR 18350 229-3	"	82	96.2	20.75	5.73	68.70	24.75	42.00	R	R	R

(Contd. on next page)

Sl. No.	Variety/genotype	Duration	Days to 50% flowering	Plant height	Panicle length	Earbering tillers/hill	No. of grains/panicle	Test weight	Yield qt/ha	Sheath Blight	Reaction to pest	Blast
IET 6314 (Manasarover)	"	"	93	115.3	25.40	4.73	-	-	38.80	-	-	-
IET 5656 (Swarnadhan)	"	"	93	104.8	25.73	4.35	-	-	40.20	-	-	-
Arkavati	"	"	90	87.0	24.00	4.73	-	-	44.2	R	R	R
IET 7626	"	"	86	100.0	22.60	5.73	-	-	39.0	-	-	-
IET 8059	"	"	87	95.5	23.50	5.30	-	-	38.1	-	-	-
MW 10	"	"	75	103.53	24.50	6.22	53.30	25.53	57.7	MR	-	MR
IR 22082-91	Late	100	100	80.48	23.52	6.30	55.80	26.38	55.8	MR	R	-
IET 5912	"	100	100	112.90	22.50	11.1	-	-	45.0	NA	NA	R
CR 1009	"	103	103	121.4	23.0	-	112.00	22.60	46.15	-	-	R
IET 8890	"	100	100	110.0	-	-	40.00	-	40.15	-	MS	-

229-3, IR131851-6-3-3-2 and Arkavati were found having multiple resistance character to major diseases (Table 1). The data presented showed that the genotypes varied in different characters. Among the twelve most promising early duration lines the plant height ranges from 89.2 (IR 50404-57-2- 2-3) to 105.7 cm (BG 7312); Panicle length varied from 22.3 cm. (C 1136-3) to 24.3 (Thai ching Sen Yu); Number of grains per panicle was more (67.43) in IR 41996-118-2-1-3 however, the test weight was more in C1136-3, and BG 7312. The genetic variability and yield components in rice has been recorded by many workers (Talwar and Goud, 1974; Raivinaya and Murty, 1979; Sinha and Biswas, 1986; Mohanty *et al.*, 1989).

High disease tolerance to all the three major diseases with moderate yield, were recorded in C 1136-3 and RP 1442-2-2-30501. These two genotypes after further confirmation at farmers field may be used as a 1st crop in disease prone areas, whereas Thaiching Sen Yu which showed resistance to bacterial blight (BB) and blast (B) may be used in the BB and BL affected areas.

Out of eight medium duration genotypes IR 31851-6-3-2, IR 18350- 229-3 and Arkavati had multiple resistance character to the major diseases with an average yield of 42-44 q/ha. First two lines i.e., IR 31851-6-3-3-2 and IR 18350-229-3 has showed the constant and stabilized yield during last five years which confirms the earlier report of Sharma *et al.* (1988). Among the four late duration rice varieties tested, none of them found resistant to the diseases as well as in good yield. However, the var IR 22- 82-91 produced 55.8q/ha yield with bacterial blight resistance.

Table 2. Performance of rice culture/varieties in LLP/NO programmes.

Genotype	Yield quintal/ha	
	1st Crop	IInd crop
Taichung Sen Yu		32.6
IR 18350-229-3	40.6	36.4
IR31851-6-3-3-2.	40.5	38.0
IE-6314	36.0	
IET8656	38.8	

Under the yield trials at farmers field in lab to land programme national demonstration scheme. All the five genotypes showed constant and stabilized yield Genotypes, IR 18350-229-3 and IR 31851-6-3-3-2 were good yielder and produced 40 to 43 q/ha as a first crop and 36 to 38 q/ha as a second crop (Table 3).

Table 3. Genotypes resistant to BLB, sheath blight and blast and their yield

Sl No.	Genotype	duration	Plant Height	Yield
1.	C1136-3	early	104.0	34.40
2.	IR 18350-229-3	medium	96.2	42.00
3.	Arkavati	medium	87.2	44.02
4.	IR31851-6-3-3-2	medium	92.5	44.00

Four genotypes presented in Table 3 have been found to possess the multiple resistance characters against major diseases like BB, BI and sheath blight. The initial yield trial showed that they are the moderate yielders. After testing to a large area under the lab to land or national demonstration it may be useful to be recommended for the areas having severe disease problems.

By using the vars RPI442-2-2-2-3-5-1, C 1136-3, IR31851-6-3-3-2 IR 18350-229-3 and Arkavati, two rice crop can be taken in the island ecosystem and the future projection can be achieved.

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EVALUATION OF *HEVEA* GERMPLASM: OBSERVATIONS ON CERTAIN PROMINANT TRAITS IN A CONSERVATORY

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A study was conducted in a source bush nursery of wild *Hevea* germplasm of 1981 IRRDB exploration during July-August, to identify the genotypes with superior performance. The genotypes represented Acre, Rondonia and Matto Grosso provenances of Brazil. Observations were made on girth, bark thickness, test tap yield, seed weight, length and breadth of the seeds and disease incidence. The general performance of MT genotypes with respect to vigour, yield and tolerance to *Phytophthora* was found to be superior. The genotypes exhibited wide variability for the characters studied. The single seed weight ranged from 1.1 – 3.75g, and the length and width of the seeds ranged from 1.9 – 2.75cm, and 1.3 – 2.03cm respectively. The MT genotypes were found to be late flowering types compared to AC and RO genotypes.

Key words : *Hevea* germplasm, evaluation, elite genotypes

Entire rubber plantations in the East is largely based on a small population of seedlings collected by Wickham in 1876 from Boin near the Tapajos River in Brazil which has resulted in a very narrow genetic base of *Hevea*. Unidirectional selection over the years for yield and the absence of suitable varieties adapted to non-traditional rubber growing areas, have further worsened the situations arising from the threats of disease triangle and physiological disorders like Brown Bast etc. The only solution to overcome this dangerous situation is the conservation and utilization of genopool through collection of wild germplasm. The present study aims at evaluating the wild *Hevea* germplasm for various characters and identifying genotypes with superior performance for further crop improvement programmes.

MATERIALS AND METHODS

A germplasm conservatory comprising of around five hundred wild *Hevea* genotypes of 1981 IRRDB exploration was selected for the study, along with the control RRII 105. This conservatory was planted during 1989 at the Central Experimental Station of the Rubber Research Institute of India, Kottayam with

a spacing of 1 × 1m, and five trees per genotypes representatives of Acre, Rondonia and Matto Grosso provenances of Brazil were selected at the age of 4 years. The observations were made on girth of the plant at 30cm height above bud union (cm), bark thickness (mm) test tap yield (g), seed-weight (g) length (cm) and breadth (cm) and disease incidence during July-August, and the genotypes were compared for their performance.

RESULTS AND DISCUSSIONS

The genotypes exhibited wide variability for the characters studied. (Table 1). Girth of the plants ranged from 21.1 to 30.0cm, test tap yield from 0.19 to 1.604g, bark thickness from 2.7 to 5.5 mm, single seed weight from 1.3 to 2.03 cm. When the mean values were compared with the control RR11 105, the girth of the wild genotypes (26.10 cm) was more than the control (22.5 cm), indicative of the tendency for vigorous growth of the wild genotypes. For the remaining characters except for test tap yield, the performance of wild genotypes was more or less comparable to that of control. Wide variation observed in the germplasm genotypes in growth, vigour, bark structure, juvenile yield and morphological characters were in accordance with the general expectation that wild and primitive forms from the centre of origin exhibit much variability (Annamma *et al.*, 1986).

Table 1. Range of variation among genotypes for the characters studied

Traits	Wild Genotypes		General Mean	Control (RR11 105) Mean
	Maximum	Minimum		
Girth (cm)	30.0 (MT 1714)	21.1 (RO 1454)	26.10	22.5
Test Tap yield (g)	1.604 (MT 1707)	0.19 (RO 1549)	0.891	2.44
Bark thickness (mm)	5.5 (MT 2230)	2.7 (RO 1253)	4.12	5.0
Single seed wt. (g)	3.75 (RO 2013)	1.10 (RO 1542)	2.17	3.71
Seed length (cm)	2.57 (AC 1997)	1.9 (RO 1509)	2.15	2.5
Seed width (cm)	2.03 (AC 2013)	1.3 (RO 1509)	1.60	1.95

A provenance wise comparison of the performance of wild genotypes for the different characters studied is given in Table 2. The genotypes from Matto Grosso provenance were found to be superior for girth of the plant, test tap yield and bark thickness, compared to RO and AC genotypes and this is in conformity with the general observations made by IRCA (Clement-Damange *et al.*, 1990) and Mercy *et al.*, 1992).

Table 2. Comparison of the mean values of the wild genotypes between the three provenances - RO, AC & MT

Traits	Mean values for the three states		
	RO	AC	MT
Girth (cm)	25.68	25.08	25.86
Test tap yield(g)	0.76	0.865	1.06
Bark thickness (mm)	3.67	4.27	4.53
Single seed wt. (g)	2.03	2.66	-
Seed length (cm)	2.12	2.34	-
Seed width (cm)	1.59	1.66	-

*Seeds of MT genotypes were not available

The list of genotypes showed vigorous growth and those which were not affected by *Phytophthora* is given in Table 3. Most of the genotypes represented the provenance Matto Grosso, indicating their inherent tolerance to *Phytophthora*, which can be utilised in a breeding programme to induce disease resistance. When the germplasm genotypes were observed for shoot rot disease by *Phytophthora*, the shoot tips of AC, RO and control RR11 105 exhibited Die back symptoms whereas the shoot type of MT genotypes did not show Die back symptoms, and were noticed to produced new sprouts at the shoot tip soon after the falling off the leaves. The general vigorous nature of the MT genotypes alongwith tolerance to *Phytophthora*, reveals the importance of this group of germplasm materials in the crop improvement programme.

Table 3. Genotypes with vigorous growth and not affected by *Phytophthora*

MT 1630	MT 1642	MT 1589	MT 1685	MT 1710	MT 1674
MT 1659	MT 1701	MT 1629	MT 1650	MT 1639	MT 1599
MT 2292	MT 1686	MT 1656	MT 1697	MT 1689	MT 1638
MT 1627	MT 1665	MT 1657	MT 1623	AC 1960	MT 1704
MT 1678	MT 1687	MT 1693	MT 1642	MT 1649	MT 1631
RO 1556	MT 1579	MT 1675	MT 1680	MT 1663	MT 1633
MT 1688	MT 1640	MT 1668	MT 1644		

When an observation was made of the occurrence of severe shoot rot (Table 4), most of the genotypes represented RO provenance indicating their poor tolerance to shoot rot. Other diseases noted in the conservatory were powdery mildew and pink disease (Table 5) and MT 2594 was severely affected

by powdery mildew and certain RO genotypes and AC genotypes were affected by pink disease.

Table 4. Genotypes affected by severe shoot rot

RO 1514	RO 1528	RO 1345	RO 1232	RO 1238
RO 1309	RO 1234	RO 1353	RO 1262	RO 1308
RO 1304	RO 1331	AC 1958	AC 1987	RO 1758
RO 2344	RO 1250	RO 1323	RO 1292	RO 1241
RO 2249	RO 1229	RO 1533	RO 2484	RO 1462
RO 2102	RO 1526	AC 1884	AC 3501	RO 1359
AC 1867	AC 1810	AC 2007	AC 1958	AC 1987
RO 1758	RO 2344	RO 3459		

Table 5. Genotypes affected by other diseases

Genotypes	Disease
MT 2954	Severe powdery mildew
RO 1558	Powdery mildew
RO 1454	Pink
RO 1334	Pink
RO 1260	Pink
RO 1341	Pink
AC 2028	Pink
AC 1961	Pink
AC 1901	Pink
AC 2456	Pink
AC 2342	Pink
AC 2439	Pink

Other general observations made in the conservatory:

Leaves: The genotypes exhibited wide variations in size, shape and orientation of the leaves.

Seed: There was clear difference in the colour, shape and mottling pattern of the seeds among the provenances AC & RO. The MT genotypes had not produced any seeds, indicating that they were late flowering types. The study reveals that, there exists wide variability among the genotypes which shows the possibility of broadening the genetic base of the cultivated rubber. The

superiority of MT genotypes for vigour, yield and tolerance to *Phytophthora* ranks it first for the inclusion in future breeding programmes of *Hevea*.

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VARIATION IN BLACKGRAM (*VIGNA MUNGO* (L.) HEPPER) X GREEN GRAM (*VIGNA RADIATA* (L.) WILCZEK) DERIVED GENEPOOL

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Thirty-two elite true-breeding lines of a black gram (HPU 27) × green gram (PIMS 3) cross alongwith checks were evaluated in a randomized block design to study the nature of variation with respect to seed yield and 14 other traits. Analysis of variance revealed significant genotypic Differences for all the traits. Phenotypic and genotypic coefficients of variation were high for seed yield/plant, biological yield/plant, clusters/plant, pods/plant, 100-seed weight, seed crushing hardness and per cent sulphur. Heritability estimates were high (>50%) for 100-seed weight, protein content, pod length seeds/pod and seed crushing hardness. The recombinant derivatives, MM 14, MM 24, MM 30 and MM 31 surpassed the parent(s) for seed yield and some of the other traits studied.

Key words : *Vigna* sp., urid bean, mung bean, hybridization, analysis of variance,

Blackgram (*Vigna mungo* (L.) Hepper) and greengram (*Vigna radiata* (L.) Wilczek) are the most important protein rich pulses of the *Vigna* group. These highly prized pulses are extensively cultivated in the tropical countries of the world. Generally, intervarietal hybridization has been used for the improvement of these pulses. However, interspecific hybridization will generate additional variability and extend the scope of combining desirable traits of blackgram and greengram (Verma and Singh, 1986). Black gram is known for its good pod bearing habit and resistance to pod shattering, and synchronous maturity; whereas green gram has higher number of seeds per pod and better seed quality. The desirable attributes of these two pulses can be combined in true-breeding genotypes following their interspecific hybridization. Such a hybridization might also lead to agronomically desirable recombinants due to intergenomic interactions. Although, attempts have been made to evolve interspecific cross derivatives using greengram as female, information is wanting regarding the potentiality of such derivatives using blackgram as the female parent. Therefore, in the present study attempt has been made to evaluate some of the true-breeding lines derived from a cross between blackgram 'HPU

27' and green gram 'PIMS 3' with respect to the nature of variation for seed yield and other traits.

MATERIALS AND METHODS

Thirty-two elite true-breeding lines of a blackgram (HPU 27) × green gram (PIMS 3) cross along with parents and PDU 1 (blackgram) were raised in a randomised block design with 3 replications during 1989 summer at Palampur, situated at 32°6'N, 76°3'E and 1,280 m above msl. Each entry was raised in a single row plot of 1.5m length with row-to-row and plant-to-plant spacings of 30 and 10 cm, respectively. Five random plants per replication were taken to record observations on seed yield per plant (g), biological yield per plant (g), harvest index (%), clusters per plant, pods per plant, pod length (cm), seeds per pod, plant height (cm), 100-seed weight (g) and seed crushing hardness. Data on days to 50 per cent flowering and to complete maturity were recorded on plot basis. Per cent protein, sulphur and phosphorus content in the seeds were determined following the procedures of Mukerhie and Wallaco (1964), Chesnin and Yein (1950) and Jackson (1967), respectively. Phenotypic, genotypic and environmental coefficients of variation were worked out following Burton and Devane (1953), whereas heritability (broad sense) and genetic advance were computed following Johnson *et al.* (1955).

RESULTS AND DISCUSSION

Analysis of variance revealed the existence of sufficient genetic variability among the derivatives under study for seed yield and 14 other traits. A perusal of the nature of variability revealed that coefficient of variation at the phenotypic level was the highest for seed yield, followed by pods per plant, 100-seed weight, clusters per plant, per cent sulphur and biological yield (Table 1). Coefficient of variation at the genotypic level was the highest for 100-seed weight, clusters per plant, percent sulphur and biological yield (Table 1). Coefficient of variation at the genotypic level was the highest for 100-seed weight, followed by seed yield per plant, seed crushing hardness, clusters per plant, per cent sulphur, pods per plant and biological yield. These coefficients were the least for days to maturity. In general, seed yield, biological yield, clusters per plant, pods per plant, 100-seed weight, seed crushing hardness and per cent sulphur content had more than 20 per cent coefficients of variability at the phenotypic and genotypic levels. High values of environmental coefficients of variability for seed yield, biological yield, plant height and pods per plant evince that these traits are highly influenced by the environment.

Besides the information on coefficients of variability, heritability is useful in predicting the expected progress to be achieved through selection. In the

present study, 100-seed weight and per cent protein content exhibited more than 80 per cent heritability (Table 1). This shows that these two traits are less influenced by the environment. Heritability estimates were more than 50 per cent for pod length, seeds per pod and seed crushing hardness and less than 50 per cent for the remaining traits. Johnson *et al.* (1955) emphasized that for estimating the real effect of selection, heritability alone is not sufficient and genetic advance in conjunction with heritability is more useful. High genetic advance was observed for 100-seed weight followed by seed crushing hardness, seed yield, seeds per pod and clusters per plant. High heritability coupled with high to moderate genetic advance was recorded for seed crushing hardness and seeds per pod exhibiting the probable prevalence of additive genes for these traits, thereby reflecting the efficiency of selection for the improvement of these traits.

Table 1. Estimates of parameters of variability with respect to 15 traits studied

Traits	Phenotypic coefficient of variation (PCV)%	Genotypic coefficient of variation (GCV)%	Environmental coefficient of variation (ECV)%	Heritability (%)	Genetic advance (% of mean)
Seed yield/plant (g)	45.51	27.52	36.24	36.60	34.24
Biological yield/plant (g)	33.46	20.96	26.08	39.30	27.05
Harvest index (%)	20.29	13.81	14.86	46.40	19.37
Clusters/plant	35.51	23.28	26.81	43.00	31.41
Pods/plant	40.80	21.05	34.95	26.60	22.37
Pod length (cm)	14.72	11.60	9.06	62.10	18.82
Seeds/pod	23.93	19.51	13.88	66.30	32.70
Plant height (cm)	22.92	13.50	18.52	34.70	16.40
Days to flowering	5.97	3.50	4.83	34.40	4.22
Days to maturity	2.66	1.23	2.36	21.20	1.16
100-seed weight (g)	36.64	35.50	8.03	95.10	71.24
Seed crushing hardness (kg/seed)	32.64	24.33	21.76	55.60	37.36
Per cent protein content	13.20	12.12	5.23	84.30	22.93
Per cent sulphur content	34.16	22.13	26.03	42.00	28.46
Per cent phosphorus content	17.18	9.45	14.34	30.30	10.50

Table 2. Estimates of mean value of 35 lines with respect to 15 traits studied

	Seed yield/ plant (g)	Biolo- gical yield/ plant (g)	Harvest Index (%)	Cluster plant	Pods/ plant	Pod length (cm)	Seeds/ pod	Plant height (cm)	Days to flower- ing	Days to matu- rity	100 seed weight (g)	Seed crus- hing hard- ness (kg/ seed)	Percent prote- in content	Per cent sulphur content	Per cent phos- phorus content
Greengram type															
MM 7	4.38	15.33	20.81	6.20	23.00	6.53	8.07	46.33	49.67	85.67	2.97	5.07	20.54	0.19	0.41
MM 9	3.22	23.81	22.90	6.23	26.60	6.20	5.87	47.33	47.67	85.67	3.17	4.60	21.58	0.16	0.45
MM 11	4.57	18.00	22.00	5.87	21.80	5.70	7.23	36.57	50.67	87.00	3.90	4.20	19.25	0.18	0.46
MM 19	4.70	18.92	24.44	7.30	22.00	6.63	9.73	49.47	51.33	84.33	2.98	3.93	16.92	0.15	0.46
MM 20	6.61	24.58	26.64	7.17	27.13	7.27	10.53	58.67	49.67	3.35	4.40	26.64	0.15	0.46	
MM 22	4.14	18.75	22.36	6.47	24.17	6.77	7.47	45.10	48.33	87.00	3.25	6.00	21.88	0.14	0.49
MM 27	3.38	15.00	22.45	5.67	21.10	6.33	9.47	36.27	47.33	86.00	2.26	3.33	16.92	0.14	0.38
MM 28	5.69	19.00	29.23	6.50	20.73	8.23	8.47	54.97	51.67	86.33	2.60	5.60	15.46	0.14	0.42
Blackgram type															
MM 2	8.66	25.00	32.60	18.00	5.47	6.20	49.00	50.33	89.00	5.43	7.27	23.92	0.11	0.36	
MM 4	6.74	22.33	29.53	10.90	26.63	5.27	5.47	53.43	54.00	89.00	4.49	8.80	25.67	0.12	0.38
MM 8	6.87	17.50	33.44	12.07	34.60	5.20	5.33	56.37	52.00	90.00	4.41	6.40	21.29	0.09	0.39

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Seed yield/ plant (g)	Biolo- gical yield/ plant (g)	Harvest Index (%)	Cluster plant	Pods/ plant	Pod length (cm)	Seeds/ pod	Plant height (cm)	Days to flower- ing	Days to matu- rity	100 seed weight (g)	Seed crus- hing hard- ness (kg/ seed)	Percent prote- in content	Per cent sulphur content	Per cent phos- phorus content	
MM 13	7.05	23.00	27.96	10.57	30.30	5.33	5.33	6.53	57.10	54.33	91.00	4.54	8.00	17.79	0.14
MM 15	5.26	14.75	35.68	8.00	2.27	4.53	5.90	33.23	51.33	89.67	4.41	8.50	18.38	0.10	0.47
MM 16	6.38	16.67	35.39	10.73	27.63	4.93	5.70	52.23	50.00	87.33	3.95	6.13	22.17	0.08	0.38
MM 17	10.45	29.00	35.18	12.47	36.07	5.73	6.20	47.47	50.33	88.33	5.59	7.67	20.71	0.07	0.39
MM 18	5.71	20.92	26.28	9.77	27.57	5.60	6.27	50.90	49.67	87.33	4.64	8.13	21.00	0.12	0.39
MM 23	8.14	33.75	22.04	10.23	32.23	5.57	8.47	61.13	47.00	87.67	4.38	5.47	21.00	0.11	0.43
Recombinants															
MM 1	5.31	18.00	29.10	6.30	21.37	6.57	9.80	54.00	53.67	85.67	2.29	5.07	21.58	0.11	0.34
MM 3	3.07	23.25	22.79	7.07	16.37	5.03	8.50	37.33	49.67	95.67	2.88	5.67	23.04	0.09	0.35
MM 5	4.49	37.58	24.40	8.27	24.00	6.57	9.80	54.00	53.67	2.29	5.07	21.58	0.11	0.34	
MM 6	3.61	14.55	24.07	6.20	13.77	6.37	9.53	49.73	51.67	85.00	2.75	6.13	21.00	0.17	0.41
MM 10	5.52	19.33	27.07	7.93	22.33	6.77	9.00	51.07	53.33	89.00	3.33	4.13	18.67	0.16	0.38
MM 12	2.61	12.50	20.81	5.20	16.00	5.90	7.00	36.20	53.67	89.67	2.94	4.07	20.42	0.12	0.42
MM 14	5.81	17.17	35.35	6.35	18.13	6.97	11.00	42.20	53.67	86.67	3.54	4.40	21.88	0.13	0.49

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	Seed yield/ plant (g)	Biolo- gical yield/ plant (g)	Harvest Index (%)	Cluster plant	Pods/ plant	Pod length (cm)	Seeds/ pod	Plant height (cm)	Days to flower- ing	Days to matu- rity	100 seed weight (g)	Seed crus- hing hard- ness (kg/ seed)	Percent prote- in content	Per cent sulphur content	Per cent phos- phorus content
MM 21	6.43	25.00	24.26	7.97	88.43	6.53	9.93	60.27	62.67	86.67	3.12	4.47	18.09	0.15	0.42
MM 24	11.54	33.75	33.63	12.73	44.87	7.37	10.00	61.43	52.67	87.00	3.56	6.80	21.00	0.16	0.40
MM 25	6.53	24.08	26.32	7.53	29.67	6.93	8.93	51.47	50.00	86.00	3.20	5.27	23.05	0.14	0.41
MM 26	4.40	18.50	23.52	6.60	19.90	6.53	9.73	40.87	47.33	86.33	2.70	5.13	22.75	0.17	0.38
MM 29	5.95	20.33	29.33	8.60	27.30	6.50	8.80	50.23	50.67	86.00	2.83	3.87	20.71	0.10	0.39
MM 30	9.16	25.83	34.86	12.13	40.07	6.70	10.53	66.47	52.67	88.00	2.61	3.90	21.59	0.13	0.41
MM 31	4.43	16.83	25.87	7.77	20.10	6.00	7.20	47.60	50.67	86.33	3.11	3.40	24.79	0.10	0.42
MM 32	5.33	19.75	25.32	11.10	38.73	6.07	6.67	63.97	53.00	87.31	3.05	4.33	18.38	0.12	0.35
PDU 1	7.94	25.3	31.07	13.20	14.23	5.07	8.33	41.20	50.67	88.00	4.88	7.00	20.13	0.06	0.29
HP 27	8.16	24.67	32.64	11.37	34.17	5.27	6.67	52.00	48.67	89.00	5.24	7.13	21.88	0.12	0.33
Gc and Mean	5.94	20.16	27.88	8.52	26.13	6.20	7.99	49.07	50.88	87.31	3.70	5.55	20.64	0.13	0.40
Ss (m) 1	1.14	3.07	2.39	1.32	5.27	0.32	0.64	5.25	1.42	1.19	0.17	0.71	0.62	0.02	0.00
CD 5%	3.51	8.66	6.76	3.73	14.89	0.92	1.81	14.82	4.01	3.37	0.48	2.01	1.76	0.05	0.09

The estimates of mean performance of the derivations for different traits are given in Table 2. From this table, it can be perceived that derivatives resembling black gram and green gram, and recombinants (having traits of both black gram and green gram) superior to the respective or both the parents have been generated. However, the number of outstanding recombinants was more than the parent like derivatives. Recombinants MM 24 and MM 30 were promising for seed yield and its related traits. Because of the seed coat colour (dull green to brown) these recombinants may not gain popularity among the farmers, but can further be improved using recombination breeding. Verma and Yadava (1986) reported the occurrence of desirable combination of traits in the advanced generation derivatives of green gram $\times$ black gram.

Increasing the seed yield of pulse crops may not be useful unless the quality attributes are given due weightage. The main quality attribute in pulses is protein content in the seeds. Besides quantity, quality of protein in terms of relative contribution of different amino-acids increases their nutritional quality. The estimation of sulphur content gives an idea about the enrichment of protein with sulphur containing amino-acids. Phosphorus, an important nutrient, is the major constituent of nucleic acids. Increased level of phosphorus is expected to enhance protein biosynthesis. Moreover, increased P-uptake efficiency of a genotype is the index of its tolerance to low pH. The recombinant line, MM 31, had the maximum seed protein and surpassed its parents. The line also had higher percentage of phosphorus. Two derivatives MM 2 and MM4, resembling black gram also had significantly high protein than HPU 27, the superior parent for this trait. Recombinant, MM 14, was the superior most with respect to per cent phosphorus in the seeds. Since seed yield had no association with phosphorus content, and at the same time, per cent sulphur is positively correlated with per cent phosphorus (Gupta *et al.* unpub.), all these traits can be combined in one genotype through recombination breeding. It may be concluded that interspecific hybridization of black gram $\times$ green gram has generated enormous useful variation for agro-morphological and quality attributes, which can be utilised for the improvement of black gram and green gram besides the development of some novel genotypes having the desirable traits of both the species.

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VARIABILITY IN TOTAL BITTERS IN *TINOSPORA CORDIFOLIA* (WILLD.) MIERS POPULATIONS

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Giloe wood is used in number of formulations in Indian system of medicine and has a large growing demand in the market. Its pharmacological activity is evaluated in terms of its total-bitters (TB) content. Accessions collected from wide areas of UP, Delhi and other regions were evaluated for TB contents. It is observed that there is a wide variability in it. Promising accessions were identified in terms of its TB content which can be grown for commercial cultivation.

Key words : *Tinospora cordifolia*, total bitters, variability

Giloe (*Tinospora cordifolia*) is a glabrous woody, climbing shrub, bearing large alternate and cordate leaves. It is a fairly common plant of the dry deciduous forests growing over hedges and small trees. This species is distributed throughout tropical and sub-tropical India from Punjab to North eastern states and extending to Deccan plateau including Konkan, Karnataka and mesophytic forests in Kerala in South India. This plant grows in varying soil types with great ease and its woody stems attain a thickness of 6cm diameter. At present, it is nowhere cultivated commercially but is raised, sometimes, as ornamental climber through stem cuttings. As a drug plant, it has large bulk demand in the market, ranging from 300-500 tonnes of dry woody stem annually.

Giloe is used in the Ayurvedic system of medicine since remote past. It is reported to be useful in treating 'Kushta, Meha, Jwara, Svasa, kasa and Aruchi' (Bhavmisra, 1969; Raghunathan and Mitra, 1982). It is known as bitter- tonic, astringent, diuretic aphrodisiac, promote longevity with curative properties against infection, jaundice and provides relief in diabetes, piles, diaorrhea, dysentery etc. (Chopra *et al.*, 1982; Gupta *et al.*, 1967; Singh *et al.*, 1975; Sharma, 1982). Although a large number of chemical compounds are reported in this plant (Bisset and Nwaiwu, 1983; Chatterjee and Ghosh, 1960; Dixit and Khosla, 1971; Hanuman *et al.*, 1986; Kidwai *et al.*, 1949; Qudrat-i-Khuda *et al.*, 1964, 1966), yet no authentic information on the identity of pharmacologi-

cally active chemical constituent(s) in *Tinospora cordifolia* is known. It is considered that the bitter extract obtained from the plant contains pharmacological activity (Wlth. India, 1976), hence a study of chemical nature of total-bitters in plants, its chemical assay and the factors affecting its synthesis and accumulation was undertaken. Utilising this newly developed methodology, woody stems of plants of *Tinospora cordifolia* collected from Uttar Pradesh, Delhi and those obtained from different parts of the country, were screened for total-bitters content. This will help in the identification of superior genotypes for domestication and commercial cultivation.

MATERIALS AND METHODS

1. Plant material

Seventy-seven wild growing populations of Giloe were sampled from foothills and eastern part of UP and Delhi state. A large number of samples were obtained from other parts of the country (Table 2, 3) also. These vines were found associated with several tree species as support and along roadsides. For this study, twigs of nearly same age group were collected in the month of February. Woody stems of 1 cm. diameter thickness were cut into small pieces, dried in shade and powdered for chemical analysis.

2. Extraction of TB

The dried and powdered stems of two materials (50 gm each) were subjected to successive extraction for 8 hours with solvents. Continuous hot extractions with successive solvents were carried in soxhlet apparatus (Table 1).

Table 1. Successive solvent extarction of *Tinospora cordifolia*

Solvent	Extractive (%)		Taste	Compound	TLC
	Sample-1	Sample-2			
Petroleum Ether (60-80)	1.07	1.52	Tasteless	-	-
Benzene	0.90	0.70	Tasteless	-	-
Chloroform	0.60	0.52	Faintly bitter	Dragendroff+	Four spots
Ethyl acetate	0.65	0.61	Bitter		Four spots
Ethyl alcohol	4.45	3.58	Bitter	Dragendroff+ Saponins	Five spots
Water	6.50	7.22	Tasteless	-	-

Table 2. Total-bitters content in *Tinospora cordifolia*

Collection from U.P.	Total-bitters(%)
Nawabganj (Gonda)	0.2313
Madhavpur (Gonda)	0.7320
Manakpur (Gonda)	0.7572
Dalpatpur (Gonda)	0.8120
Murta range Forest (Bahraich)	0.3365
Katarnia Forest (Bahraich)	0.4542
Amba (Baharaich)	1.0115
Chikwa (Balrampur)	0.2127
Purshotampur (Gonda)	0.5857
Katra (Gonda)	0.5150
Dhabrua (Basti)	0.8395
Bisraolia (Basti)	0.4538
Kaptanganj (Basti)	0.5980
Haraiya (Basti)	0.5302
Chawani (Basti)	0.9025
Rauja (Barabanki)	1.0292
Ram Snehi Ghat (Barabanki)	0.2770
Purwa (barabanki)	1.1488
Ashram (Barabanki)	0.6792
Bhathat (Gorakhpur)	0.6640
Bhathul (Gorakhpur)	0.3000
Fareda (Gorakhpur)	0.7736
Sahjanwa (Gorakhpur)	0.7300
Saraya (Gorakhpur)	0.9448
Halalgarh (Gorakhpur)	0.6460
Dalalganj (Gorakhpur)	0.6780
Shyamdevra (Maharajganj)	0.4140
Parasa (Maharajganj)	0.1312
Pipra (Maharajganj)	0.3524
Mahadeva (Maharajganj)	0.4328
Bhitauli (Maharajganj)	0.5620
Khalilabad (Basti)	0.6070
Pauri (Ratora)	0.4425
Tehri (Pao)	0.2352
Tehri (Chaih)	0.3455
Almora (Bheta)	0.2735

Both the materials were also repeatedly refluxed with water. Solvents of extractives were distilled off and residues weighed. These residues were tasted for bitterness. These were also tested with different reagents prepared in the laboratory for determining the nature of compound present in each extractives. These extractives were also run over thin-layer chromatography (TLC).

3. Column chromatography

In order to isolate compounds constituting total bitters of *T. cordifolia*, the alcoholic extract was run over column of silica gel. 50 g dried and powdered material of *T. cordifolia* was subjected to repeated refluxing with ethanol (95%) to extract out TB. These extracts were combined, concentrated to 5 ml, filtered and run over silica-gel filled (175 g) glass column with chloroform with increasing concentration of methanol (CHCl_3 , $\text{CHCl}_3/\text{CH}_3\text{OH}$ 3/1, $\text{CHCl}_3/\text{CH}_3\text{OH}$ 1/1, $\text{CHCl}_3/\text{CH}_3\text{OH}$ 1/3, CH_3OH). 22 fractions of volume 25 ml each were collected, concentrated and run over TLC for qualitative analysis.

4. Thin layer chromatography (TLC)

TLC was performed on silica gel coated (0.25 mm thick) glass plates (20 × 5cm). The plates were developed with solvents to a distance of 15 cm from the point of application. The following solvents were used:

1. CHCl_3 : CH_3OH (90/10)
2. Ethyl acetate : CH_3OH : H_2O (77/15/8)
3. Toluene : Ethyl acetate : Diethylamine (70/20/10)

The extracts were spotted (2-5 μl) on the plate and run. Attempts were made to identify the compounds by spraying the plates with following reagents prepared in the laboratory, 1. Dragendorff reagent 2. Vanillin Sulphuric acid reagent and 3. Concentrated Sulphuric acid followed by heating at 100° C for 2 min.

RESULTS AND DISCUSSIONS

1. Chemical studies

To evaluate the qualitative and quantitative nature of total bitters (TB) in *Tinospora cordifolia*, the dried powdered material was extracted with solvents successively over Soxhlet apparatus (Table-1). By testing, it was found that the extractives of ethyl acetate and alcohol were distinctly bitter. It was found that ethyl alcohol extracted all the bitters from the material by repeated refluxing (This was confirmed by testing successive extracts until no more bitterness found in the extract).

To isolate chemical compounds constituting TB, the extracts were combined, concentrated and run over column chromatography. It was found, by TLC, that bitter components were present in eluants 11-16, 20-22 and in final methanol. It was also noted that these extracts responded positively to the test for saponins and to Dragendorff reagent. One of the Dragendorff positive compound was highly basic, moved very little on TLC and responded to the test of berberine alkaloid. Furthermore, it was also observed that all these spots showed myriad of colour under UV-light. It was found that total bitters (TB) consisted of five spots shown over TLC, indicating five chemical components.

2. Chemical evaluation

It was found that, though ethyl alcohol extracted all the bitters from the material, it also contained many other impurities. A method was worked out to remove impurities from the extracts without affecting TB, Washing the extract repeatedly, first with CHCl_3 and then with C_6H_6 impurities removed from the extract. This method (Fig-1) was found to be simple, rapid and highly reproducible. Utilizing this method, the accessions were chemically evaluated.

3. Factors Affecting TB

(a) Season of collection

It was earlier, shown that material collected during winter when the plant was defoliated, showing maximum TB (Srivastava *et al.*, 1990) Fig. 2.

(b) Thickness of stem

Since thickness of the stem is directly related with its age, TB was found to be increasing with thickness of stem (Fig. 3)

(c) Host plant

It is a traditional belief amongst the Ayurvedic practitioner that this plant grown over 'Neem' and mango trees, would have increased medicinal value due to higher blitterness (Watt, 1972). However, it was found that host plants did not produce any appreciable effect over TB content of this woody climbers.

Extent of total bitters in collections

There is great variation in TB content (Table 2) in the collections of UP. The range of variation is from 0.1312 to 1.1488 per cent. Amongst the collections analysed, seven accessions were showing more than 0.8 per cent TB whereas four were as low as 0.2 per cent. By and large accessions collected from UP hills were showing average TB content ranging from 0.2352 to 0.4425 per cent. It was concluded that genotypes from Dalpatpur (Gonda), Amba (Bahraich),

Table 3. Total-bitter content in *Tinospora cordifolia* collections from Delhi and other parts of the country

Place of collection		Total bitters	Total bitters
Delhi		Outside Delhi	
Talkatora Garden	0.6157	Regional Research Centre (Ayurveda), Jaipur	0.2458
ITO Cemetery	0.3519	RRC (Ayur.), Thiruvananthapuram	0.5938
Devnagar	0.2758	RRC. (Ayur), Vijaywada	0.8085
Gulabibagh	0.2563	RRC (Ayur), Gwalior	0.2130
Zakhira	0.1538	RRC (Ayur), Itanagar	0.4280
Lohamandi	0.2721	RRC (Ayur), Gauhati	1.4227
FCI Gate	0.1206	NBPGR, Shillong	0.2028
Shankar Road Ridge	0.8715	Anand	0.1472
Rajendra Nagar (R-Block)	0.4702	Kerala Agril. Univ., Vellanikkara	0.4701
Bikaner House, India Gate	0.3369	RRC (Ayur), Coimbatore	0.2115
Mausam Bhawan, Lodhi Rd.	0.1118		
Jhandewalan	0.3885		
Panchkuin Road	0.2745		
Rajendra Nagar, Ridge Road	0.2062		
Mycology Div., IARI	1.0287		
Punjabi Bagh	0.2493		
Behind Red Fort	0.3820		
Azadpur	0.3995		
Tees Hazari	0.2375		
Culmohar Park	0.2133		
Shankar Road	0.5362		
Mandir Marg	0.2340		
Lodhi Road	0.2242		
Subramaniam Bharti Marg	0.5939		
Hauz Khas Tomb	0.2460		
Khirkkee Village	0.2898		
Kalkaji Mandir	0.2356		
Inderpuri (Military Road)	0.7360		
Inderpuri A-Block	0.5660		
Mayapuri LIG Flat	0.5027		
Sarita Vihar	0.7156		

Dhabrua (Basti), Chawani (Basti), Raoja (Barabanki), Purwa (Barabanki), Saraya (Gorakhpur) of UP were very promising. Accessions collected from Delhi were showing wide variation in TB (Table 3). It ranges from 0.1118 to 1.0287 per cent. Only two accessions collected from Shankar Road ridge (0.8715%) and

from IARI (1.0287%) were observed to be promising. Similarly materials received from other parts of the country exhibited great variation i.e., from 0.1472 to 1.4227 per cent TB. Only two accessions obtained from RRC (Ayurveda), Vijayawada (0.8085%) and RRC (Ayur), Guwahati (1.4427%) were found to be promising.

The variability in TB can be utilised in making selection of elite type for raising of new plants under domestication leading to crop improvement programme. At present raw material for pharmaceutical industry are usually collected from wild growing plants. Pharmaceutical establishments, on the other hand require a regular supply of enormous quantities of raw material which only commercial cultivation can produce. Hence information generated through this study will help in making selection of promising genotypes for commercial cultivation leading to improved yield of better raw material.

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VARIABILITY AND CHARACTER ASSOCIATION STUDIES IN FABA BEAN

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Germplasm comprising of 203 accessions (exotic as well as indigenous) on faba bean was evaluated with an objective to study the genetic variability, association between the yield and yield contributing traits and to identify the promising accessions in respect of various quantitative traits. The characters seed yield, pods/plant, branches from basal node and higher nodes showed a variation of over 32% whereas days to maturity and days to flowering showed a poor variation to the tune of 5% only. Multiple correlation and regression analysis revealed that plant height was significantly negatively correlated with the seed yield. However, the multiple linear regression model could account for only 8.0% of the variation in seed yield suggesting that the linear model is not an appropriate choice in this case. based on the phenotypic performance, promising accessions were also identified.

Key words : Faba bean, *Vicia faba*, variability, character association

Vicia faba commonly known as broadbean, belongs to the family Fabaceae tribe Viciae. The primary areas of diversity for this crop are reported to be in Asia (Central and Eastern) and the Mediterranean. It possesses high genetic potential to produce seed yield greater than cereal crops (Bean, 1967). It has been identified as a high yielding protein rich crop for the human and farm animals. In view of its high potential as a food and feed crop, concerted efforts are required for its improvement.

Collection, maintenance and evaluation of germplasm form economically important traits is one of the basic step for initiating breeding programme for genetic improvement of any crop. In this crop, reports on systematic evaluation of the germplasm are very scanty. A study on genetic divergence using D² and metroglyph analyses has been done on 84 exotic lines from West Germany and 9 indigenous lines by Chhabra *et al.* (1989). The present investigations deals with the diverse genetic material procured from different countries viz., Syria, USA and Italy.

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MATERIALS AND METHODS

The germplasm under study comprised of 199 accessions mainly from exotic sources viz. Syria, USA and Italy and 4 accessions from India. The preliminary evaluation trial was conducted at Issapur Farm, Delhi during rabi, 1992. The experiment was laid out in an augmented randomized complete block design (Federer, 1956) using two checks. The average values of five plants were used for statistical analysis. MSTATC statistical package was used for analysing the data and to study the genetic variability, association behaviour between yield and yield contributing traits and to identify the promising accessions in respect of various traits. The promising accessions were identified using dBASE III PLUS software package. The data were recorded on 12 quantitative characters : plant height (cm), branches from basal node and higher nodes, height of lowest pod bearing node (cm), pods per node; stem thickness (cm), pods per plant, seeds per pod, pod length (cm), days to flowering, days to maturity and seed yield (g).

RESULTS AND DISCUSSION

Variability analysis

Higher coefficient of variation ranging from 32 to 37 per cent was observed for the characters seed yield (32.55%), pods per plant (33.20%), branches from higher node (46.79%) and branches from basal node (37.10%) indicating that there is enough potential for exploiting this high variability present in these characters. The characters days to flowering and days to maturity showed a very poor variation indicating that most of the accessions flowered and matured almost at the same time. The vegetative character viz., plant height, pod length, seeds/pod, pods per node and height of lowest pod bearing nodes showed a medium range of variation (13.15% to 25.06%). Table-5 gives a list of promising accessions identified in respect of early maturity, higher pod potential, longer pods, dwarfness and higher seed yielding capacity.

Association analysis

The seed yield was found to be negatively correlated with the plant height indicating that the dwarf accessions are high yielding in nature as compared to the taller ones. However, on the contrary, the plant height was positively correlated with the pods per plant, seeds per pod, pod length and days to flowering. This reveals that taller plants, in general, were late flowering and having high pod bearing potential. Though taller accessions had longer pods containing more number of seeds, yet their seed yield was low. One of the reason for this phenomenon could be attributed owing to smaller seed size in case of taller accessions as compared to those of dwarf accessions.

The correlation between branches from basal nodes and branches from higher nodes was the highest, i.e., 0.73 (Table-2). The reason for this high association is due to the fact that the accessions which had higher number of basal branches also had higher number of branches from higher nodes. Branches from basal nodes showed a negative correlation with the seeds per pod indicating that the number of seeds per pod was comparatively higher for accessions having poor number of branches. The negative association between stem thickness and the height of lowest pod bearing node showed that accessions bearing pods at lower height had thicker stems.

Table 1: Mean, range and coefficient of variation for different traits in faba bean

Descriptor	Mean	SD	Range	C.V.
Days to flowering	60.4	3.84	53.0 - 68.0	6.37
Days to maturity	134.8	5.35	124.0 - 164.0	4.10
Plant height (cm)	33.9	5.25	21.6 - 47.5	15.50
Branches from basal node	4.7	1.73	2.0 - 8.0	37.10
Branches from higher node	4.1	1.50	1.0 - 8.0	36.79
Height of lowest pod bearing node(cm)	11.6	1.80	6.7 - 19.5	15.53
Pods per node	2.4	0.59	1.0 - 3.0	25.06
Stem thickness (cm)	0.6	0.08	0.4 - 0.9	13.77
Pods per plant	7.7	2.57	1.0 - 15.0	33.20
Seeds per pod	2.9	0.41	2.0 - 6.0	14.13
Pod length (cm)	4.1	0.53	2.5 - 5.5	13.15
Seed yield (g)	13.5	4.40	10.0 - 30.0	32.55

Multiple regression analysis

The multiple linear regression analysis of the data was done by taking seed yield as the dependent character and rest of the characters as independent ones. Table-3 indicated that the regression sum of squares was not significant at 95 per cent level of significance. The linear model could account for only 8 per cent of the total variation in the seed yield. Thus the linear model does not seem to be an appropriate choice in this case. Some of the relationships among the traits may be non-linear ones. The negative contribution of plant height towards seed yield (Table-2) was also confirmed by the regression model (Table 4). The contribution of pods per plant positive and significant in explaining the variation in yield.

Table 2. Correlation coefficients among quantitative traits

	1	2	3	4	5	6	7	8	9	10	11	12
1.	1.00	-										
2.	-0.10	1.00										
3.	0.12	0.73**	1.00									
4.	0.10	-0.02	-0.06	1.00								
5.	0.06	-0.04	-0.02	0.03	1.00							
6.	0.11	-0.02	0.04	-0.15*	-0.04	1.00						
7.	0.24*	0.08	0.13	-0.02	0.02	0.06	1.00					
8.	0.15*	-0.15*	-0.09	0.09	0.04	0.06	0.04	1.00				
9.	0.30**	-0.06	0.17*	-0.22*	-0.03	0.09	0.25*	0.07	1.00			
10.	0.19*	-0.02	0.06	-0.06	0.20*	-0.01	0.17*	0.04	0.09	1.00		
11.	0.03	-0.06	0.02	0.04	-0.02	0.03	0.12	-0.01	0.06	0.01	1.00	
12.	-0.15*	0.07	0.01	0.10	0.11	-0.08	0.10	-0.04	-0.06	-0.06	-0.09	1.00

1. Plant Height 2. Branches from basal nodes 3. Branches from higher nodes 4. height of lowest pod bearing node 5. Pods per node 6. Stem thickness 7. Pods per plant 8. Seeds per pod 9. Pod length 10. Days to flowering 11. Days to maturity 12. Seed yield

Table 3. Analysis of Variance for regression

Source	Sum of Squares	df	mean Square	F	Significant
Regression	310.31	11	28.21	1.50	0.134
Residual	3592.44	191	18.81		
Total	3902.75	202			

Table 4. Regression coefficient of various traits on seed yield

S. No.	Trait	Regression coefficient	Student T value
1.	Plant height	-1.4558e - 001	-2.215
2.	Branches from basal nodes	1.1677e - 001	0.426
3.	Branches from higher nodes	-5.7180e - 002	-179
4.	Height of lowest pod bearing node	2.6672e - 001	1.480
5.	Pods per node	8.4188e - 001	1.585
6.	Stem thickness	-2.3598e - 001	-0.639
7.	Pods per plant	2.6873e - 001	2.109
8.	Seeds per pod	-2.4420e - 001	-0.320
9.	Pod length	-2.0166e - 002	-0.029
10.	Days to flowering	-2.0166e - 002	-0.241
11.	Days to maturity	-7.3187e - 002	-1.264

Table 5. List of promising accessions

Traits	Promising Accessions
Early maturity	EC 143706, EC 243729, EC243828, EC 117750 A, EC 117810 A
High pod number	EC 243584, EC 243592, IC 10720, EC 117760, EC 117772
Long pods	EC 243744, EC 243626 A, EC 243633, EC 243825
Dwarfness	EC 243707, EC 243610, EC 243819, EC 243714, EC 243614
High grain yield	EC 117810 A, EC 117750 A, EC 243611, EC 243706, EC 243828

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AUGMENT 1: A MICROCOMPUTER BASED PROGRAM TO ANALYZE AUGMENTED RANDOMIZED COMPLETE BLOCK DESIGN

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A user friendly computer program named AUGMENT1 has been developed in GWBASIC supported on MS-DOS at the Documentation unit of NBPGR to analyse the data of Augmented Randomized Complete Block Designs. The programme takes care of both equal as well as unequal number of new entries/lines in different blocks for a set of quantitative descriptors. The output of the detailed analysis for individual descriptors includes two kinds of ANOVA tables, adjusted values for the new entries and 4 kinds of standard errors for testing different contrasts. The results of the analysis are stored in a text file and can be conveniently taken on a hard copy. The copy of the programme can be had from the Director, NBPGR, New Delhi.

Key words : Augment 1, PC based program, augmented design, analysis

Augmented Designs suggested by Federer (1956) are being extensively used by the germplasm evaluators for the preliminary evaluation of their germplasm trials in respect of quantitative idescriptos particularly when the number of accessions are unmanageable and the quantity of the genetic material is not sufficient to go for even two replications. Statistical analysis of such designs is slightly cumbersome as compared to that of Randomized Block Designs. The most commonly used Augmented Design is the Augmented Randomized Complete Block Design (RCBD) in which only check varieties are repeated a number of times and new accessions (to be tested) appear only once (Federer, 1956; Federer and Raghav Rao, 1975). Because of its simplicity and usefulness, this design is also practiced in fields of entomology, pathology, chemistry, physiology, agronomy and perhaps others for combining screening experiments on new material and preliminary testing experiments on promising material. Because of its wide use in these fields and mainly in the genetic resources environment, a programme named AUGMENT 1 has been developed to analyse the data of such designs.

Basic concepts about Augmented RCBD

We illustrate the concept with some hypothetical example for ease in understanding the programme

Suppose, we have 4 check varieties say C_i , $i = 1$ to 4; 10 new accessions (which are to be tested) say A_i , $i = 1$ to 10 of Sorghum and three blocks ($b=3$)

In the layout of this experiment, there have to be 7 plots (4 for checks and 3 for new varieties) in any two blocks and 8 plots (4 for checks and 4 for new varieties) in the remaining third block. We are assuming that the 1st and 3rd block are having 7 plots each and 2nd block is having 8 plots. For random allocation of these accessions in the experiment, we have to proceed as —

- (i) Allot 4 check varieties to each block randomly. In this process, say following is the arrangement —

Blocks	Entries							
	1	2	3	4	5	6	7	8
1	C_1		C_3		C_4	C_2		
2	C_3	C_1		C_4	C_2			
3	C_1		C_2	C_4	C_3			

The 8th plot is only for 2nd block.

- (ii) 10 new varieties are allotted randomly in the remaining plots of the 3 blocks. This way 22 plots are randomly occupied by 4 checks and 10 new accessions. The final arrangement looks like-

Blocks	Entries							
	1	2	3	4	5	6	7	8
1	C_1	A_9	C_3	A_2	C_4	C_2	A_1	
2	C_3	C_1	A_3	C_4	C_2	A_8	A_{10}	A_5
3	C_1	A_4	C_2	C_4	C_3	A_7	A_6	

For the analysis purpose, let us assume-

v = Number of check varieties

V = Number of new varieties

b = Number of blocks

n_i = Number of new varieties in i th block

$$N = \sum_{i=1}^b (v + n_i) = \text{Total number of plots}$$

ANOVA

Sources of Variation	d.f.	Sum of Squares
Blocks (Ignoring treatments)	$b - 1$	B
Treatments (eliminating blocks)	$v + v - 1$	SScn
Check varieties	$v - 1$	SSc
New varieties and (checks vs. new varieties)	V	SSn
Error	$(v - 1)(b - 1)$	SSe
Blocks (eliminating treatments)	$b - 1$	SSb
Treatments (ignoring blocks)	$v + V - 1$	T
Check varieties	$v - 1$	SSc
New varieties	$v - 1$	SSn(1)
Checks vs new varieties	1	SSn(2)
Error	$(v - 1)(b - 1)$	SSe

Standard Errors

Four kinds of standard errors for comparing mean differences are as follow-

- (i) Between two check variety means

$$SE(1) = \frac{\sqrt{2MS(E)}}{b}$$

- (ii) Between two new varieties in the same block

$$SE(2) = \sqrt{2MS(E)}$$

- (iii) Between two new varieties not in the same block

$$SE(3) = \sqrt{2\left(1 + \frac{1}{v}\right)MS(E)}$$

- (iv) Between a check variety and a new variety

$$SE(4) = \sqrt{\left(1 + \frac{1}{b} + \frac{1}{v} + \frac{1}{bv}\right)MS(E)}$$

Adjusted values

For comparison of new varieties, it is essential to adjust them for the block effects. For finding the adjusted value of a new accession, we have the following formula-

Adjusted value of a new accession = Unadjusted value of that accession - (Mean of the check varieties in the block where this new accession occurs - overall mean of the check varieties)

About the program AUGMENT 1

The AUGMENT 1 has been developed for equal as well as unequal number of new accessions in each block. The program requires 6 files namely, AUGMENT 1.EXE, BRUN40.EXE, BRUN40.LIB, HELP.AUG, AUGT2.EXE and HELP.EXE. For installation of the programme, create a directory C: \AUGMEN and all the above mentioned files must be copied in this directory. To run the program, one has to simply type augment1 in the C:\AUGMEN directory followed by Enter key.

Two data files are required for running this programme -

- (1) Data file for check varieties
- (2) Data file for unreplicated treatments (new accessions).

The input files (1) & (2) must be ASCII files and the fields must be delimited by commas. For file (1) the fields must be in the following order:

replication no., check variety no., ch.1, ch.2, ...

where as for file (2), the order of the fields must be:

replication no., ch.1, ch.2, ...

where ch.1, ch.2, etc. are the characters to be analysed.

Hardware requirements

1. IBM Compatible PC XT/AT with a minimum of 256 KB RAM.
2. Hard Disk with a minimum free space of 124 KB to load the program.
3. MS-DOS Ver 3.0 (or higher).

Limitations

The programme has the following limitations

- (1) No. of replications should not exceed 100.
- (2) No. of check varieties should not exceed 10.
- (3) No. of characters/descriptors should not exceed 20.

However these limits can be increased (depending upon the computer's memory) by changing the dimensions in the source program.

Sample exercise

The following example has been taken from Federer (1956). Four hypothetical varieties (check varieties A, B, C, D) and eight hypothetical seedlings (new

accessions (e, f, g, h, i, j, k, l) are used. The layout of the experiment is shown below —

Blocks				Entries				
1.	Variety or seedling	l	C	D	g	A	B	k
	Yield	74	78	78	70	83	77	75
2.	Variety or seedling	D	B	A	C	e	i	
	Yield	91	81	79	81	79	78	
3.	Variety or seedling	h	C	A	f	D	B	j
	Yield	96	87	92	89	81	79	82

Blocks 1 and 3 contain 7 entries each, and block 2 contains 6 entries. Following are the two sample input data files (CHKFILE and ACCFILE for yield of check varieties and new accessions respectively) created in the format mentioned earlier for analyzing the data of this example.

Input Files

CHKFILE	ACCFILE
1,1,83	1,74
1,2,77	1,70
1,3,78	1,75
1,4,78	2,79
2,1,79	2,78
2,2,81	3,96
2,3,81	3,89
2,4,91	3,82
3,1,92	
3,2,79	
3,3,87	
3,4,81	

An output file containing the results of analysis can be had in ASCII mode. The output for the present example is given below -

Output file for sample exercise

AUGMENTED RANDOMIZED COMPLETE BLOCK DESIGN
 ANALYSIS FOR THE DATA FILE (CHECK VARIETIES)---CHKFILE
 AND FOR DATAFILE (UNREPLICATED TREATMENTS)---ACCFILE
 NO. OF REPLICATIONS/BLOCK = 3
 NO. OF TREATMENTS OR CHECK VARIETIES = 4
 NO. OF CHARACTERS/DESCRIPTORS = 1

ANOVA (Character 1)

Source	D.F.	S.S.	M.S.	F
Blocks (Ignoring treatments) [@]	2	360.06	180.03	6.67
Treatments (eliminating blocks)	11	285.10	25.92	0.96
Check varieties	3	52.92	17.64	0.65
U.R. varieties and check vs. U.R. [#] varieties	8	232.19	29.02	1.08
Error	6	161.83	26.97	
Total	19	807.00		
Blocks (eliminating treatments)	2	69.50	34.75	1.29
Treatments (ignoring blocks)	11	575.67	52.33	1.94
Check varieties	3	52.92	17.64	0.65
U.R. varieties	7	505.88	72.27	2.68
U.R. varieties vs. checks	1	16.88	16.88	0.63
ERROR	6	161.83	26.97	

@ The S. S. of Blocks (eliminating treatments) is calculated after taking into consideration the mean effects, check variety effect and block effect. The S.S. of blocks (ignoring treatments) is the usual S.S. of blocks by considering the new accessions as single replicates.

U.R. - Unreplicated new accessions

ADJUSTED VALUES

Treat No.	Block No.	Ch. No.	Obs. value	Adj. value
1	1	1	74.00	77.25
2	1	1	70.00	73.25
3	1	1	75.00	78.25
4	2	1	79.00	77.25
5	2	1	78.00	77.25
6	3	1	96.00	93.50
7	3	1	89.00	86.50
8	3	1	82.00	79.50

STANDARD ERRORS OF DIFFERENCES

FOR CHARACTER NO. (1) :

S.E. BETWEEN ANY 2 REPL. TREAT. : 4.24

S.E. BETWEEN ANY 2 TREAT. IN THE SAME REPL. : 8.21

S.E. BETWEEN ANY 2 UNREPL. TREAT. IN THE SAME REPL. : 8.21

S.E. BETWEEN REPL. TREAT. 9(AVERAGED OVER ALL REPL.) AND UNREPL.
TREAT. : 6.70

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VARIABILITY PARAMETERS IN CORIANDER (*CORIANDRUM SATIVUM* L.)

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Different parameters were estimated to study the magnitude of genetic variability in two hundred diverse varieties/strains of coriander (*Coriandrum sativum* L.). The analysis of variance showed sufficient genetic variation among genotypes for all the twelve characters studied. Genotypic coefficient of variation, estimates of heritability and genetic gain were moderate to high for grain yield/plant, umbellets/plant, umbels/plant and 1000 seed weight, which indicated that response to selection would be very high for these yield components ultimately leading to yield improvement in this crop. However, for remaining characters medium to low coefficient of variation and low genetic gain was observed. Therefore, umbellets/plant, umbels/plant and 1000 seed weight should be given due weightage while breeding for higher seed yield.

Key words : Coriander, variability parameters, heritability, genetic gain, genotypic, phenotypic variation

Genetic variation in crop plants for characters of agronomic importance leading to the determination of complex character 'yield' forms the base, to improve grain yield per plant. The first step in any breeding programme, including the one for synthesis of ideotype, must be a quantitative assessment of the available variability in respect of the important yield contributing characters. Study of the amount of variability in different characters associated with yield and a knowledge on their heritability in relation to their contribution towards yield are the prime requisites for an efficient plant breeding programme. Practically very little systematic information is available in this crop regarding the variability parameters, however, this crop has a wide range of variability, which can be exploited for evolving high yielding varieties. Therefore, the present investigation was undertaken, with a view to ascertain the relative variability present in yield contributing characters.

MATERIALS AND METHODS

Two hundred diverse exotic and indigenous varieties/strains of coriander (*Coriandrum sativum* L.) were grown in a randomized block design with three replications at S.K.N. College, Jobner farm. Each genotype in a replication had 3 row of 3m length with 30 x 40 cm spacing. 10 competitive plants were randomly selected in each genotype for recording observations on twelve quantitative traits (Table 1). Average values of 10 randomly selected plants were used as plot means for estimating statistical parameters. The genotypic and phenotypic variances were calculated according to Panse and Sukhatme 1967. Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were computed by the method suggested by Burton 1952. Heritability estimates as per the method of Lush 1940 and genetic advance as per the method of Johnson, Robinson and Comstock 1955 were calculated.

RESULTS AND DISCUSSION

From the analysis of variance, the mean squares due to genotypes were found highly significant for all the twelve characters studied indicating sufficient genetic variation among genotypes for all these characters. Among the characters studied, straw yield per plant showed highest genotypic and phenotypic coefficient of variations followed by grain yield per plant, umbellets per plant, umbels per plant, and thousand seed weight. The findings of Joshi *et al.* (1967) and Sevda (1980) are in agreement with the present study.

The genotypic coefficient of variation alone is, however, not helpful in determining the heritable portion of variation, for which Burton 1952 suggested that GCV along with heritability estimates would give a better idea about the efficiency of selection. In the present study heritability values (broad sense) varied from 31.88 to 86.45 per cent. The highest being for days to flowering, moderate to high heritability values were observed for all the characters except grains per umbellet, thereby indicating less environmental influence on the characters in general, hence selection for the highly heritable characters on the basis of phenotypic expression would be effective. The finding is an agreement with Mathur *et al.* (1971) and Jain and Dubey (1972).

Even though heritability estimates provide useful indication of the relative value of selection based on phenotypic expression, Johnson *et al.* (1955) suggested that heritability and genetic advance when calculated together are more useful in predicting the resultant effect of selection. Gandhi *et al.* (1964) suggested that high genetic gain along with high heritability is the most effective for selection in any crop for future improvement. Genetic advance value in the present investigation were observed low for all the twelve characters. Whereas, heritability showed by these characters was moderate to high. It indicates that the expression of the characters was more subjected to non-

Table 1. Range, mean, variances, coefficient of variation, heritability and genetic advance in coriander (*Coriandrum sativum* L.)

Characters	Range	Mean $\pm$ SE	Variance		Coefficient of variation		Heritability (Broad sense)	Genetic advance (%)
			Genotypic	Phenotypic	Genotypic	Phenotypic		
Plant height (cm)	11.80-86.10	40.16 $\pm$ 6.19	81.95	139.49	22.54	29.41	58.75	14.29 35.58
Number of primary branches	1.40-8.60	4.33 $\pm$ 0.72	0.59	1.36	17.70	26.97	43.07	1.03 23.79
Number of effective branches	1.10-8.40	3.90 $\pm$ 0.78	0.58	1.48	19.47	31.20	38.92	0.98 25.13
Days to flowering	65.00-118.00	83.72 $\pm$ 0.85	77.92	90.12	10.54	11.34	86.45	16.91 20.20
Days to maturity	112.00-145.00	123.78 $\pm$ 3.10	44.37	58.76	5.38	6.19	75.51	11.92 9.63
Unbels/plant	3.20-39.30	10.10 $\pm$ 3.13	12.41	27.10	34.89	51.55	45.80	4.91 48.61
Umbellets/plant	7.10-177.80	37.00 $\pm$ 13.05	202.85	458.49	38.49	57.87	44.24	19.52 52.76
Grains/umbellete	1.70-11.80	4.67 $\pm$ 0.91	0.58	1.83	16.33	28.93	31.88	0.89 19.06
Thousand Seed Weight(g)	5.00-22.15	12.84 $\pm$ 1.37	10.57	13.38	25.32	28.49	79.01	5.95 46.34
Straw yield /plant(g)	0.19-7.79	1.79 $\pm$ 0.83	0.94	1.98	54.03	78.50	47.38	1.37 76.54
Grain yield /plant(g)	0.10-5.93	1.33 $\pm$ 0.60	0.33	0.88	43.10	70.40	37.48	0.72 54.15
Harvest Index(%)	8.93-84.80	43.99 $\pm$ 7.90	61.59	155.13	17.84	28.32	39.70	10.19 23.16

VARIABILITY IN CORIANDER

heritable component of variability. thus, these traits have little value in selection programme. The higher genetic gain showed by straw yield per plant, grain yield per plant, umbellets per plant, unbels per plant and thousand seed weight, with higher heritability values. Panse (1957) ascribed this situation due to additive gene effects. Therefore, it appears that selection for these characters should be effective and satisfactory for practical purposes. The remaining characters showed moderate heritability alongwith moderate to low genetic gain. Earlier findings of Mathur *et al.* (1971), Jain and Dubey (1972) and Sevda (1980) are in good agreement with those of the present study except umbellets per plant.

Genotypic coefficient of variation and heritability determines the component of heritable variation while the genetic gain determines the extent of its stability under selection. All these genetic parameters should be considered together for an effective improvement of different traits. The results of present investigation state that genetic coefficient of variation, heritability values and genetic gain were moderate to high for straw yield per plant, grain yield per plant, umbellets per plant, umbels per plant and thousand seed weight. It indicates as such response to selection can be stable and quite suitable for practical purpose. Thus, these characters should be given due importance while breeding for higher seed yield. The remaining characters showed medium to low genotypic coefficient of variation, medium to high heritability and low genetic gain. Hence, these characters will not respond to straight selection.

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GENETIC VARIABILITY AND ASSOCIATION ANALYSIS FOR VARIOUS QUANTITATIVE CHARACTERS IN LOCAL LANDRACES OF PEARLMILLET

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The genetic variability, heritability, genetic advance and correlations were studied for ten characters 102 treatments (100 inbreds and 2 hybrid checks). The phenotypic and genotypic coefficient of variance indicated that selection may be done for tiller number and grain yield. Plant height, tiller number, ear girth, grain density and 1000 - grain weight are positively and significantly associated with grain yield. However, these traits also found positive significant association with each other. Therefore, plant height, ear girth, grain density, 1000 grain weight and particularly tiller number should be given due importance while breeding for higher grain yield.

Key Words : Pearl millet, genetic variability, landraces, heritability, genetic advance, association analysis

Pearlmillet is an important crop of Rajasthan particularly for semi-arid conditions of Western Rajasthan due to its sustainability under various stresses. However, number of high yielding hybrids and composite populations have been developed but most of the farmers still continue to grow old local landraces of their areas because of their greater adaptability and higher tolerance to different stresses. Therefore, the genetic variability and correlation for yield components are of great value in selecting desired types amongst the local landraces. For a planned breeding programme to improve yield, complete information on the genetic variability and inter-relationship in different yield component traits is necessary. The present investigation was carried out to assess the variability and relative importance of different characters.

With the help of certain genetic parameters like coefficient of variability, heritability and genetic advance, and the inter-relationship among different yield component traits from 100 landraces in different parts of Rajasthan, an efficient breeding programme for yield improvement would be possible.

MATERIALS AND METHODS

One hundred landraces of Rajasthan alongwith two hybrid checks BJ 104 and CM 46 were studied in a randomised complete block design with three replications. Each plot comprised 2 rows of 5m length. A spacing of 50cm between rows and 15 cm within the row was adopted. All the normal agronomic practices were followed in raising the crops. Observations were recorded on ten randomly selected plants for 10 quantitative traits (Table 1).

Table 1. Phenotypic and genotypic coefficient of variation, heritability, genetic advance and genetic advance as percent of mean of land races

Character	Pcv	Gcv	h^2	GA	GA as per cent of mean
Days to flower	8.73	8.64	0.98	8.34	17.59
Days to maturity	5.34	5.26	0.97	8.34	10.68
Plant height(cm)	9.21	9.15	0.99	38.70	18.75
Ear length(cm)	15.40	15.01	0.95	7.48	30.15
Number of tiller	36.08	35.44	0.96	1.44	71.74
Ear girth(cm)	14.69	13.26	0.81	0.48	24.67
Number of node	10.40	9.39	0.81	1.58	17.47
Grain density/sq.cm.	12.61	12.55	0.99	6.71	25.72
1000 grain weight(gm)	12.53	12.26	0.96	1.93	24.69
Grain yield/plant(gm)	33.16	32.92	0.98	13.19	67.31

The phenotypic and genotypic coefficient of variability (PCV, GCV) were calculated according to the method suggested by Burton (1952), heritability (broad sense) and genetic advance (GA) as per Johnson *et al.* (1955). The formula developed by Al- Jibouri *et al.* (1959) was adopted for the calculation of correlations.

RESULTS AND DISCUSSION

Analysis of variance (Table 1) showed highly significant difference among all the characters studied. The higher phenotypic coefficient of variation and genotypic coefficient of variation were recorded for tiller number followed by grain yield but it was low for days to maturity, days to flower and plant height. The slight edge of PCV over GCV indicated a good scope for making selection of these characters. The magnitude at variability further suggested that there is enough scope of selection for number of tillers, ear girth and grain yield per plant.

The estimate of heritability of a character provides a measure of the effectiveness of selection for that character. The heritability was very high for plant height, ear density, days to flower, grain yield, days to maturity, tiller number and 1000 grain weight. It was comparatively high for ear length, ear girth and number of nodes. Similar results were obtained by Gupta and Sindhu (1972); Gupta and Dhillon (1974); Apparudai and Subramanian (1975); Vyas (1983). The highest genetic advance (as % of mean) was obtained for tiller number (72%), followed by grain yield/plant (67%), ear length (30%), grain density (26%), ear girth (25%) and 100 grain weight (25%; Table 1). Heritability alone may mislead during selection, therefore, genetic advance and heritability should be taken into consideration during selection programme (Johnson *et al.*, (1955)). In the present study the traits which had high genetic advance were also accompanied by high heritability (Table 1), it may be due to pre-dominance of additive gene effects (Panse, 1957)). Therefore, it appears that selections for those traits would be effective and satisfactory for practical purpose. High genetic advance along with high heritability was also reported in pearl millet by Shinde *et al.* (1984), Goswami and Asthara (1984) and Kunbir and Patil (1986), which support the present finding.

The phenotypic, genotypic correlation coefficients between grain yield and its nine components are furnished in Table 2. The results clearly indicate that grain yield was positively and significantly associated with plant height, number of tiller, ear girth, grain density and 1000 grain weight, whereas other characters showed positive and non-significant correlation with grain yield. It is, therefore, evident that these components though contribute to grain yield but the effect are not very perceptible. It is probably due to highly selected material which has minimized the variation for these component characters. The phenotypic correlation coefficients were highest in most of the characters than the corresponding genotypic correlation coefficient indicated that the environment had a significant role to modify the full expression of the character and/or characters and are in accordance with earlier reports in bajra (Kunbir and Patil, 1986; Phul *et al.*, 1974; Singh and Singh, 1976; Pokhriyal *et al.*, 1976; Yadav, 1977; Mukherji *et al.*, 1982) that selection for number of tiller, ear girth and grain weight would bring about simultaneous improvement in grain yield.

The results of correlation coefficients of mutual association of traits further revealed that plant height had positive and significant association with ear length, number of nodes, grain density and 1000 grain weight. Number of tiller was also highly positively correlated with ear girth, number of nodes and grain density, similarly ear girth had a positive and significant association with number of nodes and grain density. Grain density had positively and significantly association with plant height, ear length, number of tiller, ear girth and number of nodes. Whereas, 1000 grain weight showed positive and

significant association with days to maturity, plant height, ear length, number of nodes and grain density. From the foregoing association, it would be reasonable to infer that the lines high in grain yield tended to be tall and late in flowering and maturity.

Table 2. Phenotypic and genotypic correlations in landraces

Characters		Days to maturity	Plant height	Ear length	Tiller number	Ear girth	Number of nodes	Grain density	1000 grain weight	Grain yield
Days to flower	P	0.989**	0.234*	0.289**	0.51**	0.18	0.27**	0.01	0.034	0.14
	G	0.912	0.078	0.28	0.201	0.11	0.378	0.001	0.05	0.001
Days to maturity	P		0.212*	0.189	0.04	0.18	0.245*	0.07	0.70**	0.067
	G		0.22	0.189	0.03	0.101	0.28	0.001	0.10	0.067
Plant height	P			0.50**	0.16	0.045	0.44**	0.934**	0.62**	0.26**
	G			0.378	0.123	0.17	0.423	0.95	0.63	0.123
Ear length	P				0.012**	0.20*	0.445**	0.389**	0.289**	0.16
	G				0.13	0.11	0.134	0.20	0.08	0.167
Tiller number	P					0.28**	0.956**	0.901**	0.08	0.901**
	G					0.312	0.98	0.912	0.08	0.923
Ear girth	P						0.60**	0.90**	0.08	0.389**
	G						0.40	0.58	0.012	0.05
Number of nodes	P							0.38**	0.64**	0.05
	G							0.334	0.18	0.01
Grain density	P								0.43**	0.24*
	G								0.21	0.11
1000grain weight	P									0.589**
	G									0.234

* Significant at 5 per cent level

** Significant at 1 per cent level

Based on present investigations it is concluded that plant height, number of tiller, ear girth, grain density and 1000 grain weight are the major contributing characters towards the grain yield. Hence, if selection force is confined for any one or more of these traits, it will definitely lead to the improvement in pearl millet yield. However, number of tillers could be most effective among these characters as it also has very high heritability and genetic advance. Thus, these character should be given due importance while breeding for higher grain yield in pearl millet.

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ASSOCIATION ANALYSIS AMONG YIELD COMPONENTS IN THE THREE GENERATIONS OF DURUM WHEAT

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Correlation analysis between grain yield and its component traits were carried out in the three generations namely, parents, F_1 and F_2 developed by 10×10 diallel cross (excluding reciprocals) in *durum* wheat. Among component characters grains per spike and tillers per plant would lead to higher yield in *durum* wheat. The antagonistic relationship between traits of economic importance suggested that intermating in early segregating generations for atleast 3-4 years need to be adopted. A multiple cross involving JNK-4W-14, A-9-30-1, Cocorit-71 and stork's will be most appropriate to generate the variability in desirable direction for isolating valuable segregants with desirable attributes.

Key words : Durum wheat, correlation analysis, quantitative traits, generations, genotypic and phenotypic coefficient

Grain yield is the end product of interactions of many factors known as yield contributing components and is a complex trait. Selection based on this trait is usually not very useful but the one based on its component characters could be more effective. To make effective selections for higher yield, basic information on major yield contributing characters is essential to ensure efficient selection simultaneously for two or more characters. In case of *aestivum* wheat, number of findings based on fixed genotypes and segregating populations have been reported but there is very little information in *durum* wheat on correlation studies particularly in segregating populations. Therefore, the present study was conducted to collect the information on association of ten quantitative traits, with grain yield in parents, F_1 and F_2 generations of *durum* wheat.

MATERIALS AND METHODS

Ten varieties of *durum* wheat (*Triticum durum* Desf.) viz. Raj 1516, HD 45530, NP 401, Cocorit 71, Flamingo's, Stork 'S', Raj 911, A-9-30-1, Raj 2061 and JNK-4W-184, were crossed in all possible combinations excluding reci

provals. The resulting 45 F_1 's were planted to get sufficient F_2 populations these along with parents were evaluated in a randomized block design with three replications at ARS, Sriganaganagar. Each plot consisted of single 5m long row in parents and F_1 's while four rows in F_2 's with the spacing of 30cm between rows and 10cm between plants. Recommended cultural practices were followed for raising the crop. Ten competitive plants in each parent and F_1 's and 25 plants in each F_2 's progeny were selected randomly for recording observations on eleven quantitative characters. The progeny means were used for statistical analysis. Genotypic and phenotypic correlation coefficients were calculated in parents, F_1 and F_2 populations separately according to the procedure proposed by Searle (1961).

RESULTS AND DISCUSSION

From the analysis of variance, the mean squares due to genotypes were found highly significant for all the eleven characters studied indicating sufficient genetic variation among genotypes for all three characters in all the three populations. There were similarities between genotypic and phenotypic coefficient of correlation though the genotypic correlation coefficients were, in general, higher than the corresponding phenotypic correlation coefficients in all the three generations (Table 1). This suggested that selection on phenotypic basis would be equally worthwhile. Grain yield was significantly and positively correlated with number of tillers, spikelets per spike, grains per spike and straw yield in the parents, F_1 and F_2 generations. However, it showed positive and significant association with spike length and plant height in F_2 population also and are in accordance with earlier reports in wheat (Dhomkshes Rao, 1979; Gupta and Ahmed, 1979; Kumar, 1979; Choudhary *et al.*, 1985; Sharma and Kant, 1986; Verma and Yunus, 1993; Srivastava *et al.*, 1993; Chander *et al.*, 1993). In general, there were similarities in association between characters in different generations however some differences of associations of traits in different populations may be due to the differences of genetic constitution of the different populations.

Harvest index showed positive but weak association with grain yield in parents and F_1 generations, however, it showed positive and significant association with it in F_2 generation, it may be ascribed to the breakage of linkages and heterogenous nature of population. This character also showed positive and significant correlation with grains per spike in all the three generations and with number of tillers in F_2 population only. Therefore, improvement in grain yield may be made by this trait. Earlier Studies (Kaltsikes and Lac, 1971; Sidhu *et al.*, 1976; Pace *et al.*, 1978; Thakal *et al.*, 1979; Kumar and Choudhary, 1986; Sharma *et al.*, 1993) substantiate this point.

Table 1. Phenotypic (p) and genotypic (G) correlation among different characters of the parents (P), F₁ and F₂ population in durum wheat

Charac- ters			Days to matu- ity	Plant hei- ght (cm)	Num- ber of tillers	Spike length (cm)	Spikelets per spike	grai- ns per- spike	1000 grain weight (g)	Grain yield per plant (g)	Straw yield (g)	Harvest index (%)
Days to heading	P	P	0.62**	0.42*	0.09	0.75**	0.57**	0.11	-0.18	0.22	0.37*	-0.30
		G	0.66	0.42	0.17	0.81	0.60	0.12	-0.19	0.29	0.43	-0.31
	F ₁	P	0.68**	0.35**	-0.08	0.50**	0.48**	0.01	0.04	0.01	0.34**	-0.21*
		G	0.78	0.38	-0.10	0.59	0.54	0.01	0.05	0.03	0.45	0.27
	F ₂	P	0.73**	0.35**	0.07	0.63**	0.62**	0.14	-0.18*	0.17*	0.47**	-0.42**
		G	0.85	0.38	-0.02	0.72	0.68	0.15	-0.18	0.16	0.60	-0.54
Days to maturity	P	P	0.16	0.05	0.46*	0.28	-0.47**	0.36	-0.80	0.52**	-0.32	
		G	0.19	0.04	0.54	0.32	-0.52	0.42	-0.90	0.64	-0.76	
	F ₁	P	0.01	-0.01	0.38**	0.28**	-0.16	0.22	0.02	0.28**	-0.15	
		G		0.02	-0.18	0.45	0.36	-0.23	0.15	-0.12	0.25	-0.21
	F ₂	P	0.11	0.04	0.41**	0.41**	-0.06	-0.04	0.07	0.40**	-0.40**	
		G		0.15	-0.08	0.58	0.54	-0.08	-0.04	-0.04	0.46	0.34
Plant height (cm)	P	P			-0.28	0.50**	0.41*	0.30	0.19	0.29	0.57**	-0.46*
		G			-0.43	0.54	0.45	0.32	0.18	0.34	0.64	-0.51
	F ₁	P			0.07	0.58**	0.59**	0.21*	0.24**	0.32**	0.59**	-0.21*
		G			0.06	0.64	0.64	0.24	0.27	0.40	0.73	-0.30
	F ₂	P			0.04	0.40**	0.40**	0.26**	0.01	0.35**	0.59**	-0.38**
		G		-0.01	0.46	0.47	0.27	0.03	0.44	0.74	-0.50	
Numbers of tillers	P	P				0.12	0.31	0.31	-0.48**	0.63**	0.11	0.22
		G				0.05	0.41	0.39	-0.58	0.51	-0.17	0.31
	F ₁	P				0.21**	0.17*	0.33**	-0.17*	0.81**	0.52**	0.10
		G				0.15	0.10	0.53	-0.33	0.79	0.34	0.17
	F ₂	P				0.06	0.12	0.29**	-0.44**	0.69**	0.26**	0.48**
		G				-0.02	0.13	0.43	-0.65	0.60	-0.06	-0.40
Spike length (cm)	P	P					0.73**	0.15	-0.17	0.21	0.48**	-0.33
		G					0.78	0.18	-0.13	0.24	0.50	-0.41
	F ₁	P					0.60**	0.08	0.24**	0.35**	0.55**	-0.16
		G					0.63	0.06	0.20	0.36	0.64	-0.25

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	F ₂	P	0.66**	0.08	-0.13	0.08	0.40**	-0.40**
		G	0.72	0.05	-0.12	0.05	0.47	-0.45
Spikelets per spike	P	P	0.49**	-0.35	0.53**	0.35	-0.19	
		G		0.55	-0.35	0.67	0.45	-0.26
	F ₁	P		0.30**	0.04	0.39**	0.54**	-0.12
		G		0.31	0.10	0.40	0.61	-0.22
	F ₂	P		0.34**	-0.39**	0.21*	0.38**	-0.27**
		G		0.44	-0.47	0.25	0.46	-0.31
Grains per spike	P	P			-0.67**	0.72**	-0.06	0.42*
		G			-0.72	0.81	-0.09	0.51
	F ₁	P			-0.43	0.51**	0.21*	0.30**
		G			-0.60	0.65	0.26	0.24
	F ₂	P			-0.55**	0.57**	0.19	0.25**
		G			-0.69	0.71	0.13	0.36
1000 grain weight (g)	P	P				-0.36	0.49**	-0.73**
		G				-0.43	0.57	-0.80
	F ₁	P				-0.01	0.31**	-0.18
		G				-0.08	0.40	-0.29
	F ₂	P				-0.27	0.09	-0.33**
		G				-0.36	0.20	-0.46
Grain yield per plant (g)	P	P					0.40*	0.16
		G					0.34	0.02
	F ₁	P					0.68**	0.01
		G					0.66	0.06
	F ₂	P					0.48**	0.26**
		G					0.41	0.19
10. Straw yield	P	P						-0.74**
		G						0.89
	F ₁	P						-0.23**
		G						-0.29
	F ₂	P						-0.64**
		G						-0.70

* P = 0.05, ** P = 0.01

Grain weight exhibited negative correlation with yield in all three generations, however, it was significant in case of parents and F₂ population. This character also had negative and highly significant correlation with number of

tillers and grains per spike (Sharma and Kant, 1986). Therefore, simultaneous improvement for these traits would not be feasible unless unfavourable linkage are broken by intermating in the segregating populations.

Number of tiller per plant had no significant correlation with spike length, spikelets per spike and grains per spike in parental lines but there were significant positive association of tillers with these traits in F_1 . In F_2 population, tiller number showed positive and highly significant correlation with grains per spike. Therefore, simultaneous selection for such traits in genetically variable population may lead to the improvement of grain yield.

In conclusion, correlation studies revealed that selection for grains per spike and tillers per plant would lead to higher yield. The antagonistic relationship between traits of economic importance suggested that intermating in early segregating generations for atleast 3-4 years be adopted. Intermating would enhance the frequency of desirable combination of genes in the segregating population. For this purpose, a multiple cross involving JNK-4W-184, A-9-30-1, cocorit 71 and stork's will be most appropriate in present material. The material generated after intermating may offer great scope for isolating valuable segregants with desirable attributes in *durum* wheats.

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EFFECT OF STORAGE TEMPERATURES AND SEED MOISTURE CONTENTS ON VIABILITY OF *BRASSICA JUNCEA* SEEDS

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Freshly harvested seeds of mustard (*Brassica juncea* cv Pusa bold), were conditioned to five different moisture levels viz., 15, 10, 7.5, 2.5 and 1 per cent. These were packed in tri-layered aluminium foil packets and stored at five different temperatures i.e. ambient, 20, 4, -10 and -20° C. Viability measurements were made at three months interval. The results indicated that the seeds stored with 15% moisture lost their viability earlier as compared to seeds at lower moisture contents. The seeds stored at ambient temperature were the first to lose viability followed by those stored at 20, -20 and -10° C. Viability was relatively prolonged when the seeds are stored at 10° C. Seeds stored at 10 per cent moisture content maintained high viability for the entire period of the study at all temperatures of storage except the ambient and 20° C where the viability was lost in 9 and 18 months respectively. Lowering the seed moisture to 7 per cent and below could prolong the storage life even at ambient conditions.

Key words : *Brassica juncea*, seed viability, storage temperature, moisture content

The age of a seed cannot be considered solely as a function of time, for environmental factors during storage have a definite impact on this. It has long been recognized that the greater the moisture content and storage temperature of orthodox seeds either singly or in combination, the shorter is the period of survival (Roberts, 1973). Even at temperatures above 0° C many crop species can be stored up to 28 years with only minor losses provided the seed moisture is sufficiently low (Horoschailov and Zhukova, 1980). Further improvement in longevity in all orthodox species almost certainly occurs below -20° C, but this is the lowest temperature at which detectable changes in viability with time have been examined in some detail (Roberts and Ellis, 1977). Below this temperature changes in viability may occur at an extremely slow rate that their detection becomes difficult.

Mustard is one of the important oil seed crops of India. The climatic conditions of India greatly accelerate the seed ageing phenomenon under ambient storage. An experiment was designed to work out the suitable

regimes (moisture and temperature) for short, medium and long-term storage of mustard seeds.

MATERIALS AND METHODS

Freshly harvested seeds of *Brassica juncea* cv Pusa bold were procured from Indian Agricultural Research Institute, New Delhi. Seeds were conditioned to different moistures viz., 15, 10, 7, 5, 2.5, 1 per cent by either drying at 15° C and 15% RH or by adding required quantities of water to seeds in aluminium foil pouches, sealing them and storing at 4° C for five days in order to equilibrate moisture within and among the seeds. Ultralow moistures (2.5 & 1%) were achieved by freeze-drying the partially dry seeds. Seed moistures were then determined following ISTA rules (ISTA 1985). In each environment, between 20-25 sub-samples of 300 seeds per lot were sealed in aluminium foil bags and placed in different temperatures viz., ambient, 20, 4, -10 and -20° C. Samples were withdrawn at regular intervals and tested for their viability. Each germination test comprised 100 seeds divided equally among four replicates carried out in Petri plates lined with two layers of moist filter papers at 20° C and the seedlings were evaluated on the seventh day following ISTA rules (ISTA, 1985). The data were statistically analysed using MSTAT:C package.

RESULTS AND DISCUSSION

Seed longevity of mustard seeds was significantly affected by the storage temperature and seed moisture. Seeds at higher hydration level (15% m.c.) lost their viability completely within six months at ambient temperature. These seeds when stored at 20°C retained more than 80% viability up to 9 months. Under sub-zero temperatures (-10 & -20° C), these lots could be stored for 12 and 9 months respectively. The longest period these seeds could however be stored was at 4° C for a period of 18 months. (Fig. 1a). Christensen and Kaufman (1969) postulated that above 10-13% seed moisture, sprouting, heating and fungal invasion can quickly destroy viability. Halder and Gupta (1980) also reported that seed deterioration took place very quickly when the internal moisture was raised to above 10 per cent. Harrington (1960) proposed a 'rule of thumb' that states: every 1 per cent decrease in seed moisture between the levels of 5 and 14 per cent doubles the storage life of the seed. Ibrahim and Roberts (1983) however demonstrated that seed longevity in lettuce was promoted when seed moisture content was increased to 15 or 20 per cent. Their work is in line with that of Villiers (1975) and Villiers and Edgumbe (1975). They hypothesised that the mechanism of sub-cellular repair and turn-over become active at 15 per cent moisture, thereby allowing the seed to repair damaged components during the storage period. In the present study,

mustard seeds at 15% moisture level lost their viability quickly at all temperatures. Higher metabolic activity resulting in heating and fungal invasion could have resulted in rapid ageing. It is however unclear if reduced germinability is related to chilling or freezing injury (Harrington and Kihara, 1960) that may have occurred as a result of low or sub-zero temperature storage of these seeds.

Seed lots with 10 per cent m.c. could be stored for maximum periods of 9 and 18 months respectively at ambient and 20° C. At lower temperatures *viz.*, 4, -10 and -20° C the same lots maintained good vigour and viability for over 33 months (Fig. 1b). These results imply that carryover seeds can be safely and economically stored for short duration (1-1½ years) at ambient or short term storage conditions if sufficient care is taken to package the material in moisture proof storage containers. Further drying of seeds to 7 per cent m.c. prolonged their shelf life to about 21 months. These seeds eventually lost their viability in 33 months (Fig. 1c). Seeds of this category retained their full complement of vigour and viability throughout the period of the study at temperatures other than ambient. These results are in confirmation with the statement of Toole and Toole (1946) that the moisture content and storage temperature generally interact in their effect such that maintenance of either low moisture or low temperature increases their storage life. Seed desiccated to 5 per cent m.c. stored well for entire period at all temperatures including the ambient. The IPCRI advisory committee for seed storage (1976) has recommended safer limits of moisture content as 4 to 7 per cent for long-term storage of orthodox seeds.

Desiccation to ultralow levels of moisture *viz.*, 2.5 and 1 per cent did not result in any appreciable loss of viability during their storage at different temperatures (Fig. 1d). Nutile (1964) studied the effect of excessive desiccation of vegetable seeds and categorized nine vegetables according to seed resistance to desiccation injury and observed that the seeds of celery, eggplant and pepper were injured if the seed moisture was reduced from 4 to 1 per cent. Similar results were observed in beans and Peas. Woodstock *et al.* (1976) however concluded that freeze drying of pepper seeds to a moisture content of 2.5 per cent was superior to 3 per cent for storage for 12 months at 21-25° C or at 40° C. In the present study, it has been observed that freeze drying mustard seeds to ultralow moistures did not result in any noticeable injury and this effect persisted throughout the storage period at all temperatures. Ultra desiccated seeds have their metabolic activities reduced to a minimum and hence can be successfully stored for very long periods. The observation of the present study is in agreement with those of Cheng *et al.* (1990) who have shown that freeze drying can safely reduce the moisture content to ultralow levels and that this enhances seed vigour, storage life and the integrity of cellular ultrastructure. Ellis *et al.* (1993) reported the results of ultralow

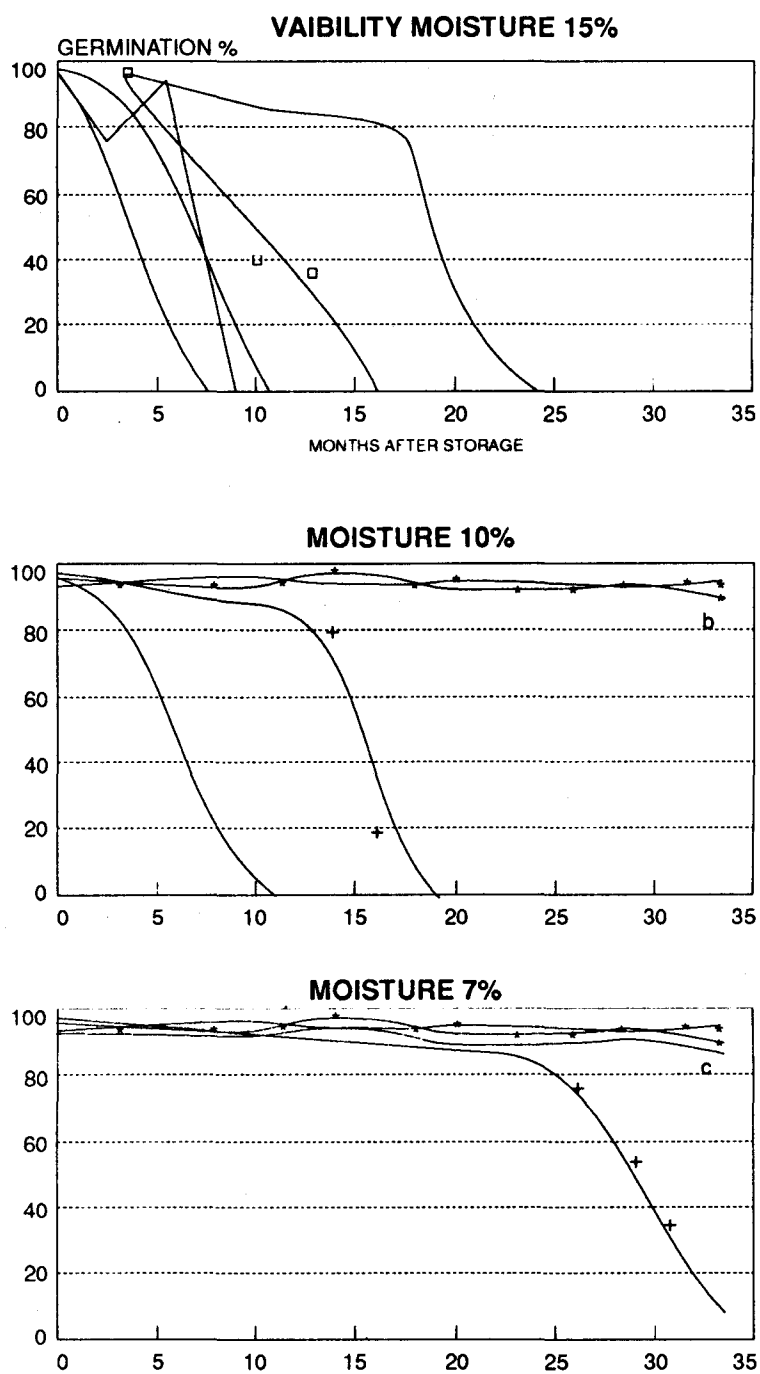


Fig.1 (a-c). Influence of different moistures and storage temperatures on the survivability of *Brassica juncea* cv Pusa bold seeds

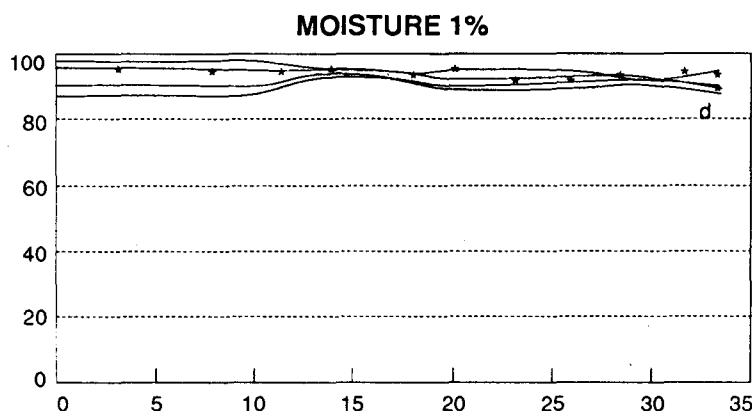


Fig.1 (d). Influence of different moistures and storage temperatures on the survivability of *Brassica juncea* cv Pusa bold seeds

storage of 17 crucifers for over 25 years. They observed that in 10 accessions no significant increase in germination ability was detected whilst only one accession showed significant decrease in germination. These results along with those of the present study suggest that ultradry storage of seeds, i.e. storage at less than 5 per cent m.c. is a promising technique and might as well enable the cost of regeneration to be reduced or even avoided in some applications.

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STORABILITY OF ONION SEEDS AT LOW MOISTURE LEVELS

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The objective of the study was to assess the storability of onion seeds at reduced seed moisture levels in ambient condition so as to know how well it compared with that under medium term conditions of the genebank. Seed moisture levels chosen ranged from 7.5 to 1.66 per cent. Germination and radical lengths were taken as criteria to assess the seed storability. Seeds stored at 4.0 - 4.5 per cent moisture (over silica gel) at ambient temperature retained viability comparable to those at 7.5 per cent moisture at +10°C upto 12 months of storage. In another experiment, laminated aluminium foil (LAF) packets and metal cans with rubber lined caps were used as containers for seeds at moisture levels of 2.8 and 1.6 per cent. Seeds stored in LAF pouches showed higher vigour (as measured by radical lengths) than those stored in metal cans. Vigour was higher in seeds at lower moisture level. Seed lots of different vigour did not retain same relative vigour rating when exposed to stress condition of accelerated ageing.

Key words : Onion, seeds, moisture; storability

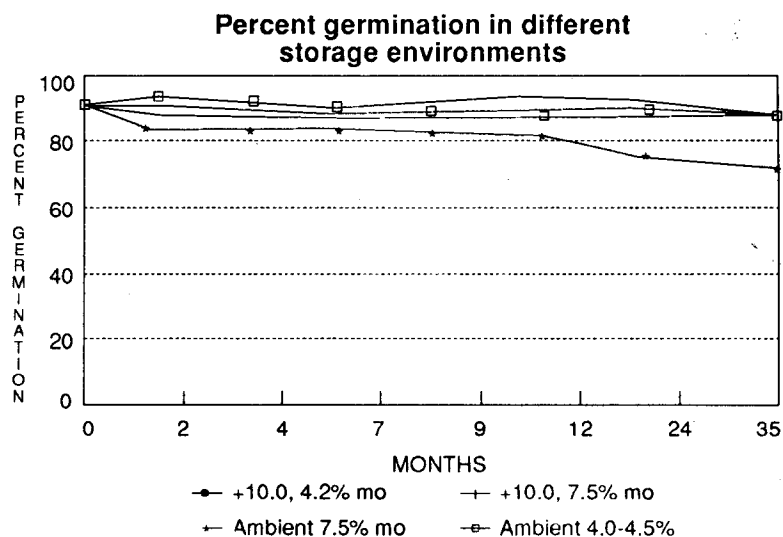
The longevity of orthodox seeds may be dramatically improved by controlling the storage environment because the increase in longevity with decrease in either temperature or moisture content is approximately exponential. It has been proposed that the seeds be dried to $5\% \pm 1\%$ moisture content for longterm storage. For seeds with poor storage characteristics further drying may be recommended (Ellis *et al*, 1986, Ellis 1988). It has been shown in certain crops that longevity at high temperature is considerably increased by reducing moisture content of seed stored below $5\% \pm 1\%$ previously recommended by IPGRI. Seeds with high oil content which tend to have poor longevity particularly benefit from ultra dry (less than 5% moisture content) storage. The ultimate aim of ultra dry seed storage research is the development of practical method for establishing a low input technology for genebank in which seeds would be stored hermetically sealed and ultra dry at ambient temperature or at least with considerably less refrigeration requirement than currently used.

The objective of present experiment was to assess the storability of onion seeds at low moisture level at ambient temperature vis a vis under medium term conditions of the gene bank i.e. +10°C. Two containers viz., laminated aluminium foil pouches and metal cans were used to evaluate their suitability for storage of seeds. The response of seed vigour level to accelerated ageing conditions was also studied.

MATERIALS AND METHODS

Freshly harvested seeds of Onion (cv. Ratnar) were obtained in the year 1988. After testing initial viability seed lot was divided into two lots and dried over regularly regenerated silica gel in a desiccator at room temperature. This provided seeds at moisture content of 7.5 and 4.0 - 4.5 per cent. Low moisture contents of 2.8 and 1.6 per cent were obtained by equilibrating seeds over concentrated sulphuric acid solution. The moisture content of the seeds was determined by the hot air oven method (Anon., 1985).

Storage treatments for different lots were as follows. Seeds with 7.5 per cent moisture were sealed in Laminated Aluminium Foil (LAF) packets and stored at +10°C and ambient temperatures. Seeds with 4-4.5 per cent moisture were stored in paper envelopes over silica gel in a dessicator at room temperature. Another lot with 4.2 per cent moisture content was sealed in LAF packet and stored at +10°C. All the seeds were tested for germination in petri dishes at 20°C as prescribed by ISTA (1985 b). Three replicates of 100 seeds each were used. Seedlings were evaluated and counted according to the criterion of normal germination (ISTA, 1985 a, b). For another experiment seeds with 2.8 and 1.6 percent moisture content were divided into four sub samples each. These were stored in sealed LAF packets and in metal boxes with rubber



lined caps at both ambient and medium term conditions. This provided a total of eight treatments. At least 20 seeds were used for vigour measurement. Vigour was assessed by measuring radical lengths at 25°C after 144 hrs. Seeds were prehumidified before sowing in all cases.

To test whether seed lots of different vigour will retain same relative vigour rating when exposed to environmental stress, two lots of two cultivars viz., Ratnar selection and Pusa red each were taken. The moisture content of the seeds was $7.8 \pm 1^\circ \text{C}$ per cent. Vigour was measured as radicle length.

RESULTS AND DISCUSSION

The initial germination of seed was 95 per cent. Under ambient conditions of storage the loss in viability was maximum in seeds with 7.5 per cent moisture level where it decreased from the initial value to 76 per cent after 35 months of storage (Fig. 1). The percentage drop in germination at +10°C, at both the moisture levels viz. 4.2 and 7.5 per cent was comparable to that in the seeds stored at 4.0 – 4.5 per cent moisture in a desiccator under less favourable ambient temperature conditions (Fig. 1).

Vigour measured as radicle length was found to be higher in seeds with 1.6 per cent moisture content than in seeds with 2.8 per cent moisture in both ambient and medium term conditions of temperature irrespective of type of container (Table 1). Vigour was higher in seeds stored sealed in LAF packets than in metal cans in all cases. Decline in vigour was most rapid in cans at 2.8% moisture and ambient temperature. LAF packets were found to be more suitable for seed storage at these moistures.

Table 1. Radicle lengths (mm) in two storage environments

Period of storage in month	Moistures							
	2.86				1.66			
	LAF	Can	LAF	Can	LAF	Can	LAF	Can
	Ambient		+ 10°C		Ambient		+10°C	
00		43.52				46.00		
6	39.01	36.61	39.17	33.75	45.17	40.22	45.41	44.42
11	32.16	15.66	34.21	27.87	43.26	37.47	45.10	39.10
15	24.72	14.65	31.36	22.35	38.80	33.77	38.80	37.71
19	23.15	13.00	26.85	16.87	28.16	27.06	38.00	26.00

Storage of seeds of different species under reduced moisture has been found to maintain viability for longer periods (Agarwal, 1982; Ellis *et al.*, 1988)

A lower limit to negative logarithmic relations between seed longevity and seed moisture content has been demonstrated in several species (Ellis *et al.*, 1988; Roberts and Ellis, 1989). Nakamura (1975) showed that in lettuce seeds stored for 20 years at ambient temperature longevity at 2.5 per cent moisture content was greater than that at 6.3 per cent moisture content. Reports on the maintenance of viability of onion show that seeds dried to 6.3 per cent moisture before sealing retain good viability for upto 3 years at 32°C (Asgrow Seed Co. 1949), whereas under ambient conditions of storage and uncontrolled moisture the germination percentage decreased from initial 97 per cent to 3 per cent after 28 months (Varier and Agarwal, 1989).

Results from this study show that at ambient temperature seeds retain good viability when stored at 7.5 per cent moisture even upto 35 months of storage and desiccation below this level i.e. to 4.0 – 4.5% enhances the storability at ambient temperatures. Further reduction in moisture content is unlikely to be hazardous as evident by maintenance of high vigour in seeds at 1.6 per cent moisture.

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SEED EVALUATION AFTER CRYOPRESERVATION IN ONION (*ALLIUM CEPA* L.) CULTIVARS

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Onion seeds though orthodox in nature have short shelf life. Low temperature storage has been strongly recommended for the long term storage of such seeds. Cryopreservation (-180°C, vapour phase of liquid nitrogen) has proved useful in a number of orthodox seeds. These seeds could be successfully stored under cryopreservation because decline in seed germination and seedling vigour due to storage at RT can be almost completely controlled. Membrane integrity and lipid peroxidation studies were used to assess the metabolic changes accompanying seed storage. Lipid peroxidation was found to be closely associated with the decline in germination and vigour characteristics but this correlation could not be established with membrane integrity.

Key words: Onion (*Allium cepa* L.), cryopreservation, vigour index

Conservation of plant genetic resources is aimed to ensure the supply of germplasm collections to a large panel of users, from plant breeders to fundamental geneticists in crop improvement programmes. Gene banks have been established for medium and long term conservation having representatives of the genetic diversity of crop species and its wild relatives. Storability of seeds and accompanying biochemical changes is an area of interest and information generated would help in developing appropriate conservation strategies. Onion seeds exhibit desiccation as well as freezing tolerance and are therefore, orthodox in nature. However, these seeds are very poor storers under ambient conditions. Ultra low temperature storage can overcome the loss in viability and vigour. The degradative processes that occur under storage at ambient conditions and can be controlled by low temperature storage. The present investigations were aimed to study the structural and biochemical features associated with them.

MATERIALS AND METHODS

Seeds of two onion varieties viz., Pusa Red (PR) and Pusa White Flat (PWF) were procured from Division of Vegetable crops, IARI, New Delhi.

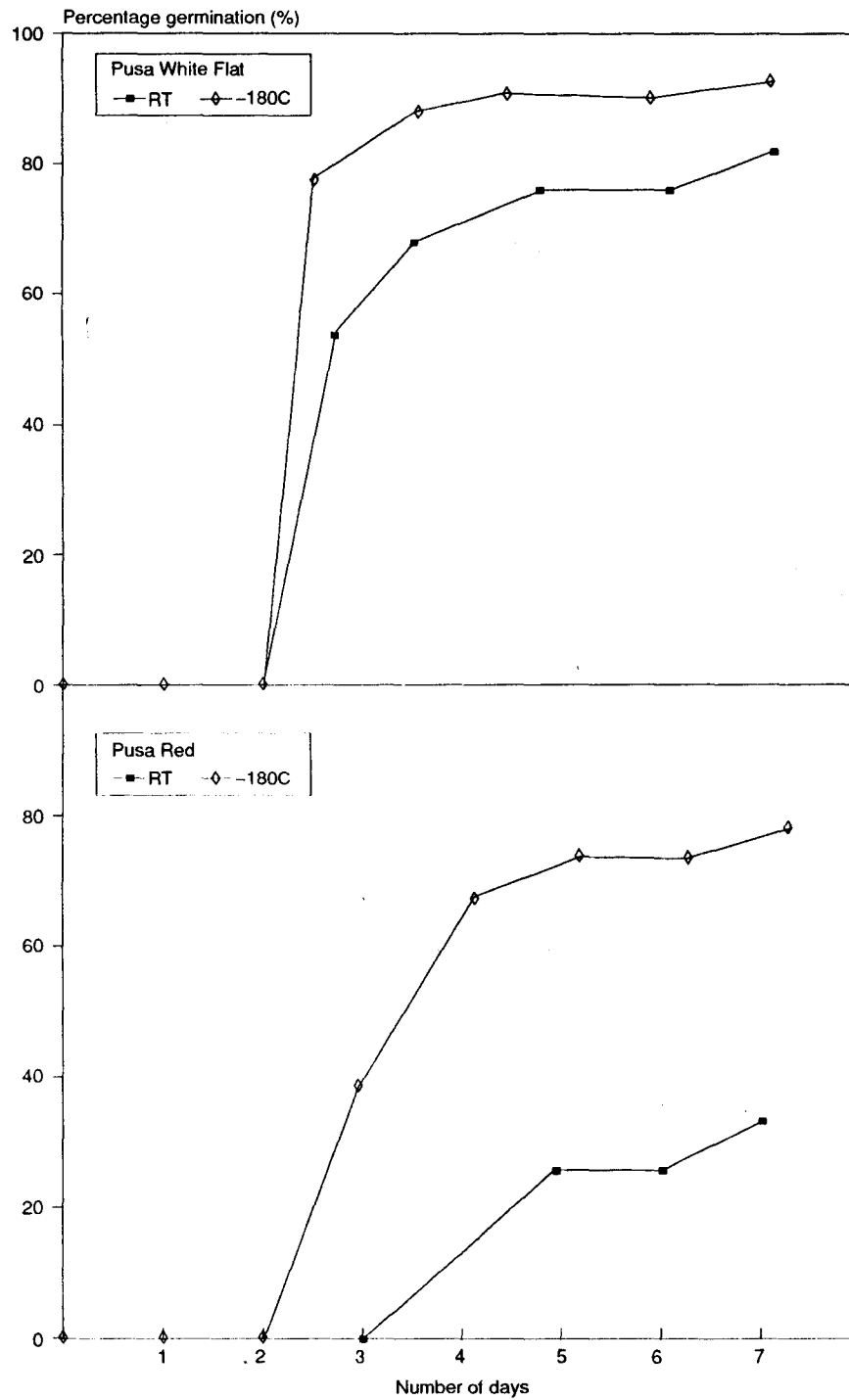


Fig. 1 : Speed of seed germination in *A. cepa* L. cultivars after storage for nine months

Initial moisture content was determined and brought down to 6-7 per cent using seed dryer (Bry-Air, India). Moisture content determinations on fresh weight basis were done by drying the seeds at $105 \pm 1^\circ\text{C}$ for sixteen hours (ISTA, 1976) in three replicates of 10 g each. Seeds were stored in polypropylene vial in -180°C at vapour phase of liquid nitrogen in the cryotank (CMS 328, USA) also in ambient conditions to be used as controls.

Stored seeds were retrieved after nine months. For retrieval from liquid nitrogen, seed vials were immediately immersed in warm water bath (38°C) for few seconds. Seeds were germinated over moist filter paper in Petri plates at $20 \pm 1^\circ\text{C}$ in three replicates of 100 seeds each and germination was recorded every day upto 7th day. The criterion of germination was normal seedling development (ISTA, 1993). For determination of seedling vigour, seeds were placed in folds of germination paper and kept in dark at $20 \pm 1^\circ\text{C}$ on template stands. Lengths of radicle and plumule were measured after nine days and vigour index was calculated following Abdul-Baki and Anderson (1973).

Lipid peroxide formation was studied by Thiobarbituric acid (TBA) colour reaction following Bernheim *et al.* (1948). 0.5g seeds of each treatment were homogenised in 5ml of TBA-TCA reagent (0.5% TBA in 20% TCA). Homogenate was incubated in an oven maintained at 95°C for 1 hour followed by transfer to ice bath immediately. Extracts were centrifuged at $1000 \times g$ and absorbance of clear supernatant was measured at 535nm and 600nm using TBA-TCA reagent as blank. Maloneldialdehyde (MDA) content was estimated by subtracting A_{600} from $A_{535\text{nm}}$.

For membrane permeability studies, 0.5g seeds of each treatment were soaked in 10ml of distilled water in three replicates. Electrical conductivity was recorded on a conductivity bridge (cell constant of $1.2 \times 10^{-6}\text{mhos}$) after every 15 min. upto 1 hr. and then after 2 hrs., 3.5 hrs., 5 hrs., and 24 hrs.

Spectrophotometric absorbance of seed leachate was also measured in ultraviolet region for estimating organic constituents. For this, leachate obtained after soaking 0.5g of seeds in 10ml of distilled water for 24 hrs. was used. Absorbance was recorded at 240nm with distilled water as the blank.

The statistical analysis were done by using MSTATC software, Version 1.4 (R. D. Freed and S. P. Eisensmith, Crop and Soil Science Deptt. Michigan State Univ. USA). The data were subjected to ANOVA in Randomized Complete Block Design and significance was tested at the 5 per cent and 1 per cent level. The correlation coefficients were analyzed between percentage germination and conductivity, UV absorbance and lipid peroxidation.

RESULTS AND DISCUSSION

Storage at ambient conditions resulted in a significant decline in germination in both the cultivars (Table 1). Seeds stored under cryopreservation

Table 1. Analysis of variance of germination and vigour characteristics in of *A. cepa* L. cultivars

Parameter	Treatment	PR	PWF	Treatment MS ^a	Error MS ^b
		Mean $\pm$ SE	Mean $\pm$ SE		
Germination percentage	RT	33.33 $\pm$ 6.11	77.33 $\pm$ 2.30	1640.44**	16.44
	-180°C	70.66 $\pm$ 2.30	86.66 $\pm$ 6.11		
Radicle length	RT	2.32 $\pm$ 0.37	2.30 $\pm$ 0.18	5.03**	0.14**
	-180°C	3.59 $\pm$ 0.35	4.63 $\pm$ 0.46		
Plumule length	RT	4.22 $\pm$ 0.23	5.30 $\pm$ 0.14	8.78**	0.06**
	-180°C	6.55 $\pm$ 0.25	7.63 $\pm$ 0.42		
Vigour index	RT	142.97	588.32		
	-180°C	716.49	1062.62		

^a: df = 3, ^b: df = 6, **: Significant at p 0.01, -: Not determined

did not show such decline and in fact had slightly higher germination values in comparison to the initial values. The radicle and plumule lengths were also adversely affected in RT stored seeds in comparison to cryopreserved seeds. Therefore, ultralow temperature of liquid nitrogen could control the degradative processes occurring at ambient conditions which result in loss of germination and reduce the vigour of seedlings grown from the surviving seed population.

Table 2. Effect of natural ageing on electrolyte concentration and UV absorbance (A₂₄₀) of seed leachate after 24 hr. leakage

Treatment		Conductivity	UV absorbance
		($\mu\text{Scm}^{-1} \text{ g d.wt}^{-1}$)	A ₂₄₀
		Mean $\pm$ SE	Mean $\pm$ SE
PR	Dead	14.25 $\pm$ 1.88	0.53 $\pm$ 0.29
	RT	14.33 $\pm$ 1.15	0.53 $\pm$ 0.05
	-180°C	16.58 $\pm$ 0.62	0.85 $\pm$ 0.09
PWF	Dead	9.43 $\pm$ 0.60	0.35 $\pm$ 0.07
	RT	12.33 $\pm$ 0.28	0.44 $\pm$ 0.05
	-180°C	14.83 $\pm$ 2.75	0.55 $\pm$ 0.01
Treatment MS		16.72*	0.08**
Error MS		2.47*	0.001**

* and **: Significant at p < 0.05 and p < 0.01 respectively.

Membrane permeability studies using conductivity measurements of electrolyte leakage from seeds after various time intervals showed lower values for dead seeds and were almost similar in RT stored and cryopreserved seeds in cv. PR. In cv. PWF also, dead seeds showed less leakage of electrolytes

in comparison to both RT and cryopreserved seeds (Fig. 2). In fact, cv. PWF seeds retrieved from cryopreservation showed the highest leakage of electrolytes.

A spectrophotometric scan between 200-400 nm showed presence of UV absorbing substances in the leachate. An λ_{max} was observed at 240 nm and, therefore, A_{240} values were recorded for all treatments (Table 3). Pattern of

Table 3. Effect of natural ageing on lipid peroxidation in seeds of *A. cepa* cultivars

Treatment		Lipid peroxidation
		Mean $\pm$ SE
PR	Dead	0.0247 $\pm$ 0.0095
	RT	0.0198 $\pm$ 0.0080
	-180°C	0.0175 $\pm$ 0.0093
PWF	Dead	0.0341 $\pm$ 0.0060
	RT	0.0227 $\pm$ 0.0030
	-180°C	0.0191 $\pm$ 0.0020

leakage of UV absorbing substances was same as observed in case of conductivity measurements, as highest leakage was observed in case of LN₂ stored seeds. Membrane integrity has been used as an index of seed viability (Bewley, 1986; Ching and Schoolcraft, 1986) and loss of integrity has been reported to be directly proportional to loss in viability. However, in the present study electrolyte leakage from the seeds retrieved from cryopreservation and thus having higher germination interestingly showed more leakage of electrolytes in comparison to seeds with lower germination and even dead seeds. These results were confirmed by analysis of UV absorbing substances spectrophotometrically. No correlation was found between percent germination and leakage of electrolytes as well as UV absorbing substances (Table 4).

Lipid peroxidation was the highest in the dead seeds followed by RT stored seeds and the lowest values were recorded for cryopreserved seeds. In both varieties, a significant negative correlation was exhibited between percent germination and lipid peroxidation (Table 4). Lipid peroxidation is considered to be a result of free radicle oxygen generation that accompanies the production of malonedialdehyde (MDA). Highly reactive free radical oxygen causes alteration in the cell structure and in turn the cellular functions (Mack *et al.*, 1991).

Though a number of studies indicate membrane permeability to be a useful criterion for assessing the loss in germinability, in case of onion this

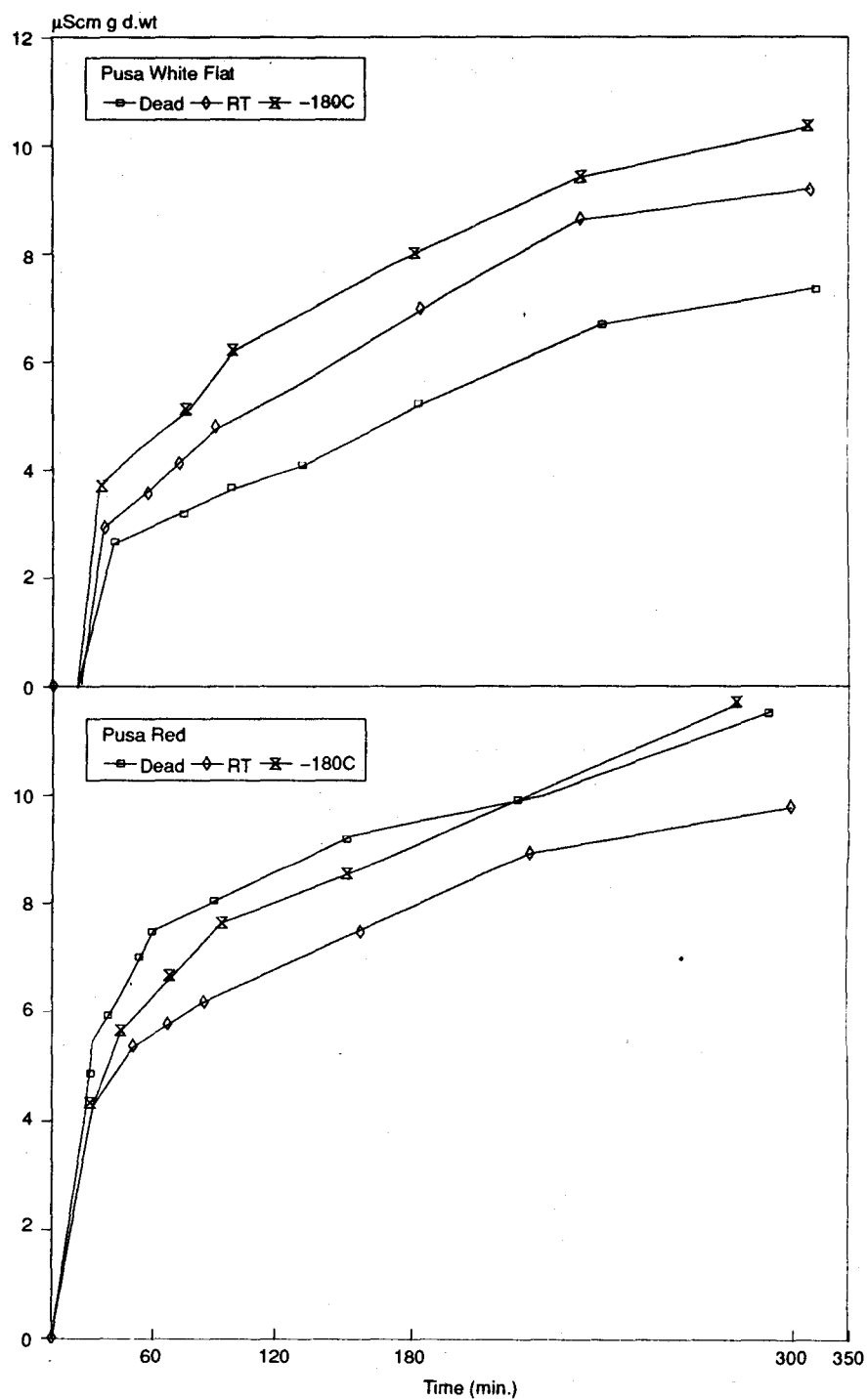


Fig. 2 : Conductivity of seed leachates measured after various time intervals in *A. cepa* L. cultivars stored for nine months

Table 4. Correlation coefficients of percentage germination with leachate conductivity, UV absorbance and lipid peroxidation in *A. cepa* L. cultivars

Parameter	Correlation coefficient with percentage germination	
	cv. PR	CV. PWF
Leachate conductivity	0.896	0.928
UV absorbance	0.882	0.886
Lipid peroxidation	-0.997*	-0.991*

*: Significant at P < 0.05 level

correlation could not be established. On the other hand, lipid peroxide formation was found to be a useful criteria to evaluate the seeds for the extent of decline in seed germination as well as the associated fall in the vigour of the seedlings under ambient conditions. This loss in germination and seedling vigour could be prevented by storing the seeds under cryopreservation where the degradative metabolic processes were also controlled as revealed by the lipid peroxidation assay.

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IN VITRO CONSERVATION OF THREATENED PLANTS OF MEDICINAL IMPORTANCE

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Procedure for *in vitro* multiplication and *in vitro* conservation of six threatened/endangered medicinal plants are reported. Various combinations of growth regulators were tested to select optimal medium for initiation and further shoot multiplication. Slow growth experiments were performed and the shelf-life of shoot cultures on multiplication and/or modified medium could be extended for 11-20 months depending on the species.

Key words : *In-vitro* conservation, *Coleus forskohlii*, *Gentiana kurroo*, *Picrorhiza kurroa*, *Rauvolfia serpentina*, *Saussurea lappa*, *Tylophora indica*

More than 1100 plant species are used in Indian ayurvedic medicine system for the formulations of different drugs. Owing to large scale and indiscriminate collection of wild materials from natural habitat for commercial purposes coupled with insufficient attempts to allow their replenishment or their cultivation, quite a few species of known medicinal importance have become threatened, vulnerable, or even extinct. Thus, there is need to conserve these species through *in vitro* conservation on priority basis. The communication discusses the achievements in the direction of *in vitro* conservation of *Coleus forskohlii*, *Gentiana kurroo*, *Picrorhiza kurroa*, *Rauvolfia serpentina*, *Saussurea lappa* and *Tylophora indica*.

MATERIALS AND METHODS

Initiation of aseptic cultures

Plants of *Coleus forskohlii*, *Gentiana kurroo*, *Picrorhiza kurroa*, *Rauvolfia serpentina* and *Tylophora indica* maintained *ex situ* served as source of explants. Seeds of *Saussurea lappa* were germinated aseptically and these seedlings were used as experimental material. Seeds and small twigs were washed thoroughly, surface sterilized with 0.2 or 0.1 per cent solution of mercuric chloride (HgCl₂) and were washed thoroughly in sterile distilled water 2-3 times. Single nodal stem segments (1.0-1.5cm) and seeds were implanted vertically onto the nutrient medium. In the case of *S. lappa*, terminal buds (shoot tip of 15 days old aseptic seedlings) were used to initiate cultures.

Shoot multiplication and rooting

The shoots regenerated from stem cuttings were subcultured after 3-4 weeks. At each subculture the individual shoots were separated and cut into approximately 1.0cm segments and transferred to multiplication medium. For rooting, individual shoots with 2-4 nodes were implanted onto rooting medium.

Culture medium

Murashige and Skoog's (1962) basal medium with 3 per cent sucrose, 100 mg/l myoinositol and 0.8 per cent agar were used as basal medium (BM). Depending on the experiment, BM was supplemented with benzylamino purine (BAP), kinetin (KN), indole-3-acetic acid (IAA), indole-3-butyric acid (IBA), naphthaleneacetic acid (NAA), gibberellic acid (GA₃), and mannitol. All the ingredients were added to molten agar and pH of the medium was adjusted to 5.8 before autoclaving at 121°C for 15 min in culture tubes closed with either cotton plugs or polypropylene caps.

Culture conditions

For multiplication, cultures were maintained at 25° ± 2°C and 16 photoperiod. For low temperature storage, the cultures were kept at culture room conditions for one week to eliminate contamination. The cultures were then transferred to incubators maintained at 5°C, 10°C and 15°C with or without light.

RESULTS AND DISCUSSION

In vitro multiplication

Attempts were made to standardise a procedure of shoot multiplication of the species. Details of surface sterilization and the best responding media for each species are given in Table 1. Results of the experiments are summarised below (see also Table 2) :

Coleus forskohlii

Surface sterilized terminal nodal segments measuring (1.0 - 1.5 cm) were cultured on MS, MS + KN (0.5 - 2.0 mg/l) in combination with IAA (0.5-2.0 mg/l) or MS + BAP (1.0 or 2.0 mg/l) in combination with IAA (1.0 mg/l) as reported earlier (Sharma *et al.*, 1991).

Table 1. *In vitro* multiplication of endangered plant species of medicinal value under study

Plant species	Surface % HgCl ₂	Sterilization Time (min)	Multiplication medium	Rooting medium
<i>Coleus forskohlii</i>	0.1	10	MS+KN 2.0 mg/l + IAA 1.0 mg/l	MS+IAA 1.0 mg/l
<i>Gentiana kurroo</i>	0.1	10	MS+ BAP 2.0 mg/l + NAA 0.2 mg/l	MS + IBA 0.1-1.0 mg/l
<i>Picrorhiza kurroa</i>	0.1	10	MS+BAP 0.225 mg/l	MS+NAA 0.5 mg/l
<i>Rauvolfia serpentina</i>	0.2	10	MS+BAP 1.0 mg/l + NAA 0.1 mg/l	MS + NAA 1.5 mg/l
<i>Saussurea lappa</i>	0.2	10*	MS+BAP 1.0 mg/l + GA ₃ 1.0 mg/l	MS+NAA 0.5 mg/l
<i>Tylophora indica</i>	0.1	7	MS+BAP 5.0 mg/l + NAA 0.5 mg/l + ascorbic acid 100 mg/l	B5 + IBA 1.0 mg/l

* For seeds

Table 2. *In vitro* conservation responses of threatened plants of medicinal importance under study

Species	Shoot multiplication	Conservation
<i>Coleus forskohlii</i>	12 shoots/4 weeks	18M at 25°C
<i>Gentiana kurroo</i>	5 shoots/4 weeks	11M at 4°C
<i>Picrorhiza kurroa</i>	30 shoots/6 weeks	16M at 10°C
<i>Rauvolfia serpentina</i>	20 shoots/4 weeks	15 M at 15°C 20M at 25°C
<i>Saussurea lappa</i>	4 shoots/ 3 weeks	15M at 4°C
<i>Tylophora indica</i>	5 shoots/5 weeks	12m at 25°C

Sprouting of single shoot was observed on almost all medium but multiple shoot formation was observed in all combination of KN and IAA tested. Optimal response in terms of shoot number and growth of shoots was attained in MS + KN (2.0 mg/l) + IAA (1.0 mg/l): Single explant cultured on this medium produced an average of 12 shoots every six weeks.

For rooting, individual shoots with 3-4 nodes were placed on MS medium supplemented with 0.5 -2.0 mg/l of an auxin (IAA NAA or IBA). Optimal rooting occurred on MS + IAA (1.0 mg/l). The plantlets thus obtained were successfully transferred and established in soil.

Gentiana kurroo

Shoot tips and nodal segments surface sterilized for 10 minutes with 0.1 per cent mercuric chloride were used (Sharma *et al.*, 1993). Different concentrations of BAP (0.2 -2.0 mg/l) and KN (0.2-2.0 mg/l) either alone or in combinations with NAA (0.1-1.0 mg/l) or IAA (0.1-1.0 mg/l) were tested. 50 per cent axillary buds sprouted only in medium with BAP (2.0 mg/l) and NAA (0.5 mg/l). The shoots developed in primary cultures were subcultured to fresh medium to test the effect of different concentrations of BAP in combination with NAA. BAP (2.0 mg/l) and NAA (0.2 mg/l) was found to be the best in terms of number of shoots and shoot growth. An average of 3.5 shoots of 4.2 cm length with 3-4 nodes were produced on this medium providing 15 propagules for the next cycle of shoot multiplication. Of the various media tested best rooting was achieved on basal medium containing 6 per cent sucrose.

Picrorhiza kurroa

Cultures were initiated and multiplied from terminal and nodal cuttings (1.0 - 1.5 cm) using the procedure of Upadhyaya *et al.* (1990). The shoots were proliferated on standard medium supplemented with 0.2 mg/l BAP. These *in vitro* multiplied shoots could be induced to form roots on MS + NAA (0.5-1.0 mg/l).

Rauvolfia serpentina

Terminal and nodal cuttings of field grown plants of *R. serpentina* were used to initiate cultures (Sharma and Chandel, 1992a). The shoots proliferated and optimal response in terms of number of shoots and growth was attained on MS + BAP (1.0 mg/l) + NAA (0.1 mg/l). These shoots were subcultured every 4-6 weeks to generate sufficient material for conservation experiments. Rooting of shoots occurred only in presence of an auxin. NAA (1.5 mg/l) induced rooting in 90 per cent of culture. Rooting was sometimes associated with callusing.

Saussurea lappa

20-30 per cent surface sterilized seeds (0.2% HgCl₂ for 10 minutes) germinated on MS basal medium. Shoot tips of 15 days old seedlings served as explant for shoot multiplication. BAP (0.5-2.0 mg/l) in combination with NAA (0.05-1.0 mg/l) or GA₃ (0.1-1.0 mg/l) was tested to achieve shoot multiplication. On an average 4.0 shoots per explant were produced every three weeks.

For rooting, individual shoots (3 weeks old) were implanted onto rooting media consisting of MS supplemented with 0.05, 0.1 0.5, 1.0 mg/l of IAA,

NAA or IBA. Best rooting occurred on MS+NAA (0.05 mg/l). Increasing the auxin concentration induced callusing. Shoot multiplication of *Saussurea* through hypocotyl and leaves was earlier reported by Arora and Bhojwani (1989).

Tylophora indica

Following the procedure of Sharma and Chandel (1992b), cultures were initiated and multiplied on MS medium supplemented with BAP (5.0 mg/l) + NAA (0.5 mg/l) + ascorbic acid. Addition of ascorbic acid was essential to induce axillary bud break. Rooting of *in vitro* shoots was readily achieved on MS + IAA (1.0 mg/l). These *in vitro* produced plantlets were successfully transferred to pots and maintained under field conditions.

In vitro conservation

Conservation experiments involved employing minimal media, osmoticum or incubation at low temperature. The results obtained so far showed that culture could be maintained for 8-16 months depending on the species and storage conditions (Table 2).

Shoot cultures of these remain viable for 3-5 months (*Saussurea*, *Rauvolfia*) in culture vessel covered with cotton plugs. In comparison, those covered with polypropylene caps remained healthy for a longer period eg., 12 months in *Coleus* and *Tylophora*, thus, polypropylene caps alone were found to be better than cotton plugs for enhancing subculture cycle. (Sharma and Chandel, 1992). This may be due to avoidance of excessive dessication coupled with nutrient depletion as compared to cultures covered by cotton plugs.

Low temperature incubation appears to be highly promising as *in vitro* cultures of *Rauvolfia*, *Saussurea* and *Tylophora* were conserved for 15, 15 and 12 months at 15°C, 4°C and 10°C respectively. In case of *Saussurea* and *Picrorhiza* also low temperature under dark condition was more effective.

Shoot cultures of these species exhibited relatively slow growth with the inclusion of mannitol in the medium. This treatment resulted in maintainance of cultures well over 9 months at 25°C while 15 months under low temperature in *Rauvolfia*, *Saussurea* and *Picrorhiza*. Experiments are currently under way to study the effect of mannitol and other osmoticum under low temperature in other species also.

In vitro techniques are being increasingly used for multiplication and conservation of germplasm of medicinal importance threatened with extinction (Arora and Bhojwani, 1989; Bhojwani *et al.*, 1989; Chandel *et al.*, 1988; Constable, 1990; Sharma and Chandel, 1992a, b). The present study described results of *in vitro* conservation experiments on six species of medicinal importance.

CONCLUSIONS

Protocol for *in vitro* multiplication of *Rauvolfia serpentina*, *Tylophora indica*, *Saussurea lappa*, *Picrorhiza kurroa*, *Coleus forskohlii* and *Gentiana kurroo* were standardized. Shoot cultures could be successfully conserved for 11-20 months without subculture. Addition of mannitol and high sucrose/agar reduced growth. Its effect on increasing shelf-life of cultures is presently being further investigated. Encapsulation of explants for cryopreservation and propagation is a potential alternative being investigated under *in vitro* conservation programme at NFPTCR.

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PULSE CROP GERMPLASM RESOURCES AT NBPGR - ACCOMPLISHMENTS AND PROSPECTS

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Pulse crops are important group of crops next only to cereals. These constitute an essentially recommended component of diet particularly for vegetarians because of their much higher protein content and the complementary amino acid composition as compared with cereal grains. In India, some pulse crops viz., *Pisum arvense*, Lentil and *Lathyrus sativus* were domesticated as early as in the neolithic and chalolithic periods. This region exhibits primary diversity for many pulse crops viz., mung bean, urid bean, chickpea, pigeonpea, cowpea and horsegram. However, pulses remained primarily the crops opted for marginal and poor lands. The native genetic resources of these crops abound in variable forms, landraces, primitive types etc. The National Bureau of Plant Genetic Resources has the mandate to plan, conduct, promote and co-ordinate activities on plant exploration and collection, germplasm import and exchange, plant quarantine, characterization and evaluation, multiplication, regeneration and distribution, documentation and conservation of indigenous and exotic genetic diversity in crop plants and their wild relatives. NBPGR has acquired and evaluated over 37,000 germplasm samples of 20 grain legumes of major and minor importance at its Headquarters and regional stations. The National gene bank's long term repository at NBPGR holds over 22,000 accessions of various pulse crops which are stored at -20°C . There is a systematic and interlinked flow of germplasm of pulse crops in the National PGR programme. The research achievements for various pulse improvement programmes has been fairly significant in the country. The NBPGR's genetic resources activities through the Indian National Plant Genetic Resources System (IN-PGRS) and Crop Advisory Committee (Pulses) have added impetus to the germplasm handling and utilization of these crops. An attempt has been made to summarize these efforts related to PGR activities on various pulse crops in the Indian context. An effective approach to disseminate information base on accessions to the users is their suitable documentation. Inventories have been published by NBPGR on various pulse crops which provide basic information on the introduced germplasm. In addition, NBPGR has also brought out a number of Catalogues on the passport, characterization and evaluation data in relation to germplasm sets of different pulse crops which may be of help to users in selecting out the right type of germplasm for making a seed request. Various suggestions for future PGR activities and their prospects are also discussed.

Key words : Grain legumes, genetic resources, management

Pulses constitute an important group of crops, second only to cereals. These possess high protein content and complement with cereals for their amino acid compositions. The Indian sub-continent is a centre of diversity for many pulse crops such as mung bean, urid bean, chickpea, pigeonpea, cowpea

and horsegram. A few pulse crops viz., *Pisum arvense*, lentil and *Lathyrus sativus* were domesticated as early as in neolithic and chalcolithic periods (Vishnu Mittre, 1974). The native genetic resources of these crops abound in variable forms, landraces, primitive types etc. The conservation and utilization of these resources would therefore, be essentially required.

GERMPLASM EXPLORATION AND COLLECTION

Several explorations have been carried out in various parts of the country and a total of 11,945 collections were made in various crop-based or multi-crop explorations in 8 pulse crops during 1976 to 1992. The collections included mungbean (1992), uridbean (1680), chickpea (1541), lentil (561), cowpea (3539), pigeonpea (1434), pea (590) and mothbean (608). Further, based upon past experiences and gaps, systematic attempts were made recently to explore and collect in prioritized areas. In order to set up such priorities, the mechanism of Indian National Plant Genetic Resources System (IN-PGRS) was exploited which includes recommendations of Germplasm Advisory Committee (GAC) on Pulses interaction with All India Coordinated Pulses Improvement Project (AICPIP), previous collectors' reports and specific collection requests by the collaborating Institutes. Thus, during the period 1988-89 to 1992 a total of 2400 accessions of various pulse crops were collected from different states (Table 1).

Table 1. Diversity of grain legumes collected during 1988-92

Crops	No. of entries	States
Pigeonpea	366	M.P., U.P., Haryana, Bihar, West Bengal, Orissa, Maharashtra, Kerala and Karnataka
Chickpea	493	U.P., Maharashtra, Orissa, Punjab, Rajasthan Haryana, A.P., Gujarat and M.P.
Lentil	180	U.P., M.P., Bihar, H.P., Tripura, J&K, Maharashtra and Rajasthan.
Cowpea	261	M.P., U.P., Haryana, Bihar, West Bengal, Orissa, Maharashtra, Tripura, Meghalaya, J&K, A.P., T.N., H.P., Karnataka and Gujarat
Blackgram(urid bean)	364	M.P., U.P., Haryana, Bihar, West Bengal, Orissa Maharashtra, Tripura, H.P., J&K, T.N., Gujarat, Rajasthan and Karnataka
Greengram (mung bean)	295	M.P., U.P., Bihar, Orissa West Bengal, J&K, Maharashtra, Tripura, Meghalaya, Bihar, Gujarat, Rajasthan and Karnataka
Pea	223	U.P., M.P., Bihar and H.P.
Frenchbean	218	Orissa, Bihar, W. Bengal, Maharashtra, Arunachal Pradesh, Manipur, H.P., J&K and Meghalaya
Total	2400	

Substantial variability was observed and collected in mung bean from Telangana region of Andhra Pradesh for plant habit, leaf size, tolerance to biotic and abiotic stresses, multi-nodal and multi-cluster bearing etc. whereas in urid bean diversity was collected from Chhattisgarh region of Madhya Pradesh and Uttar Pradesh for growth habit, maturity, seed and pod characteristics. Chickpea germplasm collections from north eastern U.P. and north western Bihar showed variability in plant and seed characters. *Cicer microphyllum*, a wild relative of chickpea abounded in patches in Spiti valley, Himachal Pradesh and its various diverse forms were collected. Variability in lentil, particularly for seed types was collected from north eastern Uttar Pradesh and Haryana and western U.P. along the Yamuna river. Maharashtra and H.P. collections are also expected to represent unique variable forms of lentil germplasm (Vishnu Mittre, 1974). Pigeonpea variability was collected from all across the country yet collections from U.P. and north western M.P. represented diverse forms in terms of plant type, seed and pod characteristics. The diversity collected in cowpea particularly from north eastern U.P., Chhattisgarh region of M.P. and the Deccan plateau, exhibited variation for plant height, pod size seed colour and tolerance to biotic stresses. This valuable addition of genetic resources of pulse crops will be useful in terms of conserving variability, their usage in plant improvement programmes and basic studies.

GERMPLASM INTRODUCTION AND EXCHANGE

In addition to the augmentation of pulses germplasm through indigenous collections, further germplasm import/exchange has been carried out from/with other countries across the globe. During 1989-92, 4299 accessions of major pulse crops and their related species were introduced mung bean and pigeonpea were introduced from Far Eastern zone (Taiwan, Thailand, Philippines, Indonesia etc.) whereas chickpea, lentil and peas from Syria (Table 2). The other

Table 2. Legumes introduced during 1989-92

Crop	No. of accessions	Source
Chickpea	1081	Syria, Myanmar, Spain, Nepal, Pakistan
Lentil	912	Syria, Bangladesh
Peas	448	Netherland, Syria, Australia
Frenchbean	431	Columbia
Mothbean	28	USA
Pigeonpea	183	Philippines Myanmar, Indonesia
Mung bean	176	Taiwan, Thailand
Cowpea	97	USA, Brazil, Bangladesh
<i>Vigna</i> spp. and other pulses crop	943	USA
Total	4299	

countries represented were Afghanistan, Australia, Bangladesh, Bulgaria, Canada, France, Germany, Italy, Nigeria and USA. Post entry quarantine clearance was done for the introduced germplasm. In the PEQN, a few promising lines were earmarked which included. EC-284065 in pigeonpea (from Australia), for early duration and high yield; EC-286030-33 in chickpea (from Syria) for resistance to *Ascochyta* blight; EC-292160 in pea (from USSR) for multiple resistance to *Ascochyta* blight and fungal root rot; EC-328164 in cowpea for earliness and high yield and a few other promising introductions in pea - (EC- 324118, -8751, -54, and 89 for multiple traits including earliness) and soybean (EC- 329157, -58, -59, -331131, -32, - 333858, -59 and 60 for early maturity and high yield).

ACTIVE GERMPLASM HOLDINGS

Over 21,000 accessions of various grain legumes viz. mung bean (2733), chickpea (2259), lentil (2156), peas (1793), Lathyrus (448), pigeonpea (2251), cowpea (3434) etc. are maintained at NBPGR Headquarters and its regional stations (Table 3). These accessions are channelized through the characterization and evaluation based on a set of carefully chosen descriptors and their descriptor states mostly for the qualitative and quantitative traits observable

Table 3. Active germplasm collection of grain legumes at NBPGR

Crop	Holdings	Sites
Chickpea	2259	Delhi (79), Akola (1469)
Lentil	2156	Delhi (710), Shimla (530), Bhowali (355), Akola (561)
Peas	1793	Delhi (1417), Shimla (281), Bhowali (95)
<i>Lathyrus</i>	448	Delhi (300), Shimla (13), Akola (135)
Pigeonpea	2251	Jodhpur (26), Akola (2192), Trichur (33)
Mungbean	2733	Shimla (125), Jodhpur (1213), Amravati (1368), Trichur (27).
Uridbean	1744	Delhi (2461), Bhowali (38), Jodhpur (345), Trichur (590)
French bean	4256	Shimla (2800), Bhowali (1345), Akola (111)
Total	21,074	

in field. The evaluated accessions are deposited with longterm repository of the National gene Bank keeping in mind the effective sample size (≥ 2000 seeds per accessions), germination percent (>90 per cent) and proper seed maturity. A set maintained in the active holdings is used for supply to indentors (Fig. 1).

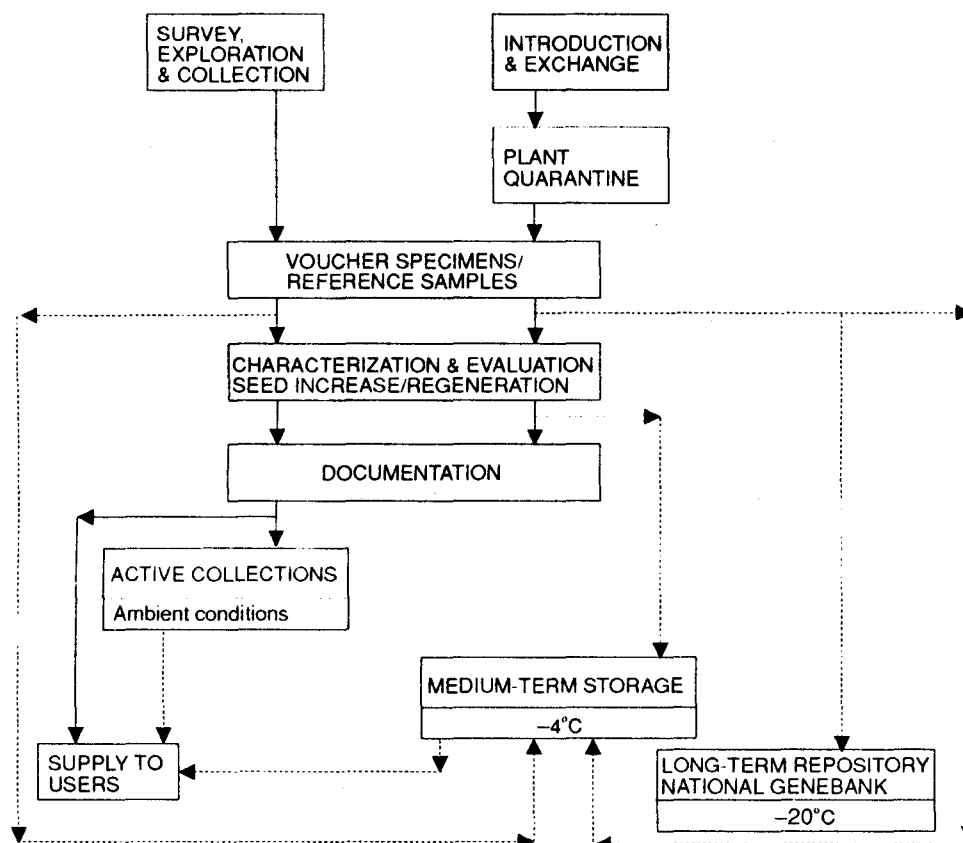


Fig. 1. Flow of germplasm

An attempt was made to identify the duplicates in germplasm holdings of major pulse crops with the help of National Coordinated Programme on Pulses, because the management of huge number of accessions is strenuous and the availability of duplicates is a serious bottleneck to this problem. A frequent exchange of germplasm between various crop based Institutes and State Agricultural Universities besides a supply on demand from NBPGR could be enlisted as the main reasons for the occurrence of duplicates. There is a difficulty in identification of duplicates particularly so in cases where the recipient centres reallocate number to the germplasm received. However, a total of 411 duplicates of germplasm accessions have been sorted out from NBPGR and IIPR collections of pigeonpea (71), mung bean (128), urid bean (38), lentil (136) and fieldpea (38) (Singh and Rana, 1993).

CONCLUSION AND FUTURE PROSPECTS

Collection and conservation of plant germplasm are expensive propositions unless linked to effective utilization (NBPGR, 1991). NBPGR has acquired and evaluated over 37,000 germplasm samples of 20 grain legumes of major and minor importance at its headquarters and regional stations. The National Genebank's long term repository at NBPGR holds over 22,000 accessions of various pulse crops which are stored at -20°C . In the recent past, systematic efforts have been taken to define and implement the Indian National Plant Genetic Resources System (In-PGRS). NBPGR is the nodal agency to co-ordinate and promote germplasm conservation and utilization under this system and all the germplasm collections in the country are ultimately linked to single base collection in the Long Term Repository of National Genebank. Further, the situation specific responsibilities for germplasm utilization, varietal improvement and testing are assigned through the Indian Institute of Pulses Research (IIPR) earlier designated as Directorate of Pulses Research (DPR). In order to effectively coordinate, plan and advise these activities on Pulses PGR's a Germplasm Advisory Committee (Pulses) was constituted by NBPGR in 1991. The GAC (Pulses) met twice, in 1992 and 1993, during which the extensive efforts taken up by NBPGR for germplasm collection, evaluation and conservation on one side and its utilization by various centres of coordinated pulses improvement programme on the other were simultaneously discussed (Singh and Rana, 1992, 1993; Singh and Lal, 1993). A list of catalogue published on pulse crops by NBPGR is given in Table 4.

Table 4. List of catalogues published by NBPGR

Crop name	Year of publication	No. of Accessions	No. of descriptors
Cowpea (<i>Vigna unguiculata</i>)	1981	707	34
Cowpea (<i>Vigna unguiculata</i>)	1982	683	24
French bean (<i>Phaseolus vulgaris</i>)	1981	1773	16
Lentil (<i>Lens culinaris</i>)	1982-83	240	14
Moth bean (<i>Vigna aconitifolia</i>)	1980	285	17
Moth bean (<i>Vigna aconitifolia</i>)	1981	848	17
Moth bean (<i>Vigna aconitifolia</i>)	1983	829	20
Mung bean (<i>Vigna radiata</i>)	1983	302	19
Soyabean (<i>Glycine max</i>)	1983	2009	18
Wingedbean (<i>Psophocarpus tetragonolobus</i>)	1983	1439	31
Winged bean (<i>Psophocarpus tetragonolobus</i>)	1984	88	31
Cowpea (<i>Vigna unguiculata</i>)	-	259	23
Red gram (<i>Cajanus cajan</i>)	-	399	14
Horsegram (<i>Macrotyloma uniflorum</i>)	-	403	12
Soybean (<i>Glycine max</i>)	1983	1353	25

The status of germplasm collection of various grain legumes in different states of India is presented in Table 5 which can serve as a useful reference for planning future explorations for collection of individual pulse crops.

The foremost priority for the effective use of pulses, germplasm collections in their effective transformation from curator's active collections to the breeders working collections, 20 centres were identified for preliminary evaluation of germplasm at multi-locations in the country. Such evaluation work would be carried out under regular monitoring of national germplasm screening nurseries (NCSNs) by the teams nominated by coordinated programme from time to time. Further, in order to streamline the gene bank, active collections management and interactions and to promote efficient utilization Rana (1992) proposed formation of situation-specific core subsets of available base collections of various crops, in developing countries, including India. It is suggested to initiate concerted efforts in this direction beginning with the crops like urid bean, pigeonpea and chickpea which have got both indigenous diversity and coverage.

Table 5. Status of germplasm collection of various grain legumes in different states of India

Priority area/Crop	Urid bean	Chick-pea	Lentil	Pigeon-pea	Pea	Mung bean	Cowpea
Andhra Pradesh	1	1	4	3	3	4	3
Bihar & West Bengal	2	3	3	2	2	3	2
Gujarat	2	1	3	3	4	3	3
Haryana	2	1	3	3	2	3	3
Himachal Pradesh	1	3	1	3	2	3	2
Jammu & Kashmir	1	3	3	2	2	2	2
Karnataka	1	3	4	3	3	3	3
Kerala	1	3	4	3	4	4	3
Madhya Pradesh	2	1	2	2	1	2	3
Maharashtra	1	2	2	2	3	1	2
Orissa	2	2	4	1	3	3	2
Punjab	3	1	4	4	4	4	4
Rajasthan	2	1	2	3	3	3	2
Tamil Nadu	2	3	4	2	4	4	2
Uttar Pradesh	1	2	1	1	1	2	1
North East Hills	2	3	3	4	4	3	2

Where: 1 = Well collected; 2 = Partly collected
3 = Poorly collected; 4 = Not collected

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PLANT GENETIC DIVERSITY COLLECTED IN CENTRAL INDIA

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Key words : Plant Genetic resources, collection, central India

Central India is occupied by several major regions viz., Grid region, Malwa plateau, Narmada valley, Satpura ridge, Chhattisgarh plains in Madhya Pradesh; Vidarbha, Khandesh, Marathwada and Konkan in Maharashtra. It also includes the adjoining regions of Andhra Pradesh and north-west region of Karnataka. To its west are the Western Ghats or Sahyadri ranges, which are enriched for genetic diversity of sesame, okra, rice, horsegram, pigeonpea, chickpea, groundnut, sorghum, castor, niger, little millets, safflower, vegetables, medicinal plants and their wild relatives. Major river basins are Krishna basin, Bhima basin, Godavari basin, Wainganga basin and Tapi Purna basin in Maharashtra. Soils are mostly derived from basalt rocks, have given rise to well known group of soils Alluvial and saline soils are in coastal areas of Maharashtra. The altitude ranges from 0 (sea coast) -1200, (Sahyadri hills) in Central India.

Germplasm collection

A total of 30 exploration trips for crop-specific and multicrop collection were undertaken to various parts of Maharashtra, Madhya Pradesh, adjoining parts of Andhra Pradesh, Karnataka and Gujarat. The explorations were for multicrop (16) and crop-specific (14) which includes explorations in collaboration with National and International organisations. Six collection trips were undertaken in collaboration with DRR, Hyderabad for wild rice in Maharashtra; ICRI, Hyderabad for pearl millet and millet in Maharashtra; CRIJAF, Barrakpore and PKV, Akola for chillies in Madhya Pradesh and Maharashtra and NRC- Soybean, Indore for soybean in Malwa region of Madhya Pradesh. Six crop specific explorations were undertaken for collection of sesame, okra and eggplant under NBPGR/IPGRI collaborative programme. The exploration details are presented in Table 1.

Table 1. Diversity collected in different crops in central India

Region explored	Month/year	Samples collected	Crop diversity
MS, MP & parts of AP	May, 1981	2359	Cereals, millets, legume, oilseeds, onion/garlic
S-E MP (Chhattisgarh)	Oct, 1981	671	- do -
S-E MP (Bastar)	Oct, 1981	828	- do -
West Maharashtra	Oct, 1986	266	Oil seeds & legume
Maharashtra & Karnataka	Sep, 1987	308	Millets, fibre, oilseeds & legume
C-W Maharashtra	Dec, 1987	195	- do -
Eastern, Maharashtra	Feb, 1988	243	- do -
N Karnataka & Maharashtra	Apr, 1988	131	- do -
Eastern, Maharashtra	Oct, 1988	15	Oilseeds & pulses
Eastern, Maharashtra	Oct, 1988	177	Wild rice
S-W Maharashtra	Dec, 1988	37	Pulses & oilseeds
Central Maharashtra	Feb, 1988	176	Oilseeds, pulses and vegetables
Western Maharashtra	Sep, 1989	212	Cereals, millets and pulses
Maharashtra & Karnataka	Dec, 1989	106	- do -
S-W Maharashtra	Mar, 1990	115	Rabi oilseeds
N-W Maharashtra	Apr, May, 1990	117	Pulses, oilseeds and cereals
Eastern Maharashtra	Sep, 1990	66	Sesame
Western Maharashtra	Nov, 1990	84	Fibre crops
Maharashtra & M.P.	Feb, Mar, 1991	200	Eggplant & okra
Eastern Maharashtra	Mar, 1991	116	Lathyrus
Madhya Pradesh	Sep, 1991	87	Sesame
Central Maharashtra	Oct, 1991	155	Sesame
Central Maharashtra	Oct, Nov, 1991	31	Oilseeds
N-W Maharashtra	Nov, 1991	27	Okra
Eastern Maharashtra	Mar, 1992	42	Oilseeds
N-W Maharashtra & part of Gujarat	May, 1992	52	Lucern
C-W Maharashtra	Oct, 1992	80	Sesame
Eastern & Central Maharashtra & MP	Jan, 1993	80	Chillies
Malwa region of MP	Oct, 1993	73	Soybean
Total		7074	

Table 2. Yearwise collection of genetic resources of crop plants from central peninsular India

Crop group	Name of the crop	1981	86	87	88	89	90	91	92	93	Total
Cereals/ pseudo- cereal	Paddy, wheat, maize, barley, Amaranth	291	43	19	111	63	25	-	-	-	552
Millets/ minor millets	Sorghum, pearl millet- <i>Eleusine</i> , <i>Paspalum</i> , <i>Panicum</i> , <i>Setaria</i> , <i>Echinochloa</i>	367	46	68	16	130	33	-	-	-	660
Legumes	Kulthi, lentil, cowpea, mungbean, uridbean, kulthi, khesari, ricebean, swordbean, limbabeen, frenchbean, <i>mucuna</i> , gram, soybean, lablab bean	1185	61	215	272	66	158	-	-	-	1957
Oilseeds	Sesame, ground- nut, niger brassicas, castor, safflower	558	66	90	128	115	108	301	80	73	1519
Bulb- crops	Onion, garlic	537	1	15	2	-	1	-	-	-	556
Vege- tables	Eggplant, chillies, tomatoes, okra, bittergourd, snakegourd, tinda, guar, ashgourd	669	33	83	82	36	229	67	80	-	1279
Fodder Crops	Lucern	-	-	-	-	-	-	52	-	52	
Fire crops	Cotton, sunhemp, jute, kenaf	-	10	3	2	16	53	-	-	-	84
Others	<i>Jatropha</i> , tamarind, <i>dioscorea</i> , tobacco, <i>colocasia</i> , ginger, turmeric, <i>Sesbania</i> , papaya, custard apple, job's tear etc.	221	6	10	40	62	76	-	-	-	415
Total		3828	266	503	653	488	683	368	212	73	7074

Crop diversity collected

A total of 7074 collections were made in over 65 crops in different crop groups viz, cereal/pseudocereal (552), millet/minor millets (660), legumes (1957), oilseeds (1519), bulb crops (556), vegetables (1279), fibre crops (84), forage crops (52) and others (415) from 2588 collection sites. The samples were taken from threshing yard, farm store and weekly village market also. An effort was also made to collect maximum information on the samples collected. Maharashtra and adjoining areas have maximum diversity of crops viz., sesame, rice, horsegram, pigeonpea, chickpea, groundnut, sorghum, castor, niger, finger millet, foxtail millet, little millet, Amarnath, safflower etc. in agricultural crops; okra eggplant, luffa, gourds, lablab bean, jute and sunhemp in fibre crops; lucern in forage crops. An extra care was taken to collect maximum variability for different traits from large populations. The variability collected was for plant type, plant habit, earliness, high bearing etc. The details of exploration and collection of genetic resources from Central peninsular India is presented in Table 2.

Landraces collected

The local landraces collected were :

Rice : Tedki, Hiramoti, Ludka, Luchai, Banceri, Lamba, Dubraj, Cello, Daur, Varangal, Columba, Kolhapuri, Kalakaushal, Tamsali, Tamde, Madhuwa, Velvak, lal-umri, Telachi, Tamugudya, Ziri, Ambemohar, Kalinga, Colam, Radhanagri, Phonda, Dhansal, Vaksal, Ranchandra, Navsal, Panch, Masura, Laldhan, Kudai, Dangi, Kodpi, Kamodpandhra, Kamod-lal, Lalsal, Kalabeda, Pandhribeda, Kalabhat, and Majhrail; Sorghum : Multi, Dagri, Rao-saheb, Dadar, Maldagri, maldandi, Piwli; wheat: Bakshi, Rohila, Bansi, kalakaushal; groundnut: Chitra, Pasri, Yarandi, Japani; brinjal: Baramasi-hara, Champion, kalindi, kateli, Baramasi, Bengali, Bhohri, Parcel, Kaccharia bhata, Gajni, Golenda, Navrang, Gulabi, Langi, Chopra, Chikni, Ringna; chickpea: Chunoli, Sole, Katesole, Lakhya and Madras chana; chillies: Longi, Paratwada local, Karanja local, Achari, Bihali local, Divani local, Bhiwapuri, Kali, Pandi, Jarela, Batka, Khurasni and Lavangi selapur local; sesame: Maghai, Hawri, Nanderi, Tidki, Gopi, Gopya, Dhawdi, Deepali, Heori, Gujarat til, Punjab til, Bhori and Chirdi and soybean: Kalitur and Dhusia

Wild relatives collected

Wild relatives of various crops were also collected during explorations i.e., *Vigna trilobata*, *Vigna umbellata*, *Pennisetum hohenackeri*, *Abelmoschus manihot*, *A. ficulneus*, *A. tetraphyllus*, *A. moschatus*, *A. tuberculatus*, *Carthamus oxycantha*, *Sesamum mulyanum*, *S. indicum* (black seeded wild), *Echinochloa crus-galli*, *Solanum torvum*, *S. surattense*, *S. khasianum*, *Corchorus capsularis*, *C. trilocularis*, *C. olitorius*, *Hibiscus surattense*, *Oryza nivara*, *Tephrosia purpurea*, *Atylosia scarabaeoides*, *Canavalia gladiata*, *Jatropha curcas*, *Physalis peruviana* and *Ocimum* species.

BIODIVERSITY CONSERVATION AND CHARACTERIZATION OF PLANT GENETIC RESOURCES

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Key words : Biodiversity, conservation, molecular characterization, IPR

The significance of biodiversity conservation and the need for its sustainable and equitable use can not be overemphasized, particularly in a country like India, which is one of the top twelve megadiversity countries of the world. Conservation and related aspects of Plant Genetic Resources (PGRs) have been discussed widely in recent years including the discussions at the three meetings of a Keystone International Dialogue Series, which concluded in 1991, and the Biodiversity Conservation Treaty signed at Rio de Janeiro in June, 1992. It has been realized that the problem of biodiversity conservation is complex, particularly when much of this biodiversity is unknown. Better characterization of biodiversity, has also become possible with the advent to new techniques of molecular biology. These two aspects are briefly described in this communication.

Extent of loss of biodiversity and the measures to stop it

It is estimated that only about 1.5 million of a total of estimated 30-50 million species (including microbes and insects) have so far been described (given scientific names) and that roughly 5000 species are lost (become extinct) every year. Because of latitudinal species diversity gradient (LSDG), i.e. due to a decline in diversity from equator to the poles, and also due to decline of biodiversity in highly productive systems, the losses are most severe in tropical countries like India, where human population swells at an alarming rate, so that here it is a battle - "human *vs* animals and plants". It is, therefore, obvious that the biodiversity can not be maintained by taking one species at a time.

Alternative strategies are, therefore, being proposed and debated. One of the suggested alternatives is to identify and protect areas, that are not only rich in biodiversity, but also provide refuge for endangered species. These

areas will have to be protected from activities that cause species loss. Since there are limits to how much land can be set aside as reserves, the problem is not so simple. The problem gets further acute in view of recent evidence that areas rich for one group of animals may not be found in diversity hotspots (Prendergast *et al.*, 1993). The same trend may hold good for plant life also.

Biodiversity is generally described by two parameters : (i) alfa (α) diversity, giving an estimate of the number of species in a specified area, and (ii) beta (β) diversity, giving an estimate of the turnover of species across space. Although we have maps of certain continents showing α diversity, little is known about β diversity. For animals, it has been shown that α diversity peaks along gradient of productivity and decline in the most productive systems. However, for β diversity, the ranges of species distribution are not well understood. Its knowledge is necessary, because if the ranges of distribution of species are large, α diversity is independent of the area sampled and national parks or wild life reserves can be placed any where, but if ranges are small and diversity low, then many scattered reserves will be needed. Although very few such studies have been conducted in plants, wild life reserves need to cover huge area of land, if *in situ* biodiversity conservation has to be undertaken at any reasonable scale. The *ex situ* conservation efforts can not be used as a substitute because, much of our biodiversity is still not documented. The impact of necessary future efforts for *in situ* conservation have been assessed in some cases as shown below.

In USA, a 'Wild land Project' calls for establishment of 'wilderness reserves', 'human buffer zones' and 'wildlife corridors' throughout the areas of human habitation. This project estimates that atleast half of the continent may need to be set apart for biodiversity preservation. Similar estimates are being made elsewhere, even though these ideas sound impractical. Some specialists, therefore, accept that some of the biodiversity will have to go, and nothing can be done about it. (See comments on "7th Annual Meeting of the Society for Conservation Biology" held on June 11, 1993 - Science 260; p. 1868-25th June, 1993).

In view of the above and even otherwise, a proposal for debate among scientific community, envisages *ex situ* conservation by sampling and freezing the biodiversity as "*library of life*", without studying it, so that the labour costs may be substantially reduced and the threatened species can be frozen for future use. This is necessary, because there is certainly a danger of losing much of the uncharacterized biodiversity, if we wait to study and characterize them before conservation (Benford, 1992). In this proposal, it is suggested that the freezing of living organisms on site can be done with ordinary ice/dry ice, to be later transferred to liquid nitrogen tanks. This job can be done by local labour, and the trained taxonomists, may study and classify the taxa, whenever possible.

Characterization of PGRs

In any effort for *in situ* or *ex situ* conservation of PGRs, their characterization is essential. This is traditionally achieved by a combination of morphological and agronomic traits. The effectiveness of this traditional approach is limited and the approach is sometimes also prohibitive. Therefore, the preparation of molecular genetic maps and DNA finger printing have proved to be valuable tools for characterization of breeding lines, crop varieties and other collections representing PGRs at national and international institutes. This is also necessary to ensure that the identity and genetic stability is not lost during conservation.

The molecular markers, that have been used for characterization of crop varieties and other plant genetic resources, include RFLPs, RAPDs, minisatellites (VNTRs) and microsatellites (SSRs). RFLPs are also being converted into sequence tagged sites (STSs) to facilitate their use by different workers at the global level. These molecular markers have also been used for map assisted selection in plant breeding programmes, and map based isolation of important genes.

Characterization of PGRs, as above, will also help (whenever required) in the protection of IPRs including plant breeders rights (PBRs) and farmers rights. There are differences in provisions for protection of these rights in the developed and developing countries, an aspect which is receiving attention both by the governments and by the scientific communities in different countries. In all situations, however, characterization of PGRs using molecular markers, will be inevitable in future.

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PHYTOGEOGRAPHICAL STUDIES IN THE GENUS MORUS L. II. GEOGRAPHICAL DISTRIBUTION AND NATURAL VARIATION OF MORUS LAEVIGATA WALL. EX BRANDIS

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Key words : *Morus laevigata*, distribution, natural variation exploration/collec-
tion

Morus L., is an important genus of the family Moraceae and distributed in temperate and subtropical regions of both the hemispheres. Out of the 68 species recognised from different parts of the World, 35 species are found in Asia, and 14 are from continental America. In India, it is represented by four species namely *M. alba*, *M. indica*, *M. laevigata* and *M. serrata* (Hooker, 1985). *M. alba* and *M. indica* are being exploited for sericulture purpose while *M. laevigata* and *M. serrata* are wild species. Realising the importance of wild species in mulberry improvement programmes, systematic work to collect the wild germplasm from Himalayas was taken up by Central Sericultural Research & Training Institute, Mysore. In the present report, geographical distribution and natural variability of *M. laevigata* are discussed in relation to their botanical and sericultural importance.

M. laevigata is one of the distinct species of the genus which was recognised by Wallich and validated by Brandis (1906). It has been reported as indigenous to India and widely recognised for its wood and edible fruits. Its leaves are rarely used for silkworm rearing (Kanjilal, 1940).

Three explorations were conducted during 1985-89 when plants were in active growth stage (spring and autumn). The geographical areas covered include north-west Himalayan regions in Jammu and Kashmir and Himachal Pradesh; central Himalayas of Uttar Pradesh and north-east states viz., West Bengal, Assam, Manipur, Meghalaya and Nagaland. During the survey agroclimatological informations such as altitude, rainfall, temperature, soil type,

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topography, floristic compositions etc. were recorded. For all the population of *M. laevigata* came across during the survey, details of habitat, population density, and other morphological features were recorded. Stem cuttings were collected and multiplied in the form of bud grafts. Eight accessions which are found useful for sericulture purpose are included in the germplasm collection of the Institute. Chromosome number and ploidy were determined in these germplasm accessions.

Morus laevigata was found distributed as wild tree species in different forests of North eastern states up to the elevation of 1000-1400 m. It is also being cultivated in some parts for rearing silkworms and also as fruit yielding tree in the backyards. Various places of collection of this species made during the survey are shown in Fig. 1.

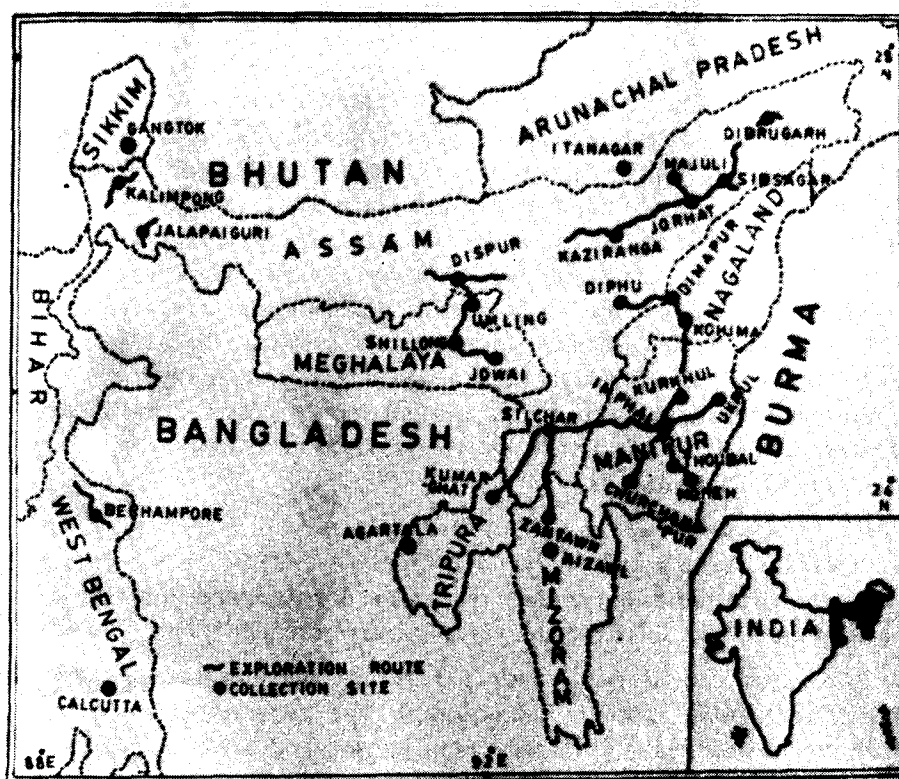


Fig. 1. Distribution of *Morus laevigata* and sites of collection in north-east India

In Assam, this species was found distributed in the forests of Diphu (Karbi Angalang district). Trees were 10-15m ht.; unlobed to heterophyllous

leaves and much larger in size measuring 30 cm breadth and 45 cm length. They also bear large fruits weighting upto 10g. In Nmling forests of Meghalaya, and in the forests of Dimapur and Jalukie of Nagaland, large trees were recorded which have large unlobed leaves and lengthy inflorescence. In West Bengal, isolated trees were noted in the Jalapaiguri, Kalimpong and Lataguri range forests. In these trees, leaves were comparatively smoother than that of other collections. In all these regions the leaves are commonly used for feeding late age silkworms. Trees were also used as timber and firewood source. Morphological variations recorded included large deciduous tree (20-30m), 2-3 m girth; bark brownish-grey with copious milky latex and large lenticels, leaves 15-45 × 10-30 cm coreaceous, ovate-cordate, serrulate; entire or lobed or heterophyllous; stipules 2 cm long, dioecious, catkins pendulant, male catkins 10-12 cm long, slender, drooping, female catkins 10-15 cm long; fruit 6-18 cm long, cylindrical, sweet but insipid. Rooting in stem cuttings was poor (0-10%). Bud grafts on local varieties showed 70-80 per cent survivality. Plants established as bud grafts exhibit luxuriant growth in the germplasm of C.S.R. & T. I., Mysore. Of the 8 collections conserved in the germplasm one is diploid, 5 are triploids and two are tetraploids. Mixoploidy has also been recorded in some collections.

In general *M. laevigata* is a distinct species as recognised by the earlier taxonomists. It is commonly distributed in North eastern regions and not found in central and north western Himalayan forests. In Delhi and other parts of Uttar Pradesh, this species is introduced as avenue/fruit yielding tree.

Preliminary studies made at the Institute revealed that, majority of the accessions showed fast growth, succulent large leaves, size of leaf, late senescence and drought tolerance. Feeding trials also indicated that leaves are acceptable to lateage silkworm. These features of *M. laevigata* are useful in mulberry breeding programmes.

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GERMPLASM EXPLOITATION FOR COLD TOLERANCE IN PIGEONPEA

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Key words : Pigeon pea, exploitation, cold tolerance

Pigeonpea (*Cajanus cajan* L. (Millsp.) spreads pantropically and grows well in warm climates. The low temperatures (below 20°C) affect its germination and growth adversely (Jabrun *et al.*, 1981). The cultivation of pigeonpea is basically confined in tropical plains and negligible in temperate climates. The production trends during last three decades have shown a stagnation in Indian subcontinent and one of the possible strategy for increased production is development of cultivars suitable for non traditional areas and cold seasons. To evolve such cold tolerant types, a search for variation in the germplasm is essential.

Large germplasm collections of pigeonpea are available and they can be utilized provided evaluation for searching cold tolerant types is done. In pigeonpea, techniques for screening germplasm to cold tolerance is completely lacking. Steps are necessary for evolving some selection criteria at early germination/seedling stage under laboratory conditions as field trials will require lot of manpower and funds to screen huge germplasm collections.

In order to get some idea about cold tolerance in the pigeonpea, the spring planting (February, 1988) of accessions were done at low atmospheric temperature and mean soil temperature of 14.8°C at 5 cm depth. All genotypes showed a poor emergence (below 50%) except one genotype with 64 per cent emergence. Further studies with different accessions of pigeonpea were done under laboratory conditions in incubator for their capacity to germinate at low temperature i.e. 14°C, which was considered low for pigeonpea germination. The comparisons were also done at 20°C and 28°C (normal). The mean germination at these three temperatures showed wide variation in genotypic behaviour (Fig.1). Genotypes at number 21, 23, 25, 27, 29 and 31 showed high or at par germination both at low and normal temperatures while others were

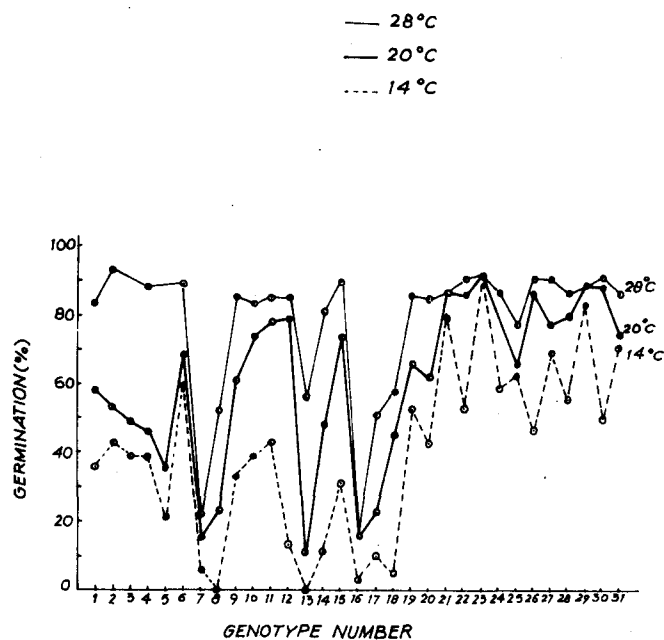


Fig. 1. Germination (%) at 15 day in pigeonpea genotypes at three incubation temperature

poor at low temperatures. The good germinators had high speed of germination as well at low temperatures. It was also apparent (Fig. 2 & 3) that differences in genotypic germination were more pronounced at low and medium tempera-

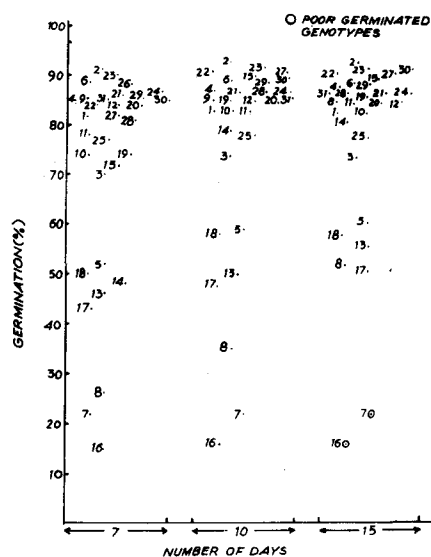


Fig. 2. Germination (%) on different days in pigeonpea germplasm at 28°C incubation temperature

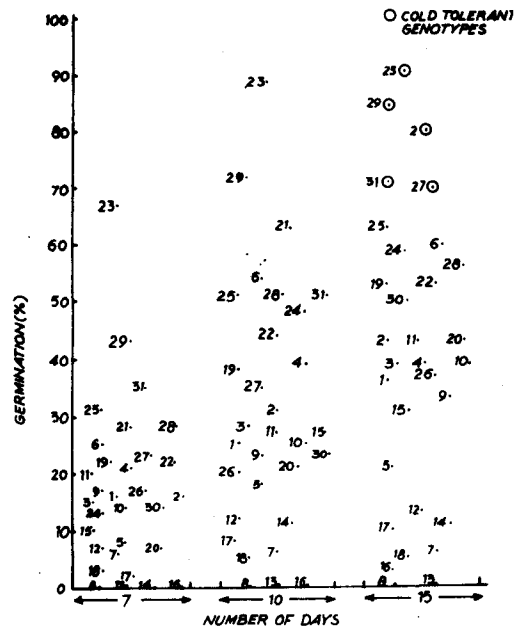


Fig. 3. Germination (%) on different days in pigeonpea germplasm at 14°C incubation temperature

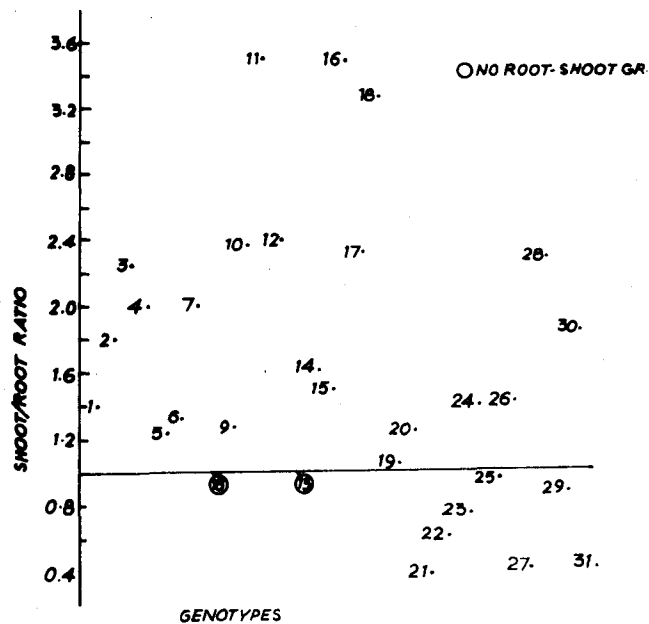


Fig. 4. Shoot/root ratio in pigeonpea genotypes at 28°C incubation temperature

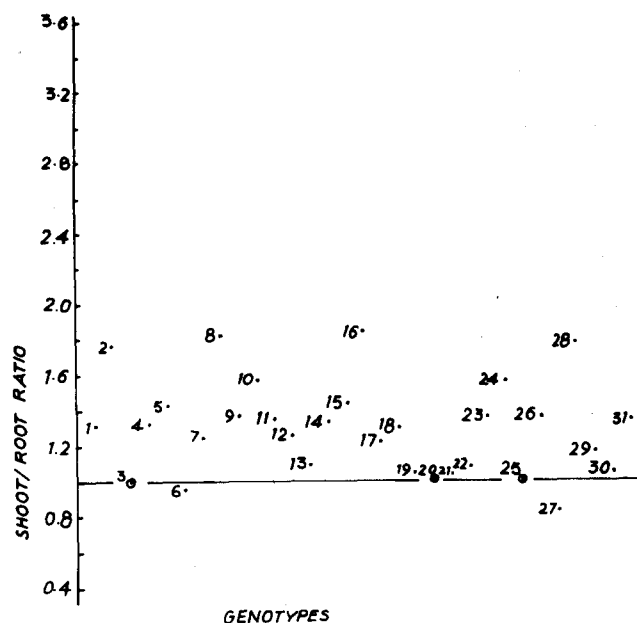


Fig. 5. Shoot/root ratio in pigeonpea genotype at 14°C incubation temperature

tures while at normal (28°C) temperature regime, genotypes showed clustering at higher peaks. The similar behaviour was recorded for field emergence at a colder site by the cold tolerant types i.e., better germinators at low temperatures. Such genotypic differences in early growth at cold temperatures during germination can become good selection criteria. Among the seedling traits it was indicative that shoot length can not be taken a criteria for selection of cold tolerant types, while the character-root length shows contrasting differences between cold tolerant and other groups at low incubation temperatures. The shoot/root length ratio in cold tolerant types at 14°C was found less than one i.e. longer roots than shoots while most of the other genotypes had a ratio more than one (Fig. 4, 5). These results confirm well under laboratory and field conditions.

Further studies on physiological, cytological and biochemical parameters being conducted, the results of which have not been presented in this paper.

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BROWN PLANTHOPPER RESISTANT GENETIC ARSENAL OF I.G.K.V. RICE GERMPLASM RAIPUR

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Key words : Rice germplasm, brown plant hopper, *Nilaparvata lugens*, resistance

In recent times, brown planthopper (*Nilaparvata lugens*) has assumed importance in Chhattisgarh region, a eastern part of Madhya Pradesh, where in 1975, its outbreak resulted to reduce the rice yield to the extent of 34.4 per cent (Gangrade *et al.* 1978). Since 1973, it had caused extensive damage to rice crop in various parts of India (Nalini Kumari *et al.*, 1975). Emergence of insect biotypes is a constraint for the use of resistant varieties in IPM programme. Therefore, to stay ahead of the problem improved resistant cultivars must be developed with more genetic diversity. A large collection of about 20,000 rice accessions are available at IGKV, Raipur of which 78.8 per cent belongs to this Chhattisgarh region only. This material was collected during 1971 to 1981 by Dr. R.H. Richharia (Sharma *et al.*, 1987). The importance of this germplasm needs no introduction. This has been stressed many times both at national and international level particularly in the context of fast spread of high yielding varieties resulting in large scale erosion of useful genes.

Nilaparvata lugens insect is being mass reared throughout the year in a air cooled glass house at $30^{\circ}\text{C} \pm 5^{\circ}\text{C}$ on potted TN₁ variety to get the steady supply of insect for various studies. A total 2500 rice accessions were screened against this insect in glass house by adopting the technique described by Kalode *et al.* (1975). Promising lines identified in seedling bulk test were retested several times and on confirmation, few of these cultivars were considered for insect feeding test.

Of the 2,500 rice accessions evaluated so far, 84 varieties were confirmed as a resistant and 32 varieties indicated moderate degree of resistance to *Nilaparvata lugens* population at Raipur. All these 84 resistant varieties exhibited

plant damage score below 3 and few of these varieties (Table 1) were free from apparent plant damage symptoms. Most of these resistant varieties belong to Bastar, Raipur, Raigarh and Balaghat districts of this region denoting possibility of ecogenetic diversity.

Table 1. Brown planthopper resistant genetic arsenal of rice germplasm

Av. Plant damage score (0-9)	Rating	IGKV Acc. No.
0 — 1	R	H 218, J 432, F 16, H 435, B 2682, D 1043, W 91, A 719
1.1 — 2	R	K 2531, D 1015, PTB 33, B 2876, D 1164, D 279, D 455II, D 455 III, K 556 II, K 1173, K 60, G 976, J 287II, B 1862, B 611, K 2478, K 430, K 446II, D 1167, B 1651, K 1832, C 738, B 57II, L 289I, A 2631, P 879, L 289II, B 2712, C 62III, G 809,
2.1 — 3	R	H 56, J 55II, C 758, K 2167, K 1167I, K 1163, D 8011, B 803II, K 2312, K 2388, K 2413 K 1592, B 2655, K 1699, D 1163, D 1771, K 224, K 711 III, B 409, K 544, B 1261, D 475, B 432II, B 846I
3.1 — 4	MR	K 2154, K 2520II, K 1751, K 1836, R 289II, K 1338IV, D 470I, G 544, G 619, G 842, K 2586, K 1272, K 86, K 197, K 2158
4.1 — 5	MR	K 2140, K 1811, K 2012, K 1831, K 2071
9	S	TN-1

R = resistant, MR = Moderately resistant, S = Susceptible

This result thus symbolises the presence of vast potential in this germ plasm with respect to BPH resistant genetic material. Now these paramount BPH resistant genetic arsenal needs further evaluation with respect to establish relatedness amongst these 84 BPH resistant accession identified. Most authentically RFLP and RAPDS analysis of rice DNA will throw more light on this aspect to disclose the new BPH resistant genes from these lines.

Feeding rate of insect on some selected varieties ranged between 0.96 mm² per female in Chapdo to 0.65 mm² per female in Hinga variety which exhibited 0.65 plant damage score. The results are crystal clear to note genetic variability amongst these identified varieties. Reaction of differential donors were also tested. The standard seedling test showed Mudgo (Bph1), ASD7 (bph2), and Babawee (bph4) to be highly susceptible. Rathu Heenati (Bph3) and Balamawee (Bph9), moderately resistant and swarnalata (bph6) and ARC 10550 (bph5) resistant (Table 2) BPH honeydew excretion test confirmed these results. Donors received from Directorate of Rice Research, Hyderabad were also resistant at Raipur, thus indicated similar virulency patterns at both locations. But comparison with donors received from Pattambi, showed BPH populations is more virulent than Pattambi.

Table 2. Resistance of selected donors to the BPH Population in Raipur, M.P.

Donor	BPH gene	Damage		Honeydew in 24 h (mm ² /female)
		Score	Rating	
Balamawee	Bph 9	4.1	MR	12.61
Swarnalata	bph 6	0.5	R	18.66
Rathu Heenati	Bph 3	5.0	MR	31.51
Mudgo	Bph 1	9.0	S	78.89
ASD 7	bph 2	9.0	S	132.37
PTB 33	R check	1.6	R	6.80
TN-1	S check	9.0	S	66.34
ARC 10550	bph 5	0.8	R	10.10
Babawee	bph 4	7.7	S	19.20
TN1		9.0	S	32.37

R = Resident

MR = moderately resistant,

S = susceptible

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EVALUATION STUDIES ON KALMEGH (*ANDROGRAPHIS PANICULATA* NEES)

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Key words : Kalmegh, *Andrographis paniculata*, evaluation

Kalmegh (*Andrographis paniculata*) is an annual herb belonging to the family Acanthaceae. It has a wide distribution beginning from moist shady lands in Himalayan foothills to Indo- Gangetic plains and humid tracts of penninsular India. The plant is 30-90 cm. in height with quadrangular stem, bracteate lanceolate leaves characterised with small winged petiole, slightly undulate margin, acuminate tip and covered with hairs all over the leaf lamina. It bears small white-purple bi-lipped flowers with dark purple tinged petals during November to January. The fruit is a linear capsule containing 8-12 seeds. The herb contains compound andrographalide in varying quantities is a terpenoid with unsaturated lactone responsible for its bio- activity (Talukdar, 1968).

The whole herb is used in ayurvedic medicines for its alterative, antihel-mintic, antipyretic, antihistamic, febrifuge and chologogue properties. It is extensively given as a remedy for fevers. It is also used as an cheaper substitute of Chirayata, *Swertia chirata*. In allopathic system of medicines it is given to tone up liver functions (Chopra 1958). Although kalmegh is extensively used in Indian system of medicines, but it is not yet cultivated. The supply of herb is met from the wild growing populations which is now under constrain. No systematic studies have been made. Considering to its value as a drug raw material the authors have initiated a study on evaluation of wild growing populations with a view to identify a suitable genotype for introduction into agriculture. The present communications is based on these studies. A total of 10 population samples assembled from various parts of India were first raised in well prepared nursery plots at NBPGR Issapur farm during first week of June 1991. The seedlings at 40-45 days of age were transferred to field at a distance of 60 cm × 30 cm in the first week of August when they attained 10-15 cm. height. The crop was given necessary interculture and irrigation.

The herb samples were collected after 100 days when it begins flowering during November, second sample was collected at pod setting stage in January and third at seed setting stage in March. The samples were shade dried and were analysed for its content by liquid chromatographic method (Srivastava 1991). Observations were taken on the following characters based on average of three plants 1) plant height cm. 2) no. of branches/plant 3) no. of leaves/plant, 4) leaf color, 5) stem characters, 6) fresh wt./plant 7) dry wt./plant 8) pod length 9) no. of seeds/pod 10) percentage andrographalide content, 11) 100 seed wt. 12) Biological yield. It was observed that at vegetative stage, the plant height ranged from 20 cm. (VG 001) to 48cm. (VG002), whereas at flowering stage the maximum was in IC-111288 (50 Cm.) and minimum in VG001 (34 cm.). IC-111284 showed a bushy habit with 4-6 branches whereas all other accessions have none or one/two branches except the main stem. Leaves are the main yield attributing character as it contains the andrographalides, the pharmacological active compounds. IC-111288 gave maximum number of leaves both at vegetative and flowering stages. In IC-111287 and IC-111288 showed dark green leaves with blackish purple lower surface whereas other accessions have lighter colour than this. Physical testing also indicate that leaves of IC-111287 and IC- 111284 are more bitter than others.

A maximum of 2.4cm. pod length was recorded in IC-111289 and IC-111285 recorded lowest pod length of 1.5 cm. at vegetatively stage. Accordingly

Table 1. Some promising lines of Kalmegh

Accession No.	Vegetative stage	Harvesting stage	Late Harvested Sample
	*gm/@gm/%	*gm/gm/%	*gm/@gm/%
IC-111286	10/-/1.90	8/3.78/0.20	7/3.02/2.85
IC-111287	12/-/3.02	12/4.16/0.19	24/11.2/5.0
IC-111288	11.5/-/0.23	20/3/40/2/55	30/14.4/6.2
IC-111289	18/-/1.10	22/11.36/0.35	-
VG-001	8/-/1/20	7/1.34/0.39	28/12.5/5.7
VG-002	14/-/-	15/7.46/0/14	18/7.6/4.25

*Fresh wt/@ Dry wt/ % andrographalide

number of seeds per pod was also maximum in IC-111289 (12-14) and lowest in IC- 111286 (4-6). Number of pods per plant at harvesting stage was highest in IC-111288 (132) and lowest in IC-111291 (18-20). Fresh herb yield on per plant basis was maximum in IC-111289 (20.3gm) at vegetative stage and 22gm. at harvesting stage whereas minimum in VG-001 (9.0) at vegetative stage and 7gm. at harvesting stage. Maximum dry herb was obtained in IC-111289 (11.36gm.) and minimum in VG-001 (2.3gm). The biological yield per row was

highest in IC-111289 (203 gm. and 220 gm.) and lowest in VG-001 (90 gm & 70 gm) at both the stages. Andrographalide content: It was noted that at vegetative stage maximum content was in IC-111287 (3.02%) whereas at harvesting stage IC-111288 showed maximum content of 2.55 per cent.

In *Andrographis paniculata*, main yield attributing characters are fresh wt./dry wt. and andrographalide content. Persual of data recorded shows that biological yield is directly correlated to the percentage andrographalide content. Highest biological yield is recorded in IC-111289 (180 gm./row/10 plts.) and maximum alkaloid content of 3.02 per cent is recorded in IC-111287 at vegetatively stage. Similarly at flowering stage maximum yield is again recorded in IC-111289 (220 g.) and maximum andrographolide content is found in IC-111288 (2.55%). Although seasonal variations in andrographalide content are reported by Maiti *et al.* (1959). An interesting feature is noticed when late harvested nursery raised plants were analysed comparatively high percentage of andrographolide content of 6.2 per cent and 5.7 per cent is recorded in IC-111288 and VG-001 respectively viz., an increase of 50-60 per cent.

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EXPLOITATION OF CITRUS GERMPLASM

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Key words : Citrus germplasm, utilization

The citrus industry continues to be based upon naturally occurring well established cultivars. It has been possible because of sudden change in heritable characters, which occur frequently in citrus. The different species of citrus and related genera also cross freely in nature and tremendous scope exists in its utilization with regard to identification of superior scion/cultivar for direct cultivation and their use as rootstock. Under north Indian conditions, the cultivation of kagzi lime (*C. aurantifolia*) poses several limitations like sparse and erratic fruiting, poor growth, susceptibility to canker and high incidence of dried twigs. Lemons may be tried under such conditions as suggested by Singh (1977). Screening of number of lime (*C. aurantifolia*) and lemon (*C. limon*) selections for a number of years revealed superiority of a lemon (suspected to be a hybrid of lime and citrus/lemon) which has typical character in growth and bearing habit. Fully developed fruits observed in the last week of April are seedless with attractive colour, smooth skin, juicy and acidity 5.5 per cent thus ideally utilized during peak summers.

Rootstock to control tree size and time of fruit maturity

Indigenous as well as exotic citrus types, related genera (*p. trifoliata*) and its hybrid (Citranges and Citrumelo) as reported by Swingle and Reece (1967) were utilized as rootstock for kinnow mandarin. Screening of seventeen rootstocks for kinnow mandarin with regard to growth, fruit yield and quality for a number of years revealed the superiority of three rootstocks viz., Troyer Citrange (Washington Naval orange x trifoliate orange), Karna Khatta (*C. karna*) and Sohsarkar (*C. karna* of Assam). Troyer citrange induced precocity and controlled tree size, thus ideally suited for close planting. A correlation in fruit yield and tree size was also observed. Besides controlling the plant vigour, time of fruit maturity was also found to be influenced by the rootstock.

It would be evident from Table 1 that fruits of kinnow mandarin on Troyer Citrange developed bright deep orange colour at the earliest and hastened the fruit maturity to a great extent (Fig. 1). Fruits obtained from this rootstock showed high T.S.S. and acidity. However, the fruits of kinnow on Karna Khatta and Sohsarkar delayed maturity by reducing the acidity appreciably. Thus fruit maturity of kinnow mandarin was extended from the end of November to mid of January by using Troyer Citrange, Karna Khatta and Sohsarkar as a rootstock.



Fig. 1. Influence of rootstock on time of fruit maturity in kinnow mandarin

Table 1. Chief characteristics of kinnow mandarin on three rootstocks

Characters	Rootstock		
	Troyer Citrange	Karna Khatta	Sohsarkar
1. Plant vigour	Standard vigour	Semi-vigorous	Vigorous
2. Tree volume (m ³)	2.80	3.50	4.0
3. Stionic compatibility	Overgrowth of rootstock	Smooth union	Smooth union
4. Precocity/fruit bearing (year after planting)	3	4	4
5. Fruit yield/plant	60 to 80	80 to 100	100 to 120
6. Fruit weight	160 g	185g	200g
7. Fruit size (cm ²)	37.3	41.5	42.6
8. Time of fruit maturity and quality	End of November to mid of December	Mid of December to end of December	End of December to mid of January
I. End of November			
Colour of fruit	Orange	Yellow	Green
T.S.S.	11.5	9.8	9.5
Acidity	1.5	1.2	0.85
II. Mid of December			
Colour of fruit	Bright deep orange	Orange	Yellow
T.S.S.	11.0	10.0	9.8
Acidity	1.2	0.98	0.82
III. End of December			
Colour of fruit	Deep orange	Orange	Orange
T.S.S.	10.8	10.5	10.2
Acidity	1.02	0.89	0.78

Tolerance to excessive heat/stress condition

Selection of kagzi kalan lemon showed tolerance to excessive heat and stress conditions during peak summer months (Fig. 2).

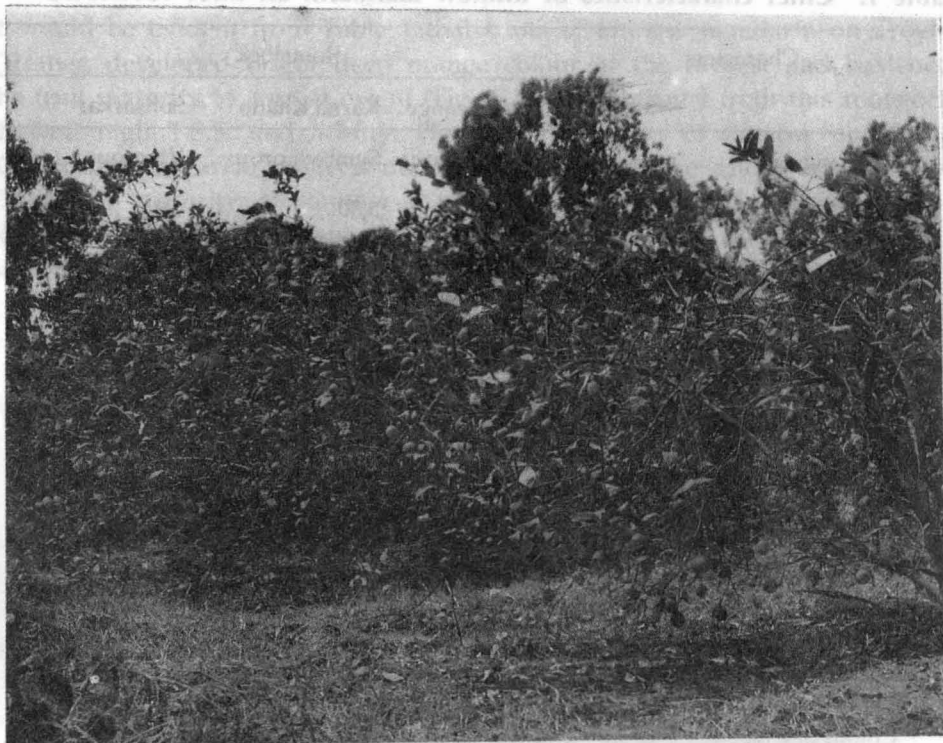


Fig. 2. Tolerance to excessive heat and stress condition in lemon

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VARIABILITY IN POINTED GOURD (*TRICHOSANTHES DIOICA* ROXB.) GERMPLASM COLLECTED FROM EASTERN UTTAR PRADESH

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Key words : Pointed gourd, *Trichosanthes dioica*, germplasm, collection, variability

India is considered to be the centre of origin for pointed gourd (*Trichosanthes dioica* Roxb.). It is extensively cultivated in 'diara lands' in Assam, Bengal, Orissa, North Bihar and eastern Uttar Pradesh. Due to its higher consumer preference and medicinal properties, the cultivation of pointed gourd was also brought to the plains of India. The performance of genotypes vary considerably with the change of environment. The environmental influence on the phenotypic expression is identified by growing the breeding material under different environments and studying the changes brought out by it.

The assessment of variability present in the crop helps in successful utilization of plant characters develop to suitable varieties for yield and stability as suggested by Singh *et al.* (1985). Pointed gourd bears different staminate flowers in long pedicel, born singly (solitary) and pistillate flowers (also solitary) in short peduncles, 1-5 carpels, usually three; thick short style terminated by three bilobed or divided papillate stigma (Seshadri, 1986).

Fifty seven genotypes of pointed gourd were collected and observations were recorded from farmer's field in eastern U.P. during August, 1994. Randomly 5 plants were taken into consideration for observation. The collections were made from Varanasi, Jaunpur, Sultanpur, Faizabad, Gonda, Siddarth Nagar, Gorakhpur, Azamgarh, Mau and Ghazipur districts (Fig. 1). It includes areas both river belts (diara land) and plains.

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Table 1. Pointedgourd germplasm characterisation

Accessions	No. of bran- ches/ plant	No. of see bran- ches/ vine	Inter- node length (cm)	Petiole length (cm)	Mid rib length (cm)	Total No. of node/ vine	Fru- ting node (No.)	Flower length (cm)	Fruit length (cm)	Fruit volu- me (cc)	Dia- meter of fruit (cm)	Fruit weight (g)	vine length (m)	No. of angu- lar ribs	Yield/ plant (kg)
U32/DR/03	14	5	14.40	1.50	4.60	28	6	4.40	6.70	31	2.60	21.00	3.30	5	0.950
U32/DR/04	9	3	10.50	4.50	5.80	58	12	3.60	5.40	26	3.10	20.00	5.50	5	0.670
U32/DR/05	12	7	10.10	3.30	5.60	57	12	2.20	4.30	42	2.40	34.00	6.20	5	0.825
U32/DR/07	10	4	12.35	4.10	5.60	52	3	4.90	3.70	34	1.80	24.00	5.40	6	0.770
U32/DR/08	8	2	13.35	3.50	6.20	35	18	4.90	6.00	20	2.20	15.00	4.20	5	0.960
U32/DR/09	16	8	14.35	3.30	4.90	34	12	3.80	5.00	21	2.10	19.00	3.55	5	0.700
U32/DR/10	13	3	15.75	4.70	5.40	52	10	3.20	4.40	30	2.00	20.00	5.80	5	0.540
U32/DR/11	11	2	12.30	4.00	5.50	38	8	5.00	6.60	24	2.70	17.00	4.70	5	0.660
U32/DR/12	7	2	12.45	3.50	7.70	34	9	4.00	6.80	28	2.80	14.00	5.30	5	0.800
U32/DR/13	14	4	14.00	3.60	6.00	45	21	3.00	6.30	25	2.80	19.00	6.10	5	0.890
U32/DR/14	5	1	6.85	1.50	3.70	18	5	3.80	7.00	20	1.90	22.00	1.20	4	0.960
U32/DR/15	8	2	13.10	3.60	6.40	30	7	4.60	5.00	22	1.60	14.00	3.50	5	1.100
U32/DR/16	6	3	14.75	4.60	5.6	29	9	4.00	6.30	26	2.30	26.00	3.15	6	0.830
U32/DR/17	11	5	12.40	2.00	6.00	36	8	5.20	7.50	30	2.20	27.00	6.55	5	0.550
U32/DR/18	23	9	6.95	2.60	4.50	41	9	4.50	6.20	20	1.20	17.00	1.90	5	0.737
U32/DR/19	20	7	12.40	3.50	5.60	25	13	2.30	5.80	16	3.90	10.00	3.15	5	0.812
U32/DR/20	12	6	7.00	1.60	5.80	15	7	5.80	4.80	30	2.40	26.00	7.75	5	0.480

(Cont. on next page)

Accessions	No. of bran- ches/ plant	No. of see bran- ches/ vine	Inter- node length (cm)	Petiole length (cm)	Mid rib length (cm)	Total No. of node/ vine	Fru- ting node (No.)	Flower length (cm)	Fruit length (cm)	Fruit volu- me (cc)	Dia- meter of fruit (cm)	Fruit weight (g)	vine length (m)	No. of angu- lar ribs	Yield/ plant (kg)
U32/DR/21	21	8	7.00	1.10	5.00	68	7	5.10	3.20	15	2.70	12.00	3.25	5	0.375
U32/DR/22	10	2	5.40	2.00	6.00	24	9	2.10	5.60	23	2.50	11.00	6.60	5	0.590
U32/DR/23	11	4	14.60	3.40	6.50	31	29	4.70	4.40	28	2.70	14.00	6.10	5	0.730
U32/DR/24	8	3	15.10	2.50	4.60	64	42	3.80	5.40	35	2.90	21.00	6.20	5	0.080
U32/DR/25	11	5	5.80	3.00	6.20	25	10	4.40	5.40	26	2.50	20.00	5.35	5	0.900
U32/DR/26	10	4	13.90	3.60	7.60	42	26	5.60	7.30	41	3.00	37.00	10.20	5	2.640
U32/DR/27	17	6	15.60	3.2	8.4	40	19	3.10	6.50	24	2.90	14.00	10.65	5	0.501
U32/DR/28	13	4	14.65	3.60	6.80	17	14	5.10	4.80	33	2.50	14.00	4.80	5	0.640
U32/DR/29	12	3	12.20	2.20	5.60	49	8	4.60	5.10	40	3.40	37.00	6.20	5	1.150
U32/DR/30	11	5	8.20	1.70	5.50	29	21	2.60	5.70	23	2.30	12.00	3.85	5	0.768
U32/DR/31	20	8	12.48	4.10	6.60	45	17	4.80	5.95	31	3.00	21.00	4.30	5	0.580
U32/DR/32	11	2	15.30	3.20	6.40	55	7	5.10	6.60	38	2.70	25.00	8.10	5	0.930
U32/DR/33	19	5	14.75	4.70	5.30	74	14	5.60	6.80	37	3.00	26.00	4.60	5	0.800
U32/DR/34	6	1	8.10	1.5	4.90	23	10	5.20	5.00	34	3.10	24.00	3.50	5	1.050
U32/DR/35	16	6	20.60	3.60	5.33	55	11	5.40	6.90	25		14.00	11.10	6	0.930
U32/DR/36	6	1	4.75	1.70	5.10	47	40	3.40	4.10	38	2.50	19.00	3.00	5	0.500
U32/DR/37	8	4	13.40	5.40	7.10	68	26	2.80	3.80	27	2.70	17.00	4.80	5	0.430
U32/DR/38	13	5	13.70	4.00	6.80	62	23	6.60	6.10	23	2.80	20.00	8.45	5	0.521

(Cont. on next page)

Accessions	No. of bran- ches/ plant	No. of see bran- ches/ vine	Inter- node length (cm)	Petiole length (cm)	Mid rib length (cm)	Total No. of node/ vine	Fru- ting node (No.)	Flower length (cm)	Fruit length (cm)	Fruit volu- me (cc)	Dia-me- ter of fruit (cm)	Fruit weight (g)	vine length (m)	No. of angu- lar ribs	Yield/ plant (kg)
U32/DR/39	8	2	9.50	3.20	5.50	27	16	5.50	5.50	16	2.60	12.00	5.55	5	0.477
U32/DR/40	23	9	15.30	4.10	5.40	89	24	6.20	4.90	22	2.50	14.00	5.30	5	0.659
U32/DR/41	10	2	12.70	2.90	10.50	52	31	7.80	6.70	28	3.20	18.00	7.50	5	2.639
U32/DR/42	18	5	10.20	1.60	7.70	98	41	6.70	6.20	31	2.20	22.00	8.20	5	2.832
U32/DR/43	27	11	10.30	3.50	10.70	46	19	6.70	6.70	28	3.60	27.00	2.80	5	2.440
U32/DR/44	14	C	10.30	2.40	9.60	49	18	7.80	3.50	30	2.60	21.00	3.15	5	0.650
U32/DR/45	27	13	7.90	2.70	7.80	76	13	8.60	5.90	39	3.15	32.00	3.60	5	2.573
U32/DR/46	11	4	13.70	2.20	7.90	59	18	5.80	5.20	25	2.60	20.00	5.35	5	0.348
U32/DR/47	18	8	15.0	4.40	6.60	49	11	5.20	6.00	30	2.70	22.50	3.75	5	0.906
U32/DR/48	21	3	13.20	3.30	5.70	79	6	4.80	6.75	32	3.40	27.00	10.30	5	2.800
U32/DR/49	7	2	7.30	1.60	5.33	56	11	5.80	4.60	24	2.9	22.00	13.10	5	0.940
U32/DR/50	12	4	10.30	2.40	5.50	63	23	6.20	5.30	38	2.6	26.00	11.05	5	0.565
U32/DR/51	17	5	15.30	2.10	4.90	93	17	5.60	7.6	40	2.70	30.00	14.40	5	0.776
U32/DR/52	24	10	10.20	3.60	5.70	47	9	5.30	5.80	35	3.20	24.00	7.25	5	0.835
U32/DR/53	16	6	11.70	2.50	8.00	89	3	6.00	3.90	26	3.30	22.00	4.45	5	0.845
U32/DR/54	11	4	11.35	3.90	5.60	90	30	5.60	7.30	28	3.00	23.00	7.75	5	0.390
U32/DR/55	27	11	13.40	4.30	5.80	46	14	3.90	5.10	35	3.10	23.00	6.20	5	0.467
U32/DR/56	23	9	10.30	3.70	5.10	110	17	4.80	6.90	36	2.90	25.00	12.00	5	0.907
U32/DR/57	13	5	7.50	3.20	3.70	58	11	4.40	5.20	23	2.80	13.00	3.20	5	0.746

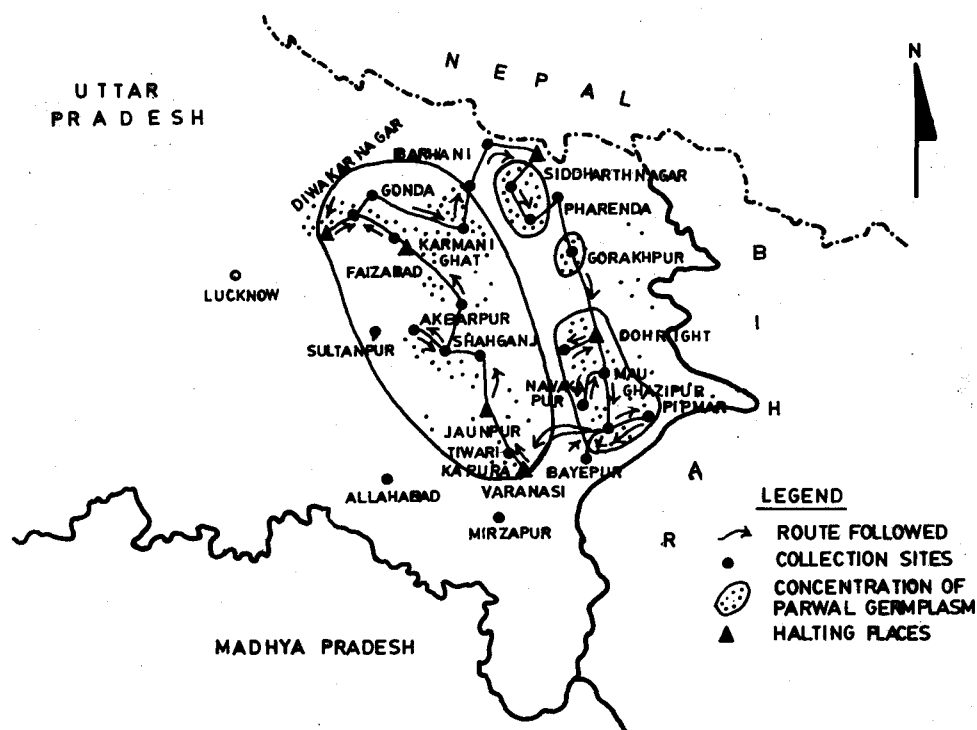


Fig. 1. Exploration route map showing parwal collection from eastern Uttar Pradesh

The mean performance of different cultivars and their vegetative and fruiting attributes are presented in Table 1. General observation of data indicated significant differences among the cultivars for the characters viz., number of branches per plant, number of secondary branches per vine, fruiting node (number) flower length (female), fruit length, fruit volume, diameter of fruit, individual fruit weight, vine length, number of angular leaves and yield per plant. The germplasm varied for number of branches per plant (5-27), number of secondary branches per vine (1-3), internodal length (5.40-15.70 cm.) petiole length (1.2-5.4 cm.), midrib length (3.70-10.70 cm.), fruit length (3.20-7.50 cm.), fruit volume (15.00-42.00 ml), diameter of fruit (1.20-3.60 cm.), individual fruit weight (10.00-37.00 g), vine length (1.20-14.40 m.), angular ribs (4-6), yield (0.375-2.832 kg) per plant.

Promising genotypes:

1. *Deshi patar* (U32/DR/09) : Collected from Pradhanpur/Jalalpur, District Jaunpur; fruits oval, tapering from both ends, average weight 19.0g, diameter 2.10 cm, yield/plant 0.7 kg, fruits whitish green, good material.
2. *Parora* (U32/DR/15) : Collected from upland areas of Hauz, Zafrabad District Jaunpur; fruits medium sized, green with white stripes, stem-end tapering but beak blunt, fruit weight 14.0g, diameter 1.60 cm, yield/plant 1.100 kg; good fruiting potential.
3. *Deshi parvar* (U32/DR/17) : Collected from upland of Kadaila (Malhani), Khetarsrai, District Jaunpur; fruits whitish green, skin comparatively hard, stem-end blunt, blossom-end tapering, vigorous vine growth, fruit weight 27.0 g, diameter 2.20 cm, yield/plant 0.550 kg, suitable for long distance transportation.
4. *Patar* (U32/DR/26) : Collected from upland areas of village Moradabad, District Sultanpur; fruits green without stripes, soft, sometimes light whitish green, fruiting in cluster, 3 fruits/cluster, fruit weight 37.05, diameter 3.0 cm, yield/plant 2.64 kg, fruiting span 5 months, September end transplanted vines yield fruits from third week of April and during August/September bumper fruiting; excellent material.
5. *Patal* (U32/DR/29): Collected from *diara* of Saryu river in Ghaghupur, District Faizabad; fruits whitish green, stem-end tapering, blossom-end slightly blunt, stripes (10) prominent at blossom-end, fruits very attractive, fruit weight 37.0g, diameter 3.40 cm, yield/plant 1.150 hg, prolific bearing.
6. *Deshi parval* (U32/DR/34): Collected from upland area from Diwakar nagar (Poore Tiwari), District Gonda; fruits green, symmetrical, slightly tapering of blossom-end, mild stripes, very attractive, fruit weight 24.0g, diameter 3.10 cm, yield/plant 1.050 kg, prolific yielder.
7. *Ghiyahawa* (U32/DR/40) : Collected from Bilar river *diara*, Mahua, Kakrahi ghat, District Siddharthnagar; fruits whitish green, very attractive, slender, soft, light weight (14 g), diameter 2.50 cm, yield/plant 0.659 kg, long span of fruiting period.
8. *Dharidarwa* (U32/DR/41): Collected from Bilar river *diara*, Kakrahi ghat, District Siddharthnagar; greenish fruits with prominent stripes, fruits tapering from both ends, spindle shaped, fruit weight 18.0g, diameter 3.20 cm, yield/plant 2.639 kg, bumper harvest.
9. *Bhaddahawa* (U32/DR.42): Collected from Bilar river *diara* area in mahua, Kakrahi ghat, Siddharthnagar; fruits spindle shaped, prominent self stripes, stripes prominent at stem-end and stretches upto blossom-end, high bulge in the middle, fruit weight 22.0g, diameter 2.20 cm yield/plant 2.832 kg, better than *Dharidarwa* and *Ghiyahawa*, bumper harvest.

10. *Krantia* (U32/DR/43): Collected from Bilar river *diara* at Kakrahi ghat, Siddharthnagar; fruits green, self-striped, stout, good, both ends tapering, spindle shaped, fruit weight 27.0g, diameter 3.60 cm, yield/plant 2.440 kg prolific yielder
11. *Parvariya* (U32/DR/44): Collected from Bilar river beds in Kakrahi ghat, Siddharthnagar; fruits green, small sized, spindle shaped, both ends tapering, high bulge in middle, fruit weight 21.0g, diameter 2.60 cm, yield/plant 0.650 kg, long span fruiting, good taste, fetches more market.
12. *Bampharawa* (U32/DR/45): Collected from Bilar river *diara*, Kakrahi ghat, Siddharthnagar; fruits dark green 5.90 cm long, attractive, stem-end tapering, blossom-end slightly blunt, fruit weight 32.0g, diameter 3.15 cm, yield/plant 2.573 kg, prolific yielder.
13. *Ujaraka parvar* (U32/DR/46): Collected from Rapti river *diara*, Sandekalan Karmanighat, District Basti; fruits greenish white in colour, without stripes, uniform fruiting, stem-end tapering, blossom-end blunt, fruit weight 20.0g, diameter 2.60 cm, yield/plant 0.348 kg, poor yielder, but very tasty.
14. *Parvar deshi* (U 32/DR/48): Collected from Rati river *diara*, Karmanighat, Basti district; whitish-green fruits, soft without stripes, very attractive fruit weight 27.0 g, diameter 3.40 cm, yield/plant 2.8 kg, bumper yield for 2-3 months (May to August).
15. *Damphar parora* (U32/DR/52): Collected from upland area, Navakapura, District Mau; fruits green, pointed from both ends, striped, high bulging, fruit weight 24.0g, diameter 3.2 cm, yield/plant 0.835 kg, average yielder.
16. *Parori* (U32/DR/53): Collected from upland area Navakapura, Mau District; fruit size very small (3.90 cm) green, high bulge in the middle; almost round in shape, fruit weight 22.0g, diameter 3.30 cm, yield/plant 0.845 kg, prolific fruiting potential, good taste, good market potential.
17. *Parora deshi local* (U32/DR/56): Collected from upland portion of Ganga river basin in Bayepur, District Ghazipur; fruit light green whitish, tapering from both ends, slender (6.90 cm), fruit weight 25.0g, diameter 2.90 cm, yield/plant 0.907 kg, good yielder, very tasty.

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FIELD EVALUATION OF YAM GERMPLASM

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Key words : Yam, germplasm, evaluation

Yams are one of the delicious group among the tropical tuber crops - cassava, sweet potato, aroids, elephant footyam, chinese potato and yambean. They are rich in energy (high starch) and also supply certain vitamins (B-complex) and minerals. These are dietary staples of low income group people in hills and plains of tropical and sub-tropical climates. They also ensure food supply in times of food scarcity. Tribal populations of N-E states consume yams in large amounts and also feed the hard fibre portions to the pigs. The rich yam diversity (Sharma and Hore, 1993) had little or no information on various traits useful for systematic classification and genetic improvement work. The present work is an attempt in the same direction.

A set of 240 accessions belonging to 10 different taxa (Table 1) in tuberous

Table 1. *Dioscorea* taxa studied for characterisation

Species Studied	Accessions No.
* <i>Dioscorea alata</i> L.	45
* <i>Dioscorea bulbifera</i> L.	40
<i>Dioscorea pentaphylla</i> L.	18
* <i>Dioscorea esculenta</i> (Lour.) Burkill	32
* <i>Dioscorea pubra</i> Bl.	35
* <i>Dioscorea hamiltonii</i> Hook.f.	29
<i>Dioscorea culindrica</i> Burm.	15
<i>Dioscorea oppositifolia</i> L.	08
<i>Dioscorea glabra</i> Roxb.	16
<i>Dioscorea prazeri</i> Prain & Burkill	02

*Widely cultivated for human food and as pig feed.

form were planted for evaluation at Barapani (900m msl) farm in Meghalaya. These collections were planted in 30 cm deep pits filled with well rotten compost @ 1.2 kg/pit spaces at 1m × 1m between rows and plants. Usually 3 plants per accession were planted during the month of April/May i.e. onset of monsoon. Seed tubers weighed about 200-250 gm and were planted 15 cm deep in the pit. Weeding and earthing up was done in July. Harvesting was done in December.

The accessions (collected from Garo Hills and Assam (Sharma and Hore, 1993) were characterised for fourteen descriptor and descriptor states over two years (1992-93) and the results are presented and discussed under following heads.

Vine growth and vigour : This character was scored using 1 to 9 scale where 1 represented very poor and 9 very good vine growth and vigour. Majority (179) accessions had poor rating whereas twenty four accessions possessed good vigour and growth. During 1992, many (199) accessions suffered severe attack of *Helminthosporium* leaf spots. The number of prominent vines and their growth vigour has been found to be the most important yield component (Rishi *et. al.*, 1988).

Stem twining : This is important character and helps in identification of species of *Dioscorea*. The large number (164) of accessions had right side stem twinning while only 76 showed left stem twinning.

Spines in stem base : This is one of the characteristic feature of the species. Terete vs. prickly stem base is a criteria for identifying the edible types and local people give much importance on it. Among the characterised materials, 69 accessions possessed the spines at stem base while rest 171 accessions had non-spinous stem base.

Winged stem : Winged stem is also an aid for identification and distinction of species or to determine the variability within the taxa. Out of total 240 accessions studied, only 183 accessions were having winged stem.

Pigmentation of petiole base : Light purple, purple and light green, these three kinds of colour were observed in the matured petiole base. Such distinctions were noticed in 10 accessions which were light purple, while pure purple comprised of 32 accessions. Green or light green were observed in rest 198 accessions.

Lamina characteristics :

- a) *Lamina lobation* : Lobation in lamina though is a variable character within the species but it helps as identifying tool for intraspecific distinction. Practically, it helps in separation of supraspecific categories of plant within the family. Such distinction were recorded as follows
- Single lobed - 222 accessions; Trifoliate - 14 accessions; pentafoliate

4 accessions. Leaf area has also been found to be closely correlated ($r = 0.90$) with tuber weight per plant (Rishi *et al.*, 1988).

- b) *Young leaf pigmentation* : Colour of young leaves is also variable and 5 major types of colour were recorded among the 240 accessions studied. These were - Green (3); Light green (165); Dark green (64); Light purple (5) and Purple (3).
- c) *Variation between distance of basal leaf lobes* : The variation is remarkable in this character which ranged from 1.3 cm to 9.4 cm. The maximum distance was observed in NIC-12341 while minimum was recorded in NIC 12339. Similarly, the variation in leaf-size character was also noticed. In respect of leaf length and breadth it varied from 5.3 cm (NIC-12496) to 27.7 cm (NIC-12562) length and 1.7 cm (NIC-12541) to 17.5 (NIC-12367) breadth respectively.

Among the reproductive characters of the accessions, emphasis was laid on the following criteria which helps to distinguish the promising accessions. Tuber shape, root hairs on tubers, flesh colour of tuber, fresh tuber yield per plant and yield potentialities among the accessions were taken into consideration. These characters helped to identify the edibility preferences and serve for selection of accessions for large-scale cultivation.

- a) *Tuber shape* : Morphologically, though there is no regular shape sized for particular species detection yet 6 types were identified. They are digitate (4); spherical (64); cylindric (92); oval (30); oblong (47) and flattened (3). The shape of tuber also indicate the space and soil depth requirement for future regeneration of particular accessions.
- b) *Root hairs on tuber* : It is a general observation that edibility criteria, stress tolerance and propagation potentialities can be determined visually through the tubers possessing degree of hair density in its surface. Scoring criteria indicated that there were low (1-3) density of hairs in 109 accessions, medium (4-6) in 97 accessions, high (7-8) in 28 accessions and very high (9) in 06 accessions.
- c) *Flesh colour of tubers* : Examination of sliced tubers among 240 accessions indicated light purple colour in 82 accessions, cream colour was seen in 51 accessions while rest 107 accessions were white colour completely.
- d) *Fresh tuber yield per plant* : The maximum yield of fresh tuber was received from NIC-12572 which was 4100 gms. The minimum yield was given by NIC-12559 which was only 20 gms.

Some more promising accessions which gave more than 3 kg/plant of fresh tuber yield were - NIC-12528; NIC-12555; NIC-12366; NIC- 12284; NIC-12387; NIC-12417; NIC-12572; NIC-12349 and NIC-12420.

Fresh tuber yield per plant appeared to be highly correlated in positive direction with characters such as tuber number per plant, length and circumference (Ebong, 1987), with number of prominent vines per plant and leaf area (Rishi *et al.*, 1988).

Further work on evaluation of acidity (due to presence of calcium oxalate crystals), diosgenin or botogenin contents (precursor of cortisone used in treatment of rheumatoid troubles) etc. would be rewarding since in a study by Bindroo and Bhatt (1988) diosgenin content varied from 2.9% to more than 6%. Further work for identification of morphotypes, varietal and specific status of the material is under investigation.

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SCREENING OF ONION GERMPLASM RAISED FOR SEED CROP AGAINST PURPLE BLOTCH

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Key words : Onion, germplasm, purple blotch disease

Purple blotch caused by *Alternaria porri* (Ellis) Ciferri is an important disease of onion crop in India. Both seed as well as bulb crops are infected but the intensity is higher in the former. To control this disease, various cultural (Awad *et al.*, 1978; Boelema and Ethlers, 1967) and chemical methods (Desai *et al.*, 1979; Gupta *et al.*, 1981) have been tried but disease still continues to be a serious problem. Breeding for disease resistance appears to be an effective, economical and practical method of disease control. This paper reports the relative reaction of different onion genotypes against purple blotch in the field trials.

The trial was conducted at Punjab Agricultural University, Ludhiana where the field soil was sandy loam in texture (pH 8.2). One hundred and thirty-five onion genotypes (Table 1) were sown in randomized block design in plots measuring 12 square metre. All the recommended agronomic practices were followed throughout the crop season. The disease score was taken about ten days prior to seed harvesting. For recording the per cent disease intensity (PDI), a 0-5 class rating technique was used, where 0 = no disease and 5 = more than 80 per cent area covered by the disease symptoms. The PDI calculated as $PDI = 100 (Scr) 95n^{-1}$, where Scr = Sum of all class ratings, n = number of scapes examined and '5' as the maximum class rating in the scale. Based on the disease intensity values, the genotypes were rated as resistant (R), moderately resistant (MR), susceptible (s) and highly susceptible (HS) with PDI in the range between 0-5, 6-15, 16-25 and more than 25 respectively.

The data on disease intensity showing the relative reaction of different genotypes are presented in Table 1. The incidence of purple blotch varied

with the genotypes. None of the 135 genotypes screened against purple blotch disease remained disease free. As many as 27 contracted less than 10 per cent disease intensity. Out of these 27 genotypes, 12 viz., PO-1, PBR-2, PBR-3, PBR-4, PBR 5, PBR-6, PBR-7, PBR-8, PWO-1, Red Creole, Lohru and Hybrid Superex contracted a disease intensity of less than 5 per cent and were rated as resistant. Twenty-three genotypes contracted an intensity of 6-15 per cent and were rated moderately resistant. Thirty-seven genotype with a PDI of

Table 1. Relative reaction to onion genotypes raised for seed crop against purple blotch

Reaction	P.D. Value	Number of genotypes	Genotypes
Resistant (R)	0-5	12	PO-1, PBR-2, PBR-3, PBR-4, PBR-5, PBR-6, PBR-7, PBR-8, PWO-1, Red Creole, Lorhu, Hybrid Superex
Moderately resistant (MR)	6-15	23	PO-7, PO-11, PO-15, PO-17, PO-20, PO-21, PO-26, PO-27, PO-31, PO-32, PO-35, PO-37, PO-48, PO-51, PO-56, PO-62, PO-72, PO-79, Onion early yellow, Punjab red round, PB-48, VL-1, Market sel-1
Susceptible (S)	16-25	37	PO-2, PO-4, PO-5, PO-13, PO-14, PO-18, PO-30, PO-34, PO-36, PO-38, PO-39, PO-41, PO-43, PO-49, PO-50, PO-52, PO-54, PO-55, PO-60, PO-65, PO-66, PO-74, PO-75, PO-77, PO-80, PO-81, PBR-1, Sel-102-1, Punjab selection, PWR, INBRED-2, Shah Koti, Pusa Rattnar, Delhi-1, IHR-403, INBRED-6
Highly susceptible (HS)	>25	63	PO-3, PO-6, PO-8, PO-9, PO-10, PO-12, PO-16, PO-19, PO-22, PO-23, PO-24, PO-25, PO-28, PO-29, PO-33, PO-35, PO-36, PO-37, PO-38, PO-39, PO-40, PO-42, PO-44, PO-45, PO-46, PO-47, PO-53, PO-57, PO-58, PO-59, PO-61, PO-63, PO-66, PO-67, PO-68, PO-69, PO-70, PO-71, PO-73, PO-76, PO-78, PO-82, PO-83, Onion early texas, Onion yellow granex, Pusa Red, Arka Niketan Bombay var, Early Grano, N-53, Inbrd-58, Puna Prizetaker, Inbred-17, IHR-114, IHR-387, IHR-392, Inbred-I, Afdr, Market Sel-2, IC-1981010, Patriot, Gujarat No.1, PWF

16-25 per cent showed a susceptible reaction. The remaining genotypes belonged to highly susceptible group (PDI > 25%). Some of the genotypes belonging to the resistant category have been involved in the hybridization for onion improvement. The variety PBR-5 has been approved by the Punjab Agricultural University for the general release to the state farmers under the name 'Punjab Jyoti'.

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