Important Crop Germplasm Introduced into India During 2001

RV Singh, Deep Chand, Vandana Tyagi, Nidhi Verma, SP Singh and BS Dhillon
Germplasm Exchange Unit, National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110 012 (India)

The introduction of exotic germplasm has enriched the Indian agriculture since times immemorial. The short statured, lodging resistant, input responsive, high yielding introductions of wheat and rice have played a pivotal role in ushering in the era of Green Revolution. Genotypes carrying cytoplasmic-nuclear male sterility and fertility restoration genes brought in the era of hybrid breeding in crops like sorghum, pearl millet and rice that enabled the exploitation of heterosis. Further, it was the introduced germplasm which enabled soybean and sunflower to become major field crops in India. During the year 2001, 23,368 accessions of germplasm of 60 crops were introduced from 35 countries/International Agricultural Research Institutes. The information on the germplasm carrying genes for specific traits, that has been introduced by National Bureau of Plant Genetic Resources (NBPGR), New Delhi is presented in Table 1.

Table 1. List of promising and useful germplasm in various crops introduced by NBPGR during 2001 and the recipient Indian institutes

Crop Name/ EC Number	Source Country/Institute	Traits of interest	Recipients
Cereals			
Oryza sativa (rice)			
EC 467691-719	IRRI, Philippines	Lowland rice, fine slender grains	• Agriculture College and Research Station, Madurai, Tamil Nadu
Var. CP-SLO-17 EC 469595	IRRI, Philippines	Variety having wide compatibility genes	• NBPGR Regional Station, Cuttack, Orissa
EC 478048-52	IRRI, Philippines	Glutinous rice	• Directorate of Rice Research, Hyderabad, Andhra Pradesh
Triticum aestivum (wheat) EC 467256-265	CIMMYT, Mexico	Resistant to septoria leaf blotch, stem rust, leaf rust and high yielding	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
EC 467328-344	Germany	Septoria leaf blotch resistant lines	• Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh • NBPGR, New Delhi
EC 479350-374	USA	Hard and soft homozygous waxy germplasm	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
EC 479375-78	USA	Soft red winter wheat, resistant to *Stagonospora nodurum*, stripe rust, powdery mildew and leaf rust	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
Var. Bobcat EC 467937	Canada	Resistant to stem and leaf rust	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
Var. Club Bvuchi and Eltan EC 468368-69	USA	Soft white winter wheat	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
Var. Edwin EC 468366	USA	High grain yield	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi

Crop Name/ EC Number	Country	Traits of interest	Recipients
Var. Prowers and Prowers 99 EC 481176-77	USA	Hard red winter wheat, superior baking quality, high grain yield, resistant to stem rust	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
Var. Scholar EC 467720	USA	Hard red spring wheat, resistant to stem rust	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
Var. Finley EC 468367	USA	Stripe rust resistant and good milling quality	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
Var. Harding EC 467680	USA	Red winter wheat, excellent winter survival, high yielding	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
Var. Wesley EC 477993	USA	Superior bread making quality, resistant to stem rust, high yielding	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
Zea mays (Maize) EC 468257-285	CIMMYT, Mexico	Drought tolerant lines	• Tirhut College of Agriculture, Muzzaffarpur, Bihar • Directorate of Maize Research, New Delhi
Hordeum vulgare (barley) Var. Orca EC 473921	USA	Large grain, high protein content, resistant to stripe rust	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
Avena sativa (oat) Var. Sandy EC 469501	USA	High grain yield, good malting quality	• NBPGR Regional Station, Bhowali, Uttaranchal
Var.-Riser EC 469502	USA	Early maturing, resistant to crown rust	• NBPGR Regional Station, Bhowali, Uttaranchal
Var. Trucker EC 469503	USA	Spring oat, high grain yield	• NBPGR Regional Station, Bhowali, Uttaranchal
Var. Florida EC 473801	USA	Early maturing, high yielding, resistant to crown rust	• NBPGR New Delhi
Millets and Forages			
Sorghum bicolor (sorghum) EC 478277-303	Canada	Forage and grain type	• NRC for Sorghum, Hyderabad, Andhra Pradesh
EC468940, 468942	Nigeria	Large grain type	• Division of Genetics, IARI, New Delhi
GP- N 316-320 EC 482673-77	USA	Nuclear male sterility lines	• NRC for Sorghum, Hyderabad, Andhra Pradesh
GP- N 313-15 EC 482670-72	USA	Fertility restores in A 1 cytoplasm suited for the production of high quality grain for feed or food	• NRC for Sorghum, Hyderabad, Andhra Pradesh

Crop Name/ EC Number	Country	Traits of interest	Recipients
Pennisetum glaucum (pearl millet)			
EC 470391-97	USA	Drought tolerant and dual purpose type	• Rajasthan Agricultural University, Bikaner, Rajasthan • NBPGR, RS, Jodhpur, Rajasthan
Oilseeds			
Arachis hypogaea (groundnut)			
EC 470030	Sudan	Bold seeded	• ICRISAT, Patancheru, Andhra Pradesh
Brassica nigra (mustard)			
EC 472729-38	Germany	Genotypes resistant to Alternaria blight	• Department of Plant Breeding, Punjab Agricultural University, Ludhiana, Punjab
Glycine max (soybean)			
EC 468377-424, 468499, 468509, 468599	USA	Rust resistant lines	• NRC for Soybean, Indore, Madhya Pradesh
EC 483054-55	Australia	Rust resistant lines	• NRC for Soybean, Indore, Madhya Pradesh
EC 468443, 468448, 468472, 468529,468542,468568, 468585,468600,468606,468610	USA	Lines resistant to Soybean mosaic virus	• NRC for Soybean, Indore, Madhya Pradesh
EC 468455, 468504,468528, 468535	USA	Root knot nematode resistant lines	• NRC for Soybean, Indore, Madhya Pradesh
EC 468458, 468462,468511	USA	Resistant to downy mildew	• NRC for Soybean, Indore, Madhya Pradesh
EC 468490, 468594	USA	Linolenic acid less than 5.5 %	• NRC for Soybean, Indore, Madhya Pradesh
EC 468491, 468555,468557	USA	Drought and heat tolerant	• NRC for Soybean, Indore, Madhya Pradesh
EC 468505, 468533	USA	Resistant to multiple foliar feeding insects and stink bugs	• NRC for Soybean, Indore, Madhya Pradesh
EC 468563	USA	Low lipoxygenase line	• NRC for Soybean, Indore, Madhya Pradesh
EC 468623	USA	Resistant to Soybean scab	• NRC for Soybean, Indore, Madhya Pradesh
EC 473774-780	AVRDC, Taiwan	Vegetable type soybean	• Annamalai University, Annamalai Nagar, Tamil Nadu
EC 478225	USA	Resistant to Soybean cyst nematode	• NRC for Soybean, Indore, Madhya Pradesh
EC 483041	USA	Resistant to foliar feeding insect and stem canker, processing type with high protein	• NRC for Soybean, Indore, Madhya Pradesh
EC 483042	Australia	Genetic male sterile lines	• NRC for Soybean, Indore, Madhya Pradesh
EC 483043-46	Australia	Vegetable types	• NRC for Soybean, Indore, Madhya Pradesh
EC 483048	Australia	Low trypsin inhibiting enzyme	• NRC for Soybean, Indore, Madhya Pradesh

Crop Name/ EC Number	Country	Traits of interest	Recipients
EC 483049-50	Australia	Photoperiod insensitive lines	• NRC for Soybean, Indore, Madhya Pradesh
EC 483052-53	Australia	Insect tolerant lines	• NRC for Soybean, Indore, Madhya Pradesh
EC 483056-59	Australia	Bacterial pustule resistant lines	• NRC for Soybean, Indore, Madhya Pradesh
EC 483060-61	Australia	Drought tolerant lines	• NRC for Soybean, Indore, Madhya Pradesh
Vegetables			
Lycopersicon esculentum (tomato)			
EC 468370-72	USA	High β-carotene content, mid season maturity, suitable for processing	• NBPGR, New Delhi
EC 468337-41	AVRDC, Taiwan	Tolerant to tomato leaf curl virus, tomato mosaic virus and bacterial wilt	• IIHR, Bangalore, Karnataka
EC 490117-43	AVRDC, Taiwan	Heat tolerant inbred lines, tolerant to bacterial wilt	• Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh
Capsicum annum (chilli)			
EC 468630	AVRDC, Taiwan	Cayenne type for bright red colour pepper powder	• Nirmal Agricultural Research Development Foundation, Pacchora, Maharashtra
Allium cepa (onion)			
Var.-Early red			
EC 473300	Israel	High yielding	• Indo-Israel Project, IARI, New Delhi
Fruits			
Juglans regia (walnut)			
Var.-Pleral lara, De montignal, Meylannaise, Hartley EC 467892-95	France	High yielding varieties	• Dr.YS Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh
Prunus avium (cherry)			
Var.-Vivo, Vogue, Viscount EC 469405-407	Canada	High yielding varieties	• Central Institute of Temperate Horticulture, Srinagar, Jammu and Kashmir
Physalis sp. (gooseberry)			
EC 467434-462	USA	Sweet and sour type fruit with good amount of pulp	• NBPGR Regional Station, Phagli, Shimla, Himachal Pradesh
Pistacea vera (pistachio nut)			
Var. Kerman EC 468651	USA	High yielding varieties	• Regional Research Station, Kinnaur, Himachal Pradesh
Hippophae rhamnoides (seabuckthorn)			
EC 468632-33	Russia	High vitamin-C content	• Directorate of Research, Ch. SK HPKVV, Palampur, Himachal Pradesh

The NBPGR is continuing its efforts to identify promising germplasm through literature search and personal contacts, and to introduce the same for utilization by Indian plant breeders.

Genetic Resources of Spices and their Conservation in Bay Islands

KN Shiva[1], MA Suryanarayana[2] and RP Medhi[2]

[1] *Indian Institute of Spices Research, Marikunnu Post, Calicut-673 012, Kerala*

[2] *Division of Horticulture & Forestry, Central Agricultural Research Institute, Port Blair-744 101, Andamans*

The vegetation cover and forests of our country offer a great diversity of flora, of which the Andaman - Nicobar phytogeographic zone is one, whose flora is interesting and remarkable due to the tropical humid climate and insular nature of the territory. Out of 2,500 species of flowering plants occurring in these islands, about 11 per cent are endemic and another 11 per cent are economically important or useful to mankind. In addition to cultivated spices (black pepper, clove, cinnamon, nutmeg, ginger, chilli and turmeric), wild relatives of spice crops also exist in the fragile island ecosystem. The important genera include *Alpinia, Amomum, Costus, Curcuma, Garcinia, Globba, Hedychium, Kaempferia, Myristica, Piper, Vanilla* and *Zingiber,* of which the maximum diversity is present in the genera *Piper, Zingiber, Garcinia* and *Myristica.* Due to over-exploitation of natural resources, some of the endemic species of these islands are under the threat of extinction. Concerted efforts have already been initiated to conserve the valuable genetic resources of spices for posterity.

Key Words: Bay Islands, Andaman and Nicobar Islands, Conservation, Germplasm, Status, Spices

India is known as 'Land of Spices' to the world. Out of 109 spices listed by the ISO (International Organization for Standardization), about 60 spices are cultivated in India. India is homeland for black pepper and cardamom and secondary centre of origin for cinnamon. India is a major producer for many of the spice crops.

The vegetation cover and forests of our country offers great diversity of flora, of which Andaman-Nicobar phytogeographic zone is one, whose flora is interesting and remarkable due to the tropical humid climate and insular nature of the territory. The Andaman and Nicobar archipelago consisting of about 572 islands, islets and coral reefs, lies in the Bay of Bengal between the latitude of 6° -14°N and 92°-94°E longitude. It is also called Bay Islands. General climatic condition is that of warm and humid tropics with temperature ranging from 22° to 32° C. Mean relative humidity is about 82 per cent with average rainfall varying from 3000-3500 mm.

These islands are unique treasure of beauty and biodiversity with about 86 per cent under forest cover of the total geographical area. These islands harbour 2500 species of flowering plants of which about 11 per cent are endemic and another 11 per cent are economically important or otherwise useful to mankind. Over 150 species of wild relatives of crop plants are reported to occur in this archipelago (Sreekumar, 1997).

Materials and Methods

Botanical explorations were conducted over a period of three years in the forest floor of Andaman and Nicobar group of Islands and information gathered from the tribal groups/local people and literature. An attempt has been made to compile and document the genetic resources of spices with respect to its status, extra-Indian species, utilization and conservation.

Results and Discussion

Status: A wide range of diversity exists in the spices in the form of varieties/cultivars/improved varieties, species and related taxa in the bay islands (Tables 1 and 2). The spice crops that are mainly grown/cultivated in bay islands are black pepper (450 ha), ginger (390 ha), chilli (252 ha), clove (95 ha), cinnamon (53 ha), turmeric (38 ha) and nutmeg (21 ha). Spice crops are cultivated in an area of around 50,000 hectares

Table 1. Status of genetic resources of spices in Andaman and Nicobar Islands

Crop	No. of accessions			
	Wild and related species	Cultivated species/ varieties	Exotic species/ varieties	Total
Black pepper	8	14	–	22
Cardamom	3	–	–	3
Ginger	16	13	4	33
Turmeric	3	2	–	5
Nutmeg	7	1	–	8
Clove	3	1	–	4
Cinnamon	4	1	–	5
Garcinia	10	–	–	10
Bay leaf	–	1	–	1
All spice	–	1	–	1
Tamarind	–	1	–	1
Curry leaf	–	1	–	1
Vanilla	1	1	–	2
Coriander	1	1	–	2

Table 2. Promising germplasm of spices crops cultivated in Andaman and Nicobar Islands

Sl. No.	Crop	No. of germplasm accessions	Varieties/accessions/ species
1	Black pepper	6	*Piper betel* viz., CARI-1 to 6
		14	Varieties – Panniyur-1, 2, 3, 4 and 5, Karimunda, Kottanadan, Sreekara, Subhakara, Panchami, Pournami, P-24, Shimoga, TMV-5
2	Ginger	17	Varieties - IISR-Varada, Rejatha, Mahima, Nadia, Wynad, Jorhat Local, Karakai,, Thing-lai-don, Rio-de-Janeiro, Jamaica, China, Acc. Nos. 204, 35, 27, 3573, 279, 294
3	Turmeric	2	Varieties – GL-Duram III, CLS-22
4	Cinnamon	3	Species –*Cinnamomum cassia, C. burmanii, C. loureirre*

(2001-2002) (Shiva *et al.*, 2003). For many of these crops, wild and related species are found to occur in these islands. The important genera include *Alpinia, Amomum, Curcuma, Garcinia, Globba, Hedychium, Kaempferia, Myristica, Piper, Syzygium, Vanilla* and *Zingiber* (Shiva *et al.*, 2002a). Maximum diversity is represented by *Zingiber* (33), *Piper* (22), *Garcinia* (10), *Myristica* (8), *Curcuma* (5) and *Cinnamomum* (5) (Dagar, 1989; Ellis, 1986; 1988; 1990; Parkinson, 1984; Rao, 1996; Rema and Krishnamoorthy, 2000; Singh *et al.*, 1998; Sreekumar and Ellis, 1990; Subramaniam and Sreekumar, 1998 and Suryanarayana *et al.*, 2001). The status of genetic resources of spices and their related species along with its habit, distribution, status, etc. are enumerated in Tables 1, 2 and 3.

Extra-Indian Species: Apart from this, wild and related taxa of extra-Indian species that are naturalized/introduced such as *Piper clypeatum, P. miniatum, Knema laurina* and *Myristica elliptica* are reported to occur in these islands (Rao, 1996) (Table 4).

Table 3. Genetic resources of spices and related species in Bay Islands

Sl. No	Common/local name	Scientific name	Family	Habit	Distribution	Status
1		*Acorus calamus* L.	Araceae	Herb	Andamans	Introduced
2		*Alpinia manii* King ex Baker.	Zingiberaceae	Herb	Andamans	Endemic
3		*Alpinia phoenicea* Kamph. ex Kurz	Zingiberaceae	Herb	Nicobar Islands	Rare and endemic
4		*Amomum aculeatum* Roxb.	Zingiberaceae	Herb	Andamans	Common
5		*Amomum fenzlii* Kurz	Zingiberaceae	Herb	Nicobars	Endemic
6		*Amomum maximum* Roxb.	Zingiberaceae	Herb	Andamans	Common
7		*Boesenbergia albo-lutea* (Baker) Schl.	Zingiberaceae	Herb	Andamans	Rare and endemic
8		*Boesenbergia pandurata* Roxb.	Zingiberaceae	Herb	Andamans	Rare
9	Bay leaf	*Cinnamomum tamala* (Buch. Ham) Nees & Ebermaier	Lauraceae	Tree	Andamans	Introduced
10	Cinnamon	*Cinnamomum verum* Bercht. & Prest	Lauraceae	Tree	Andaman and Nicobar Islands	Introduced
11		*Cinnamomum obtusifolium* Nees	Lauraceae	Tree	South and Middle Andamans	Rare
12	Coriander	*Coriandrum sativum* L.	Apiaceae	Herb	Andaman and Nicobar Islands	Introduced
13		*Costus speciosus* (Koenig) J.E. Smith	Zingiberaceae	Herb	Andaman and Nicobar Islands	Common
14	Turmeric	*Curcuma longa* L.	Zingiberaceae	Herb	Andaman and Nicobar Islands	Introduced
15		*Curcuma mangga* Val. & Van Zijp.	Zingiberaceae	Herb	Andaman	Common
16		*Curcuma zeodaria* (Christm) Rosc.	Zingiberaceae	Herb	Andaman	Introduced
17	Burmese coriander	*Eryngium foetidum*	Apiaceae	Herb	Andaman and Nicobar Islands	Introduced
18		*Garcinia andamanica* King	Clusiaceae	Small evergreen tree	Andamans	Endemic
19		*Garcinia cadelliana* King	Clusiaceae	Small tree	South Andamans	Rare and endangered endemic
20		*Garcinia calycina* Kurz (Kamorta Islands)	Clusiaceae	Small tree	Nicobars	Rare and endangered endemic

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Table 3 Contd.

Sl. No	Common/local name	Scientific name	Family	Habit	Distribution	Status
21	Cowa-fruit or the cowa mangosteen tree	*Garcinia cowa* Roxb. ex. DC. Prodr.	Clusiaceae	Medium tree	Evergreen forests of Andaman and Nicobar Islands	Common
22		*Garcinia hombroniana* Pierre	Clusiaceae	Small tree	Nicobar Islands	–
23		*Garcinia jelineckii* Kurz	Clusiaceae	Small tree	Nicobar Islands	Endemic
24		*Garcinia kingii* Pierre and Verque	Clusiaceae	Small tree	Andamans	Rare and endangered endemic
25		*Garcinia kurzii* Pierre	Clusiaceae	Small tree	Andaman and Nicobar Islands	Rare and endemic
26		*Garcinia microstigma* Kurz	Clusiaceae	Small tree	Andaman Islands	Endemic
27		*Garcinia speciosa* wall	Clusiaceae	Medium tree	Evergreen and semi-ever green forests Andamans	Common
28		*Garcinia xanthochymus* Hook. f. & Thom.	Clusiaceae	Ever green tree with medium size	Evergreen forests of Andaman and Nicobar Islands	Common
29		*Globba marantina* L.	Zingiberaceae	Herb	Andaman and Nicobar Islands	Common
30		*Globba pauciflora* King ex Baker	Zingiberaceae	Herb	South Andamans	Endemic and rare
31		*Globba versicolor* Sm.	Zingiberaceae	Herb	Andamans	Rare
32		*Hedychium coccineum* Koen.	Zingiberaceae	Herb	Andamans	Common
33		*Hedychium coronarium* Koen.	Zingiberaceae	Herb	Andamans	Introduced
34		*Horsfieldia macrocarpa* var. *canaroides* (King) Sinclair	Myristicaceae	Tree	Andaman and Nicobar Islands	Endemic; rare and endangered
35		*Kaempferia rotunda* L.	Zingiberaceae	Herb	Andamans	Common
36		*Kaempferia siphonantha* King ex Baker.	Zingiberaceae	Herb	Andaman	Endemic; rare and threatened
37		*Knema andamanica* ssp. *nicobarica* (Warb.) de Wilde	Myristicaceae	Tree	Nicobars	–
38		*Knema andamanica* (Warb.) de Wilde ssp. *andamanica* (Warb.) de Wilde	Myristicaceae	Tree	Andaman and Nicobar Islands	Endemic
39		*Mesua manii* (King) Kosterm	Clusiaceae	Shrub	South Andaman	Endemic; rare and endangered
40	Curry leaf	*Murraya koenigii* (L.) Sprengel	Rutaceae	Shrub	Andaman and Nicobar Islands	Introduced and common
41		*Murraya paniculata* (L.) Jack	Rutaceae	Tree	Andaman and Nicobar Islands	Common
42	Jungli- Jaiphal	*Myristica andamanica* Hook. f.	Myristicaceae	Tree	Andaman and Nicobar Islands	Endemic and rare
43	Nutmeg	*Myristica fragrans* Houtt.	Myristicaceae	Tree	Andaman and Nicobar Islands	Introduced
44		*Myristica glaucescens* Jack. var. *andamanica* (Worb.)	Myristicaceae	Tree	Sinclair Islands, Austin-I	Common
45		*Myristica kingii* Hook. f.	Myristicaceae	Tree	Junglebar, Port Blair	–
46	Allspice	*Pimento dioica* (L.) Merill	Myrtaceae	Tree	Andamans	Introduced
47	Betel vine	*Piper betel*	Piperaceae	Climber	Evergreen forests of Great Nicobar Islands	Common
48	Tippili	*Piper longum* L.	Piperaceae	Climber	Andaman & Nicobar Islands	Introduced
49	Black pepper	*Piper nigrum* L.	Piperaceae	Climber	Andaman & Nicobar Islands	Introduced and common
50		*Syzygium andamanicum* (King) Balakr.	Myrtaceae	Tree	Andamans	Endemic and rare
51	Clove	*Syzygium aromaticum* Merr.& Perry	Myrtaceae	Tree	Andaman & Nicobar Islands	Introduced
52		*Syzygium kurzii* (Duthie) Balakr. var. *andamanica* (King) Balakr.	Myrtaceae	Small tree	South Andaman	Endemic; rare and endangered
53		*Syzygium manii* (King) Balakr.	Myrtaceae	Tree	Middle Andamans	Endemic; rare and endangered
54	Tamarind	*Tamarindus indica* L.	Caesalpiniaceae	Tree	Andamans	Introduced and common

Table 3 Contd.

Sl. No	Common/local name	Scientific name	Family	Habit	Distribution	Status
55		*Vanilla andamanica* Rolfe.	Orchidaceae	Climbing herb	Middle, South and Little Andamans	Endemic
56	Vanilla	*Vanilla fragrans* (Salisburry)	Orchidaceae	Climber	Andaman and Nicobar Islands	Introduced
57		*Zingiber odoriferum* Bl.	Zingiberaceae	Aromatic herb	South Andaman (especially Port Blair)	Common
58	Ginger	*Zingiber officinale* Rosc.	Zingiberaceae	Herb	Andaman and Nicobar Islands	Introduced
59		*Zingiber spectabile* Griff.	Zingiberaceae	Aromatic herb	South Andaman and Nicobar Islands	Introduced
60		*Zingiber squarrosum* Roxb.	Zingiberaceae	Herb	South and Little Andamans	Common
61		*Zingiber zerumbet* Rosc. ex Sm.	Zingiberaceae	Aromatic herb	South Andamans (especially Port Blair) and Nicobar Islands	Common

Utilization: Most of the spices and its related species are being utilized by the tribal, local people and settlers for various ailments/purposes (Awasthi, 1987; Dagar, 1989; Rema and Krishnamoorthy, 2000; Singh *et al.*, 1998; Sreekumar, 1993; and Subramaniam and Sreekumar, 1998) (Table 5). Besides, they can also be utilized as potential sources for medicines, salt and pest and disease tolerance/resistance, etc.

Table 4. Extra-Indian spices found only in Andaman and Nicobar biogeographic zone of India

Sl. No.	Spice	Family	Habit	Distribution
1	*Piper clypeatum*	*Piperaceae*	Climber	Malaya
2	*Piper miniatum*	*Piperaceae*	Climber	Malaya, Java
3	*Knema laurina*	*Myristicaceae*	Tree	Thailand, Malaya, Borneo, Sumatra, Java
4	*Myristica elliptica*	*Myristicaceae*	Tree	Malaya, Sumatra, Borneo

Table 5. Spices and related species used by natives for various purposes in Bay Islands

Sl. No.	Spice	Usage
1	*Acorus calamus*	Rhizome-fever; Ornamental
2	*Alpinia manii*	Leaves chewed and sprayed to collect honey by tribals; Ornamental
3	*Alpinia phoenicea*	Ornamental
4	*Amomum aculeatum*	Ornamental
5	*Amomum fenzlii*	Root and flower-gastro-intestinal troubles, (stomach disorders), malarial (intermittent) fever and other fevers; Leaves chewed and sprayed to collect honey by tribals; Ornamental
6	*Amomum maximum*	Ornamental
7	*Costus specious*	Leaves-stomach disorders by 'Shompen' tribal; Rhizome – snake bite
8	*Curcuma longa*	Rhizome powder – wound healing
9	*Curcuma mangga*	Ornamental
10	*Curcuma zeodaria*	Rhizome-cooling; Ornamental
11	*Garcinia hombroniana*	Fruit- edible; Timber
12	*Garcinia microstigma*	Young leaves-cooked and eaten by Burmese
13	*Garcinia* sp.	Root-washing uterus after child birth by 'Shompen' tribal
14	*Garcinia speciosa*	Wood-bridge, house posts and bows
15	*Globba marantina*	Rhizome-Asthma, eyes disorders; Ornamental
16	*Globba pauciflora*	Ornamental
17	*Globba versicolor*	Ornamental
18	*Hedychium coccineum*	Ornamental
19	*Hedychium coronarium*	Rhizome-rheumatic; Ornamental
20	*Kaempferia rotunda*	Tuber powder is used in mumps; Ornamental
21	*Kaempferia siphonantha*	Ornamental
22	*Murraya paniculata*	Timber
23	*Myristica andamanica*	Wood for pulp
24	*Myristica elliptica*	Whole plant-to heal wounds by 'Shompen' tribal

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Table 5 Contd.

Sl. No.	Spice	Usage
25	*Myristica* sp.	Fruit – stomach disorder by 'Nicobarese' tribal
26	*Piper longum*	Leaves-betel by natives
27	*Piper* spp.	Leaves chewed along with the nuts of arecanut by tribals
28	*Syzygium samarangense*	Rheumatic pain (leaves-Joint pains) by 'Nicobarese' tribals; Rhizomes – widely used as anti-arthritic, anti-inflammatory, anabolic and anti-fertility agents.
29	*Vanilla andamanica*	'Pods'- vanillin /flower as cosmetic 'vanilla'
30	*Zingiber odoriferum*	Stem juice-tranquilizer for honey bee
31	*Zingiber officinale*	Rhizome extract used for coughs by 'Nicobarese' tribals
32	*Zingiber spectabile*	Ornamental
33	*Zingiber squarrosum*	Petioles-chewed when thirsty by 'Onges' tribals
34	*Zingiber zerumbet*	Rhizome-hot remedy for cough, asthma, worms, leprosy and other skin diseases; Boiled rhizomes – pulmonary infections; Ornamental; Rhizome is used for cooling also.

Conservation

Due to rapid industrialization, urbanization and other unsustained developmental activities, over-exploitation of resources and felling of trees, many of the species are found as rare and threatened or thinly populated in these islands. Even some of such species of spices are vulnerable or under the threat of extinction.

In this direction, CARI has actively involved in collection and conservation of germplasm using as *ex-situ* and *in vitro* technique. Apart from this, local bodies of Port Blair such as Forest Department, Botanical Survey of India have also taken up necessary steps to conserve them under *in situ* and in the experimental gardens cum arboreta through *ex situ* approach, respectively. The recently concluded "National Symposium on Biodiversity *vis-à-vis* Resource Exploitation: An Introspection "at Port Blair has also highlighted the urgency in conserving the wild flora (biodiversity) of these islands and their sustainable utilization for commercial exploitation (Shiva *et al.*, 2002b) for the benefit of posterity.

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Principal Component Analysis in Guinea Grass (*Panicum maximum* Jacq.) Germplasm

Abha Jain, AK Roy, P Kaushal, DR Malaviya and SN Zadoo
Crop Improvement Division, Indian Grassland and Fodder Research Institute, Jhansi-284 003, Uttar Pradesh.

Principal component analysis was carried out using morphological traits in 63 germplasm accessions of *Panicum. maximum* Jacq. The analysis resulted in identification of seven clusters. The largest cluster had 19 accessions followed by clusters with 14 and 10 accessions. Average distance of cluster members from cluster centroids was found to range from 1.543 to 2.695. Many of the clusters comprised entries from as diverse sources as humid Southern India to dry Africa. The study indicated that opportunities exist to select the most desirable type for any agro-ecological zone out of the wide genetic diversity available.

Key Words: Guinea grass, *Panicum maximum*, Germplasm, Cluster, Principal component analysis

The genus *Panicum* of tribe Panicoideae (Family Poaceae/ Graminae) comprises about 500 species distributed in tropical parts of the world. *Panicum maximum* Jacq. popularly known as guinea grass is an important pasture grass. It is adapted and cultivated in many countries because of its high yield, nutritious fodder and tolerance to saline and shade conditions. Guinea grass is native to Africa particularly east Africa, Kenya and Tanzania where wide genetic diversity exists. The crop has been introduced and exploited as a good quality, high yielding fodder particularly in tropical and sub tropical parts of the globe.

In India, initially *P. maximum* var. Makuni was introduced from Australia followed by a number of varieties like 'Hamil', 'Riversdale' and 'Gatton Panic'. (Malaviya, 1996). Indian Grassland and Fodder Research Institute, Jhansi has collected wide genetic diversity of the crop through exploration and introduction of exotic germplasm.

Earlier studies have also reported wide genetic diversity for yield and yield attributing characters in Guinea grass (Burton *et al.*, 1973, Ramaswamy and Raman, 1971, Judd, 1974, Thomas, 1975, Sidak *et al.*, 1977). However, most of the studies were related to the yield contributing characters and the correlation of such traits. Very few attempts were made to group different accessions based on their similarity. In a Japanese study similar to the present one, 119 accessions were clustered into 11 groups based on principal component analysis (Nakajima *et al.*, 1978). Wide diversity was observed in several germplasm lines collected from different parts of India that were put into seven groups on the basis of morphological traits especially qualitative traits (Malaviya, 1996, 1998, Kaushal *et al.*, 1999). The present study aimed at grouping diverse germplasm lines for exploitation in genetic improvement programme.

Materials and Methods

Sixty-three germplasm lines of *P. maximum* were used in the study (Table 1). The healthy seeds of different accessions were sown in the second and the third week of June 1999 and one month old seedlings were transplanted to field at row to row distance of 75 cm and plant to plant distance of 50 cm. Observations on metric traits such as plant height, stem diameter, leaf length, leaf width, flag leaf length, flag leaf width, flag leaf sheath length, peduncle length and inflorescence length were recorded at 50% flowering stage. The observations were recorded on 3 plants selected at random. The data was analyzed statistically using Principal Component Analysis using Euclidean distances. The computation was done using the computer software SPAR1.

Results

The principal component analysis based on 9 morphological traits indicated that the first three components account for 62.11% of total estimated variation. Separate percentages of variations attributable to the first 8 components by decreasing order were 26.22 – 20.27 – 15.62 – 11.22 – 9.75 – 6.14 – 4.77 – 3.92 (Table 3). In the present study, 8 principal components were used in the subsequent cluster analysis which accounted for 97.9 % of the observed variation. The analysis resulted in grouping of 63 germplasm accessions into seven clusters on the basis of their relative similarity/ variation (Table 1).

Nineteen accessions were included in cluster-3 while 14 accessions were clustered in cluster-1 and 10 accessions were observed in cluster-7. In cluster-2 and cluster-5,

seven accessions each were included while three accessions each were clustered in cluster-4 and cluster-6.

Maximum values for morphological traits like plant height, flag leaf length, flag leaf width and inflorescence length were observed in cluster 6. The average leaf length was maximum in cluster-4 and minimum in cluster-5, while leaf width was maximum in cluster-2 and minimum in cluster-3. Maximum flag leaf width was recorded in cluster-6 and minimum in cluster-3. Average and standard deviation of 7 clusters for 9 characters are given in Table 2.

The maximum distance between cluster centroids was observed in cluster-5 and cluster 6 and the cluster-1 and cluster-3 were closest. Average distance between respective cluster members and cluster centroids in different clusters ranged from 1.543 - 2.695. Distances between cluster centroids are given in Table 4.

Table 1. Clustering of genotypes from different geographical regions based on morphological characters.

Cluster number	Geographical region of collections and accession number				
	Ethiopia	India			
		South	North	Central Plains	North East Hills
1	IG 97-32, IG 97-05, IG 97-14	IG 01-96, IG 01-155, IG 01-218, IG 01-169, IG 01-216, IG 01-204, IG 01-82, IG 01-152, IG 01-206.	IG 01-134	IG 01-224	–
2	IG 97-35, IG 97-27	IG 01-121, IG 01-196, IG 01-200, IG 96-241, IG 96-240	–	–	–
3	IG 97-48, IG 97-41	IG 01-221, IG 01-166, IG 01-116, IG 01-93, IG 01-176, IG 01-89, IG 01-119, IG 01-106, IG 01-90, IG 01-151, IG 01-170, IG 01-210	IG 01-183, IG 01-180	IG 01-227, IG 01-229	IG 01-101
4	–	IG 01-171, IG 01-191	IG 01-83	–	–
5	IG 97-08, IG 97-17, IG 97-06, IG 97-22	IG 01-160, IG 01-122, IG 01-188	–	–	–
6	–	IG 01-126, IG 01-205, IG 01-198	–	–	–
7	IG 97-04, IG 97-48-1	IG 01-173, IG 01-88, IG 01-162, IG 01-124, IG 01-85	–	IG 01-87, IG 01–228	IG 01-141

Table2. Morphological characters (mean ±standard deviation) in different clusters of germplasm lines of *Panicum maximum*

Cluster no.	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	Flag leaf length (cm)	Flag leaf width (cm)	Flag leaf sheath length (cm)	Peduncle length (cm)	Inflorescence length (cm)	Stem diameter (cm)
1	181.89 ±18.22	56.00± 13.39	1.95± 0.18	11.34± 2.22	1.17± 0.27	18.39± 2.05	42.07± 7.40	34.86± 5.13	0.44± 0.07
2	169.40 ±18.93	68.67± 10.97	2.27± 0.47	18.67± 4.66	1.65± 0.20	20.02± 3.11	30.26± 4.24	27.69± 2.88	0.50± 0.15
3	201.61 ±18.61	65.84± 10.87	1.95 ± 0.20	7.83± 1.97	0.70± 0.20	18.89± 1.43	50.45± 7.73	29.32± 2.63	0.42± 0.07
4	202.00 ±21.38	76.17± 5.39	1.63± 0.23	13.00± 2.29	1.20 ± 0.53	33.00± 3.04	44.50± 0.50	33.50± 2.60	0.42± 0.03
5	145.14 ±17.10	38.50± 11.24	1.64± 0.18	11.46± 3.34	0.97 ±0.31	17.57± 1.48	48.21± 11.71	27.21± 4.01	0.40± 0.07
6	206.33 ± 7.69	70.00± 5.00	2.20± 0.18	24.50± 4.27	1.68± 0.41	22.50± 3.91	47.33± 7.37	48.17± 2.25	0.43± 0.03
7	200.00 ±14.33	58.85± 13.11	1.62± 0.12	13.15± 4.84	1.00± 0.26	20.85± 2.55	64.35± 9.06	34.65± 2.39	0.48± 0.07

Table 3. Eigen vectors, eigen root values and variations for principal components in 63 accessions of Guinea grass.

Traits	EIGEN VECTORS								
1	0.095	0.295	0.368	0.482	0.515	0.242	-0.240	0.267	0.289
2	0.595	0.367	-0.186	-0.150	-0.190	0.375	0.403	0.337	-0.038
3	-0.151	-0.509	-0.397	0.385	0.279	0.028	0.427	0.379	-0.084
4	-0.352	0.187	-0.282	0.021	0.054	0.606	-0.302	-0.072	-0.543
5	-0.056	-0.064	-0.422	0.067	-0.092	0.374	-0.021	-0.397	0.710
6	-0.233	-0.105	-0.090	-0.260	-0.317	0.013	-0.425	0.707	0.278
7	-0.289	-0.269	0.563	-0.380	0.061	0.468	0.387	0.008	0.100
8	-0.500	0.450	0.107	0.407	-0.465	-0.105	0.368	0.055	0.063
9	-0.314	0.440	-0.280	-0.463	0.537	-0.249	0.202	0.069	0.138
Eigen roots	2.360	1.824	1.406	1.009	0.878	0.552	0.429	0.353	0.189
Variation (%)	26.22	20.27	15.62	11.22	9.75	6.14	4.77	3.92	2.10
Variation (cumulative)		46.49	62.11	73.33	83.08	89.22	93.99	97.91	100

Table 4. Inter-cluster distance among 7 clusters based on morphological characters.

Cluster no.	1	2	3	4	5	6	7
1	0.000						
2	2.953	0.000					
3	2.066	4.065	0.000				
4	4.282	4.869	4.296	0.000			
5	2.658	4.286	3.272	5.438	0.000		
6	4.071	4.326	5.292	4.880	6.123	0.000	
7	2.444	4.442	2.422	3.855	3.436	4.376	0.000

Discussion

The study of genetic relatedness helps in genetic upgradation programmes, as it throws light on selection strategies and evolutionary dynamics in a particular germplasm collection. Morphological traits have been used by several workers to assess the variability and identify donor for specific traits. In the present study, attempts were made to estimate diversity/similarity of various traits in 63 germplasm accessions collected principally from two geographical areas, Ethiopia (Africa) and India (South, North- east, Central plains and North-west regions).

An analysis of the principal components enables a synthetic description of the observed variability obtained by reducing the number of the original variables. In the present studies, the first three components accounted for 62.11% of total estimated variations. Eight principal components used in the cluster analysis accounted for 97.9 % of the observed variation. By examining the coefficients or eigen vectors of individual components, indications were obtained on their level of association with the original variables.

Characters such as leaf length (0.595), inflorescence length (-0.500) showed higher coefficients in the first component while the second component showed significant variation associated with the leaf width (-0.509), inflorescence length (0.450) and stem diameter (0.440). Flag leaf width (-0.422) and peduncle length (0.563) were found to characterize the third principal component.

In the present study, the material resolved into seven distinct clusters. As is clear from Table 1, the Indian collections were represented in all the seven clusters, whereas the Ethiopian collections were represented in five clusters only. The representation in different clusters, however, cannot be taken as an evidence of greater variability in Indian collections, which are represented by 50 accessions as compared to Ethiopian collections represented by 13 accessions only. Bulk of accessions (53.8%) were represented in cluster-1 and cluster-3, which are incidentally closest to each other. Ethiopian accessions are conspicuous by their absence in cluster-4 and cluster-6. Cluster–6 is represented by only three Indian collections and forms a conspicuous group in itself showing highest average values for four of the nine characters *viz.*, plant height, flag leaf length, flag leaf width and inflorescence length (Table 2). This cluster is having well above average distance from all other cluster centroids (Table 4). Similarly, cluster- 5 represented by four out of eleven (30.76%) Ethiopian collections were conspicuous in as much as it shows lowest average values for five of the nine characters including plant height (Table 2).

Unlike earlier studies where mean, range, coefficient of variation were taken as estimate of variability, the clustering augments the scope for selection of desirable types for genetic improvement programme as it provides an insight of genetic similarity among different germplasm lines.

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Diversity of Watermelon *Citrullus vulgaris* Linn. from Agra and Kanpur Region

KP Singh[1] and SVS Chauhan[2]
[1] *Department of Botany, RBS College, Agra-282 002 (Uttar Pradesh).*
[2] *Department of Botany, School of Life Sciences, Dr BR Ambedkar University, Agra-282 002 (Uttar Pradesh)*

Exploration for watermelon (*Citrullus vulgaris* L.) was undertaken in south-west and central parts of Uttar Pradesh where wide range of fruit and seeds variability was observed. The species was uniformly distributed throughout south-east region of Ganga river bank at Farrukhabad and Kanpur. It exhibited considerable variation in fruit shape, rind colour and mottling, colour of stripes, glossiness, fruit size, weight and flesh colour.

Key Words: Watermelon, Diversity, Exploration, Collection

The watermelon (*Citrullus vulgaris* L. – Cucurbitaceae) is indigenous to tropical Africa. There are reports that it has been found in wild state on both sides of the equator. Pangalo (1930; 1944; 1955) has made extensive studies of Asiatic watermelon. On the basis of both field and herbarium studies, he was convinced that watermelon is indigenous to India. Watermelon is widely spread throughout the tropics and sub-tropics, but do best in the hot drier areas with an abundance of sunshine. It grows best on fertile sandy soil, particularly on sandy river banks. Uttar Pradesh is one of the largest distributing centre for watermelon. The present study was undertaken to collect the germplasm of watermelon from Mathura, Agra, Etawah, Kanpur, Farrukhabad, Etah and Hathras districts (Fig. 1).

Collection of Germplasm

South-west region (Mathura, Agra, Etawah, Kanpur, Farrukhabad and Hathras districts) of Uttar Pradesh, was surveyed for collection of watermelon germplasm. The sites were selected at a distance of 15-20 km from each other on the basis of different climatic zones so as to collect maximum variation. Mature seeds were extracted from ripe fruits (8-10) in each accession. Herbarium were also prepared for most of the sample collected. Data was collected on the vigour, earliness and productivity, shape, colour, thickness and texture of rind.

Observations

The fruits were collected from both the plains as well as from bank of river Yamuna at Mathura. The fruits were entirely spherical in shape but were small, medium or large in size and light to dark green in colour. The stripes were present mostly on medium sized fruits and rarely on larger fruits. The diameter of the fruits ranged between 14-16 cm (small), 16-18 cm (medium) and 18-20 cm (large). Similarly, the weight of the fruits collected from the plains ranged between 0.5-2.0 kg (small), 2.0-5.0 kg (medium) and 5.0-8.0 kg (large). On the other hand, the fruits collected from Yamuna river bank were large in size as compared to those collected from the plains. The diameter of these fruits was 15-17 cm (small), 17-19 cm (medium) and 20-24 cm (large) and their weight ranged between 0.5-2.5, 2.5-7.0 and 7.0-10.0 kg respectively.

The fruits collected from the plains and bank of Yamuna river at Agra district also exhibited considerable variability in both shape and size. The fruits collected from plains were spherical but either small, medium or large in size. They were light to dark green in colour. The diameter of fruits ranged between 12-16 cm (small), 16-18 cm (medium) and 18-20 cm (large). The weight of small fruits ranged between 0.5-2.20 kg, for medium sized fruits it was between 2.20-5.50 kg and those of large fruits it was between 5.50-8.0 kg. On the other hand, the fruits collected from the bank of Yamuna river were larger than those collected from the plains. The diameter of fruits was 15-17, 17-20 and 20-25 cm with weight ranging between 0.6-2.50, 2.5-6.5 and 6.5-10.0 kg of small, medium and large fruits respectively.

The fruits collected from plains as well as from the banks of river Yamuna at Etawah district were similar to those collected from Mathura and Agra but exhibited some variation in both diameter as well as weight. The diameter of fruits collected from plains ranged between 12-14 cm (small), 14-16 cm (medium) and 16-18 cm (large). The weight of small fruits was between 0.4-2.0 kg, while those of medium sized fruits it was

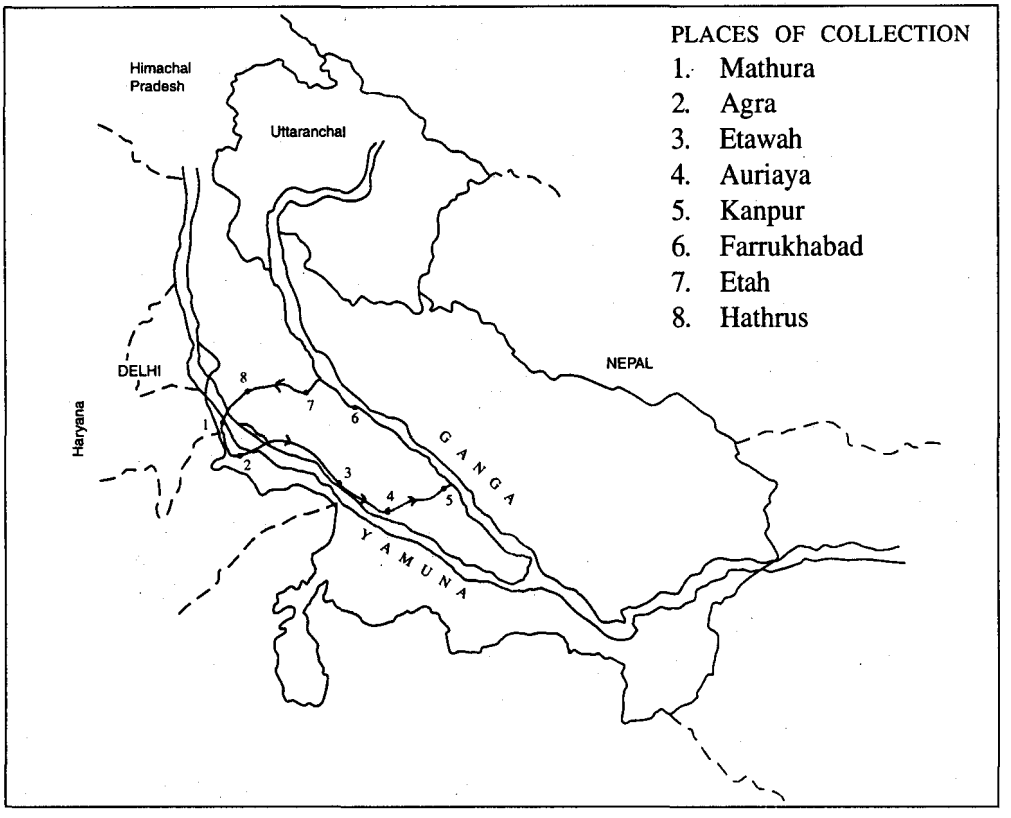

Fig 1: Exploration route map for collection of Watermelon from parts of U.P.

2.0-5.50 kg and those of large fruits it was between 5.50-7.00 kg. On the other hand, fruits collected from the bank of Yamuna were either small (14-16 cm) or medium (16-18 cm) or large (18-22 cm) and their weight ranged between 0.5-2.0, 2.0-6.0 and 6.0-8.0 kg respectively.

The fruits of watermelon collected from plains as well as from the bank of river Ganga are commonly known as Katri in Kanpur district. The fruits were either spherical or elongated. These were small, medium and large in size. The colour of fruits was light to dark green or even greenish brown in colour. The diameter of spherical fruits ranged between 14-16 cm (small), 16-18 cm (medium) and 19-21 cm (large) with 1.0-2.5, 2.5-5.0 and 5.0-7.0 kg weight in small, medium and large fruits respectively. On the other hand, spherical fruits collected from bank of river Ganga were either small (15-18 cm) or medium (18-20 cm) or large in size (21-28 cm) with 2.0-5.0, 5.0-7.0 and 7.0-13.0 kg weight respectively. On the other hand, the elongated fruits collected from river bank were 25-60 cm long with a diameter of 14-16 cm. The weight of such fruits was between 5-10 kg. These were light green or greenish brown in colour without stripes.

The fruits collected from the plains and bank of river Ganga in district Farrukhabad were either spherical or elongated and light to dark green in colour. The fruits were either small (12-14 cm) or medium (14-16 cm) or large (18-20 cm) in size. The weight of fruits ranged between 0.5-3.0 kg (small), 3.0-7.0 kg (medium) and 7.0-8.0 kg (large). Similarly, the fruits collected from the bank of river Ganga were small (15-18 cm), medium sized (18-22 cm) and large (22-26 cm) and their weight ranged between2.0-5.0 (small), 5.0-8.0 (medium) and 8.0-14 kg respectively. Elongated fruits (20-50 cm long with 10-12 cm diameter and 3.0-7.0 kg weight) were also collected from the Ganga river bank. These were light green and with stripes.

Various types of fruits were collected from plains as well as from the bank of Ganga in Etah district. The fruits were either small, medium or large sized. These were light to dark green or some times greenish brown in colour. Stripes were also present on their surface. It was interesting to note the presence of a small beak at the distal end of fruits. The diameter of small, medium and large fruits ranged between 12-14, 14-16 and 18-22 cm respectively with fruit weight ranging between

0.5-2.0, 2.0-6.0 and 6.0-8.0 kg in small, medium and large fruits respectively. On the other hand, the fruits collected from the bank of river Ganga were small (16-18 cm), medium (18-20 cm) or large (20-24 cm) in size and their weight was between 2.0-8.0, 8-10 and 10-12 kg respectively in small, medium and large fruits. The weight of fruits with a peak ranged between 4-8 kg.

The fruits of watermelon collected from the plains of Hathras were spherical, small, medium or large in size and light to dark green in colour. The strips were sometimes present only on the large fruits. The diameter of fruits was 10-12 cm (small), 12-14 cm (medium) and 14-18 cm (large) and fruit weight ranged between 0.3-2.0, 2.0-5.0 and 5-7 kg respectively.

The germplasm collected from plains of Mathura district was brown and black in colour and they were 9.0x0.70 cm in size. The weight of 100 seeds was 5.70 g. On the other hand, the seeds collected from the bank of river Yamuna were small (1.16 x 0.82 cm) in size with 9.20 g weight of 100 seeds and black in colour with prominent margin.

The seeds collected from the plains of Agra were 0.86x0.69 cm in size and 100 seed weight was 5.13 g. On the other hand, the seeds collected from the bank of river Yamuna were brownish black in colour and their size was 1.24x0.82 cm with 9.42 g weight of 100 seeds.

The germplasm of watermelon collected from plains at Etawah was brownish black in colour. The seed size was 0.96x0.72 cm with 6.23 g 100 seed weight. However, the seeds size (1.34x0.85 cm) and 100 seed weight (8.92 g) of germplasm collected from bank of river was slightly higher than those collected from plains.

The seeds collected from plains as well as bank of river Ganga (Katri) at Kanpur were white, brown, dark brown or black in colour with pointed end. The seed size and 100 seed weight was 9.0x0.61 cm and 6.00 g respectively in plains. On the other hand, seed size (1.14x0.85 cm) and 100 seed weight (8.00 g) was slightly higher from those collected from the bank of Ganga river.

The seeds collected from plains as well as Ganga river bank of Farrukhabad district also exhibited variability. The seeds were either brown, black or half brown and half black. The seed size in plains was 0.78x0.61 cm and their 100 seed weight was 4.32 g. On the other hand, the seeds of 1.6x0.74 cm size with 9.32 g 100 seed weight were collected from the bank of river Ganga.

In Etah, the seeds also exhibited some variation. The colour of seeds was brown, black and whitish black. The size of seeds was 0.92x0.73 cm with 100 seed weight as 5.92 g in plain area. On the other hand, the seeds collected from the bank of river Ganga were 1.12x0.82 cm in size and their seed weight was 9.20 g.

The germplasm collected from Hathras district was brown and light black in colour with white lines. The size of seeds was 1.10x0.80 cm and their 100 seed weight was 7.25 g.

Thus, the germplasm collected shows rich genetic diversity in watermelon. The landrace variability is of considerable interest as it is attuned to sandy river bank conditions but also adapted to agro-ecological niches. The germplasm varied in fruit shape (elongated and spherical) and colour (light to dark green) with or without strips. The seeds also exhibited great deal of diversity in colour, shape and weight. There is need of biochemical and molecular evaluation of these collections. These findings will be of great use in hybridization programmes and in the development of new varieties.

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Diversity of Fruits in Bottle Gourd (*Lagenaria siceraria* L.) Collected from Mainpuri District, Uttar Pradesh, India

KP Singh[1], SVS Chauhan[2] and Umesh Srivastava[3]

[1] *Department of Botany, R.B.S. College, Agra-282002 (Uttar Pradesh).*

[2] *Department of Botany, School of Life Sciences, Dr. B.R. Ambedkar University, Agra-282002 (Uttar Pradesh).*

[3] *Principal Scientist, NBPGR, Pusa Campus, New Delhi-110012.*

A great deal of diversity in fruits as well as seeds in bottle gourd (*Lagenaria siceraria* L.) was observed in Mainpuri district, Uttar Pradesh (India). Variability in fruit and seed shape, size and colour, their uses are described in the present paper.

Key Words: Bottle gourd, Germplasm, Diversity, Kamandal

There is little doubt that bottle gourd (*Lagenaria siceraria* L., Cucurbitaceae) has been under cultivation in old world for a considerable period of time. India is considered to be the centre of origin for *Lagenaria.* Due to its high consumer preference and medicinal uses, *Lagenaria* is now extensively cultivated in Arunachal Pradesh, Assam, Bihar, Madhya Pradesh, Maharashtra, Punjab, Tamil Nadu, West Bengal and Uttar Pradesh. The present study was undertaken to study the diversity in fruits and seeds in bottle gourd *L. siceraria* from various parts of Mainpuri district, Uttar Pradesh, India.

Materials and Methods

A survey was made for the collection of diversity in the germplasm of *Lagenaria siceraria* from Mainpuri, Bhaogan and Karhal tahsils and blocks of Mainpuri district. Field data and germplasm of bottlegourd was collected from the farmer's field, river bank as well as from the protected areas. The characters recorded were habit, habitat, status of the species, topography of the area, sample type, sampling method, source and plant characters. Collected germplasm from farmers fields, protected areas, threshing yards, market, farm store etc. was packed in polythene bags and sent to National Bureau of Plant Genetic Resources (NBPGR) New Delhi for its storage in National Gene Bank.

Results and Discussion

Lagenaria siceraria commonly known as white flower gourd or bottle gourd, is monoecious, long running or climbing plant.

The diversity in fruits as well as seeds of bottle gourd observed in various parts of Mainpuri district has been described in the following paragraphs.

1. Goal Bottle Gourd

This type is not common and was collected in the months of September and October from road side villages of Mainpuri tehsil. The fruits are spherical or globular with smooth and soft surface (Fig. 1). The pericarp is thin (0.3-0.5 cm) and soft. The seeds are brown in colour and measure 1.3-1.5 x 0.7-0.8 cm in size with 100 seed weight as 10.80 g. The fruits are used as vegetable and for making sweets.

2. Chakti Bottle Gourd

It is also rarely cultivated and was collected from Kurauli block of Mainpuri district. The fruits are spherical in shape (Fig. 2). The fruit surface is smooth and thin with soft pericarp (0.2-0.4 cm). The seeds are light brown in colour and their size ranges between 1.3-1.4 x 0.6-0.8 cm. The 100 seed weight was 10.25 g.

3. Tuma Bottle Gourd

It was collected from a small village of Vernahal block of Karhal Tahsil. The fruits are large pyriform and looks like a tuma hence called tumari (Fig.3). The pericarp is tough and the thickness ranges between 0.6-1.0 cm. The seeds are medium size with triangular apex. They are dark brown in colour. The size of seed ranges between 1.8-1.9 x 0.8-0.9 cm and 100 seed weight is 10.6 g.

4. Long Bottle Gourd

It is commonly grown in all parts of Mainpuri district. The fruits are elongated and are 30-100 cm long. Their surface is smooth with thin and soft pericarp (0.3-0.5 cm) (Fig. 4). The seeds are light brown in colour and their size ranges beween 1.3-1.4 x 0.7-0.8 cm. The 100 seed weight was 10.68 g.

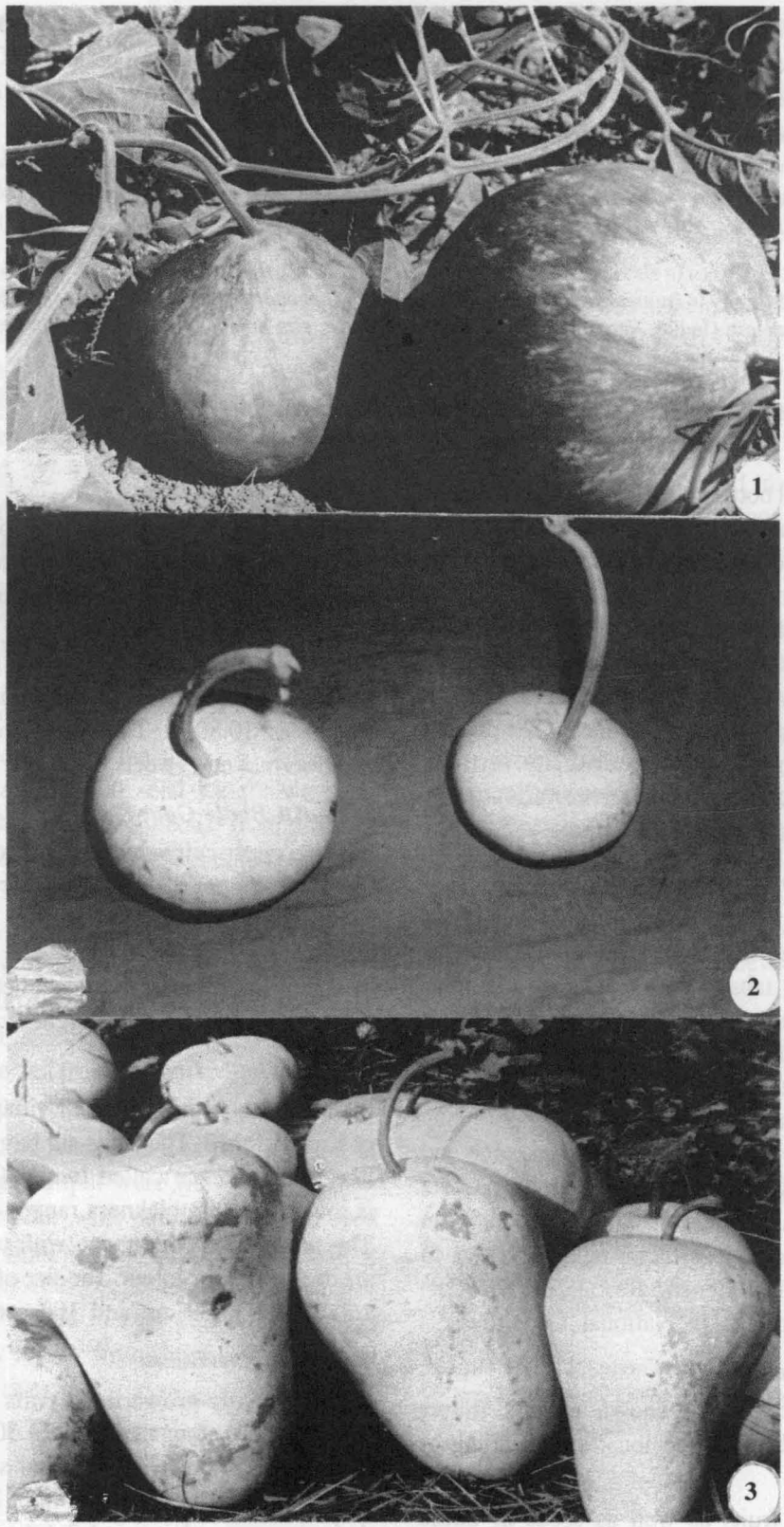

***Fig. 1**: Goal (spherical) Bottle gourd collected from road side village of Mainpuri district;*
***Fig. 2**: Chakti Bottle gourd collected from Kurauli block;*
***Fig. 3**: Tuma Bottle gourd collected from Vernahal block of Karhal tahsil*

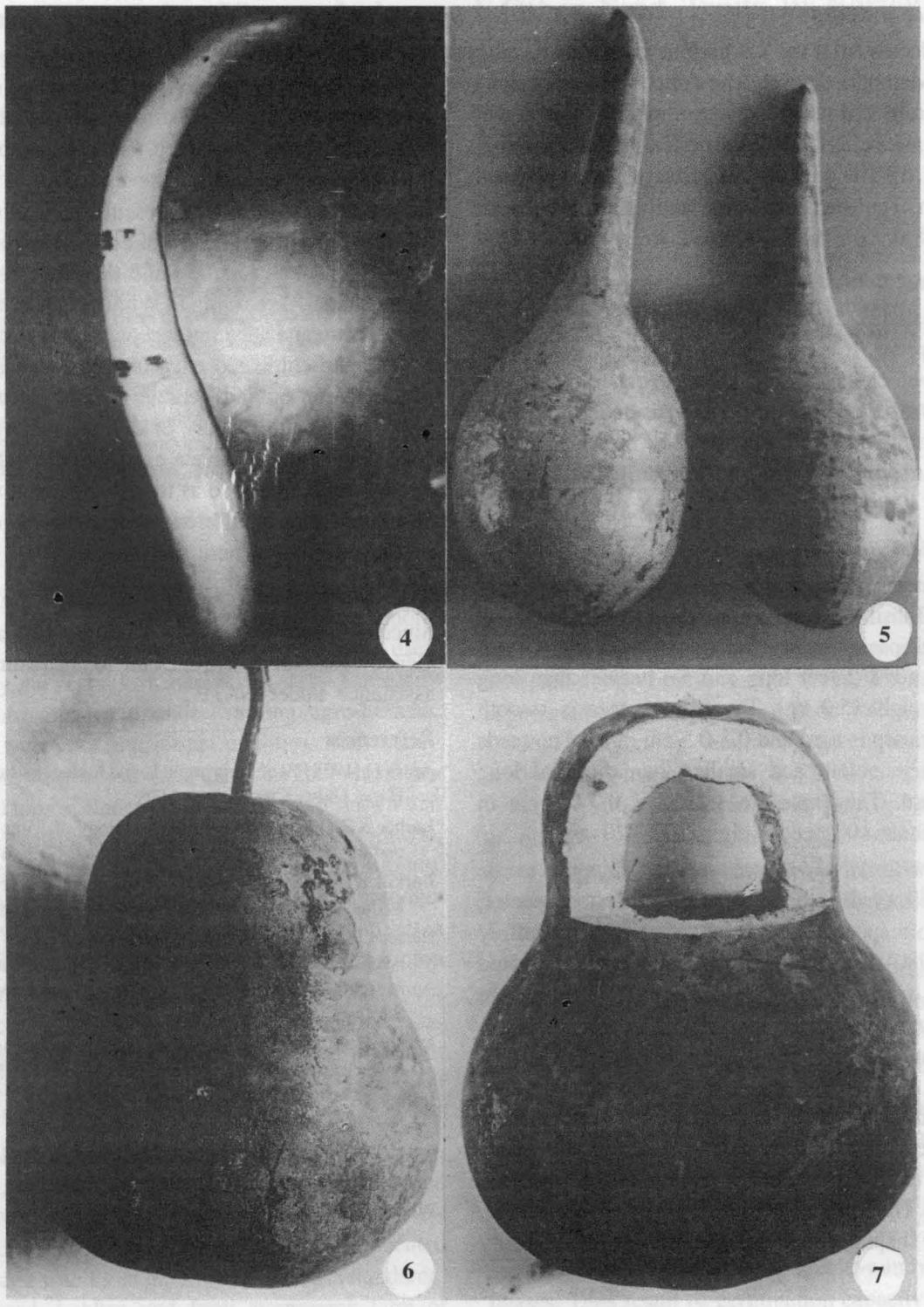

***Fig. 4**: Long Bottle gourd collected from all parts of Mainpuri district*

***Fig. 5**: Bean Bottle gourd collected from Kurauli block*

***Fig. 6**: Kamandal Bottle gourd collected from Kurauli block*

***Fig. 7**: Kamandal used by Indian Saint*

5. Bean Bottle Gourd

It was collected from the Lakhrajpur village of Kurauli block of Mainpuri district. The fruits are bean shaped and ripe fruits are used to make a musical instrument used by snake-charmers. The pericarp is smooth but tough (Fig. 5). The thickness of pericarp ranges between 0.3-0.5 cm. The seeds are white and measure between 1.5-1.6x0.8-0.9 cm and 100 seed weight is 11.20 g.

6. Kamandal Bottle Gourd

It is cultivated by Sadhus (Saints) near their huts over which it creeps. It is collected from Hanukhera village of Kurauli block of Mainpuri district (Fig. 7). The fruits are pyriform (Fig. 6). The pericarp is rough and hard and 1-2 cm thick. The seeds are dark brown in colour and medium sized (1.3-1.4 x 0.7-0.8 cm). The 100 seed weight is 12.40 g.

7. Cylindrical Bottle Gourd

It is cultivated in villages of Mainpuri district particularly in Kishni Tahsil. The fruits are cylindrical in shape but sometime ellipsoidal shaped fruits have also been observed. The fruits are 1-2 feet long and are heavier then long lauki in weight (5.0 kg). The fruit surface is smooth but the pericarp is hard and 0.3-0.5 cm thick. The seeds are brown in colour and smaller than those of long bottle gourd. They measure 1.2-1.3 x 0.7-0.8 cm in size and their 100 seed weight is 10.20 gm.

Lagenaria siceraria was earlier thought to be monotypic including only a single cultivated species, but six more species have been recognized by Jeffrey (1962 & 1980). One of these is the monoecious cultivated *Lagenaria siceraria* (Mol.) standl and five others are wild perennial, dioecious species of Africa and Madagascar. Recent work has confirmed the existence of two sub-species of *L. siceraria* one is from Asia and the other one is from both Africa and the New World (Heiser, 1973). The fruits as well as the seeds of the genus *Lagenaria* exhibit great deal of variability in shape, size and weight. The fruits may be either pyriform, cylindrical, oval, club shaped, tuma or bean shaped. At maturity they are hard shelled, smooth surfaced and green to whitest in colour.

Barber (1909) has divided the pericarp of cucurbits into six more or less distinct parts namely, epicarp, hypoderm, outer mesocarp, middle mesocarp, inner mesocarp and endocarp. The thickness of pericarp of fruits collected during the present course of study varies between 0.3-1.0 cm and that of a pyriform fruit is thickest (1.5-2.0 cm) and toughest and therefore, used to serve as Kamandal. According to Whitaker and Davia (1962), the pericarp and adherent receptacle which compose the fruit of the cultivated cucurbitaceae vary in thickness (thick or thin or rind), colour (white, green, yellow or red), and texture (watery or dry, sclerenchymatized or soft). The central planceta extend to the outer wall and divide, turning back so as to give a parietal appearance. However, certain differences exist between the fruits of the different genera and species.

Acknowledgements

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Germinative Capacity, Vigour Index and Other Seed Traits in Barley and Their Utility in Future Crop Improvement

Rudrasen Singh Raikwar and SR Vishwakarma
Department of Genetics and Plant Breeding, ND University of Agriculture and Technology, Kumarganj, Faizabad-224 229 (Uttar Pradesh)

Seed vigour is recognized as a component of seed quality distinct from germinability. The performance of established genotypes shows variations often associated with differences in seed vigour that may be physical, physiological or genetic in nature. Assessment studies led to the following findings: The wide range for different characters and comparison of means of germplasm using least significant differences indicated existence of very high degree of variability for all characters studied. The genotypes RD-2592, RD-2503, RD-2035, F_6 (S x S)-128, BH-492, K-560 25th IBON-10, F_6 (S x S)-102, 29 and K-603 showed high mean performance for grain yield coupled with other desirable seed traits. The genotypes 25th IBON-106, 25th IBON-48 and 7th HBSN-2 were found better for grain hardness, appealing seed shape and low husk content, respectively. Studies indicated that these superior genotypes may be utilized as donors in barley hybridization programme for improving most of the present day genotypes showing deficiency for yield and quality components.

Key Words: ***Hordeum vulgare L.*, Germination capacity, Vigour index, Hybridization**

Since ages, barely (*Hordeum vulgare* L.), a member of Poaceae family has held a prestigious place among cereals. It is grown worldwide for multifarious uses. Being hardy and versatile in nature, it possesses elasticity for superior grain yield under varying agro-climatic situations, with good nutritional qualities. Malt barley is used in brewing industry and medicine for preparation of beer and tonics. Recent studies have also shown that barley surpassed other cereals in the content of ß- glucon, total dietary and soluble fibre and easy digestibility. The cooling and soothing effect of flour/food product of barley is beneficial in treating hyper cholesterolemia (Anderson *et al.*, 1990). An estimated five per cent crop loss occurs each year because of low seed vigour (Woodstock, 1973). The present investigation was undertaken to assess and utilize the genetic variation for yield contributing seed traits in new accessions of exotic barley.

A total of 88 genetically and geographically diverse accessions, particularly stabilized F_6 generations, obtained from National Bureau of Plant Genetic Resources, New Delhi were evaluated during *rabi* 1998-99 in Augmented Block Design with three intermittent checks (standards) namely, Azad, Lakhan and Jyoti at research farm of Genetics and Plant Breeding, ND University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh. Each accession and check was grown in single row of 1.5m length. The checks were distributed systematically in each block after 11 genotypes. Distance of plants within rows was maintained at about 10cm by thinning. Row to row distance was kept at 25cm apart. Recommended package of practices was followed to raise healthy crop. Five competitive plants were randomly selected to record observation for twelve metric traits. The analysis of augmented block design was done following Federer (1956). For scoring laboratory germination, counted seeds were germinated at 28 $\pm$ 2^0 C temperature and 97 per cent of relative humidity. Seeds showing emergence of plumule and radicle of 2 mm were counted as germinated. Vigour index was measured as seed germination (%) multiplied by seedling length (cm) after 5 days of germination.

Wide variability existed for all the traits amongst genotypes studied. High magnitude of variability in genotypes further provides the opportunity for selection to evolve a promising variety having desirable characters.

Mean squares for tillers/plant, spike length, weight of grains/spike, thousand grain weight, husk content, grain yield/plant were significant. However, variations due to blocks were found non-significant for germinative capacity, vigour index, plant height, harvest index, grain hardness and seed shape both in vegetative and reproductive phases. Thus result of germination capacity and vigour index indicated that intra-varietal differences were more pronounced. In general, long and bold seeds with higher vigour showed high germination (>85%). Bold seeded (>3mm = long axis/short axis) varieties with low to medium seedling vigour (93-144) showed more than 60% germination.

Germinative capacity ranged form 52.47 to 85.80 per cent. Eighteen genotypes were listed in top non-significant group. The highest and lowest value for vigour indices were observed in case of SBPM-EC 408442 (203.4%) and 25th IBON 59 (74.13%), respectively. Out of 88 genotypes, only 9 genotypes were of dwarf plant stature. Some of the dwarf and fertilizer responsive elite lines screened were 20th IBYT-2, 7th HBSN-2 and PL-604. The nine lines had better tillering capacity.

Six genotypes, present in the top non-significant group for higher seed yield per plant (g) were RD-2552 (6.76), RD-2503 (6.53), RD-2035 (6.46), F_6 (S x S)-128 (6.44), BH-492 (6.13) and K-560 (6.10). The highest yielding genotype RD-2552 showed high mean performance for most of the yield components. Similarly high mean performance was also found in RD-2035 whereas RD-2503 was found superior for number of tiller/plant, spike length, weight of grain/spike, harvest index, thousand grain weight and seed shape. The second highest yielder RD-2503 showed high mean performance for some other characters like number of tillers/ plant, spike length, weight of grain/ spike, thousand-grain weight, grain hardness and seed shape.

The third highest yielder, RD-2035 appeared in top non-significant group for vigour index, number of tillers/ plant, spike length, weight of grain/spike, harvest index, thousand grain weight, grain hardness, seed shape and husk content. The genotype F_6 (S x S)-128 showed very high mean performance for vigour index, grains/ spike, harvest index and seed shape as it was present in non-significant group. BH-492 appeared in top non-significant group for germinative capacity, number of tillers/ plant, spike length, harvest index, seed shape. K-560, which ranked sixth for seed yield, had virtue of being in top non-significant group for germinative capacity, number of tillers/ plants, spike length, weight of grains/ spike, harvest index and seed shape.

The most desirable and high performing genotypes were 7th HBSN-85 (for germinative capacity, seed shape and number of tillers/plant) SBPMEC 408442 (for vigour index, plant height number of tillers/ plant, spike length thousand grain weight and seed shape), F_6 (S x S) 87 (for plant height and seed shape), 7th HBSN 35 (for number of tiller/ plant, grain hardness seed shape). Likewise F_6 (S x S) 104 showed best response for plant germinative capacity, weight of grains/ spike and husk content and K-604 exhibited high performance for harvest index, seed shape and husk content, followed by F_6 (S x W)-20 for 1000 grain weight, 25 IBON-106 for 1000 grain weight and grain hardness, 25th IBON-48 for seed shape F_6 (S x S)-31 for grain hardness and husk content (Table 1).

Mahalakshmi *et al.* (1994) suggested that two rowed species are cross compatible and fully inter-fertile with cultivated barley. Improvement in the progenies was found to be due to improved harvest index and water use efficiency. It was further suggested that wide crosses of barley on locally adopted genotypes may be more effective in dry environment than wide crosses on exotic germplasm. In confirmity of above results Kabirian (1998) proposed that harvest index was not significantly influenced by plant density alone. However, the barley plant had a higher harvest index. Weltzien and Fishebeck (1990) especially observed that plant height and time to flowering were of intermediate variation, while under stress environment, highly significant genetic variation

Table 1. The most desirable genotypes identified for 12 characters studied.

Sl.No.	Characters	Genotypes
1	Germinative capacity	7HBSN-85, 25IBON-35, F_6SXS-30'SBPMEC408424, F_6 SXS-102, 25IBON-27, 7HBSN-79'25IBON-10
2	Vigour index	SBPMEC408442'EC408424'25IBON-106'25IBON-3,7HBSN-85, 25IBON-109, 25IBON-48.
3	Plant height	F_6 SXS-87, SBPMEC-408424, 25INON-97, F_6 SXS-86, F_6SXS-128, EC404163, 25IBON-44, 5HBSN-65.
4	No of tillers per plant	7HBSN-35, 7HBSN-85, 7HBSN-38, 7HBSN-65, 7HBSN-79, 7HBSN-8,EC408424,25IBON-3, 20IBYT-19.
5	Spike length	F_6SXS-128, EC-408442, F_6SXS-90,25IBON-48, EC-408424, 25IBON-29, 7HBSN-16, F_6SXS-86,EC-404163, 25IBON-12.
6	Weight of grains	F_6SXS-104, F_6SXS-6, F_6SXS-102, F_6SXS-3, RD-2503, F_6SXS-107, F_6SXS-4, EBN-67, F_6SXS-90, 20IBYT-2
7	Grain yield per plant	RD-2592, RD-2503, RD-2035, F_6SXS-128, BH-492, K-560, 25IBON-10, F_6SXS-102, 25IBON-29, K-603.
8	Harvest index	K-604, K-603BH-492, 25IBON-29, RD2503, K-560, 25IBON-10, 25IBON-52, RD-2559, F_6SXS-102
9	Thousand grain weight	F_6SXW-20, 25IBON-52, F_6SXS-31, EC-408442, F_6SXW21,25IBON-71,RD-2035, F_6SXS-86, F_6SXS-4.
10	Grain hardness	25IBPN-106, 25IBON-35, 25IBON-23, F_6SXS-123, PL-512,7HBSN-35, F_6SXS-86, RD-2508, F_6SXS-31, F_6SXS-102.
11	Seed shape	25IBON-48, EC-404163, 25IBON-44, 25IBON-59, 25IBON-29, 25IBON-23, F_6SXS-85,EBN-35, 25IBON-717HBSN-85.
12	Husk content	F_6SXS-31, F_6SXS-84, 25IBON-106,7HBSN-11, F_6SXS-104, EC-404162, 25IBON-23, F_6SXS-6, 25IBON-12, 5HBSN-65.

among genotypes and races was found responsible for grain yield. Similarly in the present study, days to 50 per cent flowering, followed by seed shape, breadth of seed and plant height had comparatively low variability indicating that for these traits additional variations need to be induced.

Vigour is recognized as an important factor distinct from germinability and likewise genotypes having similar germinability may exhibit different degree of vigour. Genetic differences evident among cultivars in respect of seed vigour as measured by different parameters suggested that it should be possible to incorporate this trait into high yielding genotypes, through appropriate breeding methodology. This would help to minimize the yield loss due to seed deterioration.

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Genetic Variability, Character Association and Path Analysis of Oil Yield and its Component Characters in Wild Marigold (*Tagetes minuta* L.)

Vibha Singhal* and LJ Srivastava
Department of Forest Products, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan-173 230 (Himachal Pradesh)

Genetic variability, character association and path analysis between oil yield and its contributing traits were studied in 20 genotypes of wild marigold. Highly significant differences between genotypes were recorded for most of the characters studied except for oil content in leaves and flowers. High phenotypic and genotypic coefficients of variation coupled with high heritability and moderate to high genetic gain recorded for estimated oil yield per hectare, number of branches per plant, number of leaves per plant, leaf yield per plot, flower yield per plot, number of flower heads per plant and plant height indicate the predominance of additive gene effects in controlling these traits. Correlation and path analysis revealed that number of flower heads per plant and oil content in flowers are overriding traits among all other growth and yield parameters, there for more emphasis should be laid upon them while designing selection indices for improvement of oil yield

Key Words: *Tagetes minuta*, Variability, Path analysis, Oil yield

Development of high yielding cultivars requires a thorough knowledge of the existing genetic variation and also the extent of association among yield contributing characters. The observed variability is the result of genetic differences among the plants, different environment in which they are growing and interaction between genotype and the environment. Genetic variability is complex but if its magnitude and type are known, it can be manipulated to obtain good gains for some characteristics/traits in any improvement program whereas environmental variation have no significance in breeding program. Correlation and path analysis establish the extent of association between yield and its components and also bring out the relative importance of their direct and indirect effects, thus give a clear understanding of their association with yield. The present paper deals with the above genetic constants and character association in 20 genotypes of *Tagetes minuta*, the herb highly valued for its essential oil.

Materials and Methods

The material comprised of twenty collections covering Solan and Sirmour districts of Himachal Pradesh especially from the potential source of its availability. These places range between 360-1350m above mean sea level. The experiment was laid down in Randomized Block Design (RBD) with twenty treatments and three replications for each treatment, having plot size of 1.8x1.8m. Achenes were sown in lines at 30x45cm spacing. Observations were recorded for five random plants per genotype in each replication for characters including plant height, number of branches, leaves and flower heads per plant, leaf and flower yield, oil content in leaves and flowers and estimated oil yield per hectare. Standard statistical procedures were followed for estimating genetic constants-phenotypic and genotypic coefficients of variation (Burton, 1952), heritability (Hanson et al., 1956) and genetic gain (Johnson et al., 1955). Genotypic and phenotypic correlation coefficients were calculated following Searle (1961) and path analysis following the method of Dewey and Lu (1955).

Results and Discussion

The variability estimates presented in Table 1 projected wide range of variability for growth and yield parameters particularly for estimated oil yield per hectare, number of branches and leaves per plant. Phenotypic coefficients of variation for different characters were higher than the corresponding genotypic coefficients of variation, though the extent of difference between the two was relatively low. The genotypic coefficients of variation for estimated oil yield per hectare and number of branches per plant were greater than 30 percent indicating high amount of genetic variability for these characters. Whereas, the genotypic coefficients of variation ranged from 15 to 25 per cent for number of leaves per plant, number of flower heads per plant, flower yield per plot, leaf yield per plot and plant height reflecting fairly good range of variability at genotypic level. However low value of phenotypic and genotypic coefficients of variability were recorded for oil content in leaves and flowers.

* *Present Address: National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110012. E-mail: Singhalvibha@lycos.com*

Table 1. Mean, range, coefficients of variability, heritability, genetic advance and genetic gain of growth and yield characteristics in *Tagetes minuta*

Character			Coefficients of variability (%)				
	Mean	Range	Phenotypic	Genotypic	Heritability	Genetic advance	Genetic gain(%)
Plant height (cm)	147.31	105.20-184.20	17.39	16.81	93.42	49.31	33.47
No. of branches/plant	20.36	10.00-29.91	35.60	35.02	96.80	14.34	70.98
No. of leaves/plant	108.90	76.94-160.50	24.73	24.05	94.54	52.45	48.17
Leaf yield/Plot (g)	206.12	132.31-260.11	18.45	18.15	96.80	75.85	36.80
No. of flower heads/plant	334.98	250.50-495.41	23.51	23.19	97.33	157.93	47.14
Flower Yield/plot (g)	663.88	450.62-925.40	23.07	20.94	82.36	259.90	39.16
Oil content in leaves (%)	0.40 (0.625)	0.29-0.47	6.16	5.97	94.12	0.07	11.94
Oil content in flowers (%)	0.72 (0.847)	0.51-1.04	9.61	9.46	96.67	0.16	19.20
Estimated oil yield (l/ha)	19.41	10.26-35.51	38.40	38.12	98.52	15.15	77.94

Values in parentheses are transformed values

Since broad sense heritability includes both additive and epistatic effects, it will be useful in predicting effectiveness of selection only when accompanied by high genetic gain. High values of heritability were recorded for all characters ranging from 82.36 per cent for flower yield per plot to 98.52 per cent for estimated oil yield per hectare. The characters viz., estimated oil yield per hectare and number of branches per plant recorded high genetic gain whereas number of leaves per plant, number of flower heads per plant, flower yield per plot, leaf yield per plot and plant height registered moderate genetic gain. Selection for these characters is likely to accumulate more additive genes leading to scope for potential improvement in their performance. Oil content in leaves and flowers recorded high heritability but did not show expected genetic gain, suggesting presence of non-additive gene action, thus selection will not be efficient for improvement of these traits. Expression of such traits can be modified through hybridization followed by selection. Pandey (1992) in *Solanum khasianum*, Harne (1993) in *Valeriana jatamansi*, Devagiri (1994) in *Heracleum candicans* and Rampal (1996) in *Gentiana kurroo* reported similar observations.

Inheritance of most of the traits is complex in nature and is influenced by wide range of associate characters. Presence of significant correlation among characters which have high heritability and are less affected by environmental variables permit better use of indirect selection i.e. selection applied for the contributory or associated traits would bring simultaneous improvement of the desired trait. Based on the estimation of phenotypic and genotypic correlations, the breeder decides the breeding methodology to be followed so that the useful correlations can be exploited and undesirable ones can be modified by generating fresh variability to obtain new recombinants. In the present investigation, it was reported that all growth and yield parameters were strongly correlated at phenotypic and genotypic level. In general, the genotypic correlations were higher than the corresponding phenotypic ones, which could be either due to modifying effect of the environment or the strong inherent association of these characters at genetic level. Plant height number of branches, leaves and flower heads per plant, leaf and flower yield per plot and oil content in leaves and flowers with high heritability and moderate to high genetic gain were significantly and positively correlated to oil yield per hectare. Thus, oil yield per hectare can be improved significantly through indirect selection for any of these traits. Biswas (1982) in *Rauwolfia serpentina*, Singh and Mahey (1991) in *Anethum graveolens* and Rampal in (1996) in *Gentiana kurroo* observed similar results.

Rapid improvement in the principal character is expected to result if selection is practiced for component characters. The component characters are quite often interrelated which affect their direct relation with principal character thereby, making correlation coefficients not much reliable as selection indices. So much so, when more variables are included in the correlation studies, the indirect association becomes more complex and it becomes imperative to separate them out. In such a situation, path coefficient analysis helps to dissociate the direct and indirect effects by partitioning and distributing the correlation coefficients over different contributing traits. The results of present investigation on path coefficient analysis revealed direct positive effect of number of flower heads per plant, oil content in flowers, oil content in leaves, number of leaves per plant

Table 2. Estimates of phenotypic and genotypic correlation coefficients among different growth and oil yield contributing parameters in *Tagetes minuta*

Character	Plant height (cm)	No. of branches/ plant	No. of leaves/plant	Leaf yield/ plot (g)	No. of flower heads/ plant	Flower Yield/ plot (g)	Oil content in leaves (%)	Oil content in flowers (%)	Oil yield (l/ha)
Plant height (cm)	1.0000	0.936	0.880	0.872	0.918	0.765	0.894	0.901	0.907*
	1.0000	0.954	0.885	0.911	0.923	0.973	0.899	0.904	0.913**
No. of branches/plant		1.000	0.936	0.905	0.938	0.751	0.926	0.899	0.939
		1.000	0.951	0.963	0.958	0.957	0.948	0.915	0.958
No. of leaves/plant			1.000	0.970	0.902	0.675	0.919	0.857	0.915
			1.000	0.978	0.905	0.851	0.923	0.860	0.923
Leaf yield/plot (g)				1.000	0.882	0.665	0.894	0.816	0.875
				1.000	0.914	0.860	0.928	0.845	0.916
No. of flower heads /plant					1.000	0.793	0.960	0.921	0.972
					1.000	0.891	0.963	0.923	0.978
Flower Yield/plot (g)						1.000	0.777	0.756	0.779
						1.000	0.992	0.949	0.985
Oil content in leaves (%)							1.000	0.928	0.969
							1.000	0.931	0.974
Oil content in flowers (%)								1.000	0.963
								1.000	0.966
Estimated oil yield(l/ha)									1.000
									1.000

All the *phenotypic and **genotypic correlations are significant at 5% level of significance

Table 3. Estimates of direct and indirect effects of various growth and oil yield contributing parameters on oil yield

Character	Plant height (cm)	No. of branches/ plant	No. of leaves/plant	Leaf yield/ plot (g)	No. of flower heads/ plant	Flower Yield/ plot (g)	Oil content in leaves (%)	Oil content in flowers (%)	Oil yield (l/ha)
Plant height (cm)	**-0.413**	0.064	0.080	0.013	0.440	-0.034	0.123	0.370	0.913
No. of branches/plant	-0.136	**0.067**	0.086	0.014	0.456	-0.033	0.130	0.374	0.958
No. of leaves/plant	-0.126	0.064	**0.090**	0.014	0.431	-0.029	0.127	0.352	0.923
Leaf yield/Plot (g)	-0.130	0.064	0.090	**0.014**	0.435	-0.030	0.127	0.346	0.916
No. of flower heads/plant	-0.132	0.064	0.082	0.013	**0.476**	-0.035	0.132	0.378	0.978
Flower Yield/plot (g)	-0.139	0.064	0.077	0.012	0.482	-0.035	0.136	0.388	0.985
Oil content in leaves (%)	-0.128	0.063	0.083	0.013	0.459	-0.034	**0.137**	0.381	0.974
Oil content in flowers (%)	-0.129	0.061	0.078	0.012	0.440	-0.033	0.128	**0.409**	0.966

Note: Bold values indicate direct effect
Residual effect = 0.0096

number of branches per plant and leaf yield per plot on oil yield per hectare, whereas plant height and flower yield had direct negative effects.

The direct negative effect caused by plant height and flower yield per plot on oil yield per hectare was supposed to be counterbalanced by high positive indirect effects via number of flower heads per plant and oil content in flowers. Further it can be concluded that, among all growth and yield parameters, number of flower heads per plant and oil content in flowers are overriding traits, therefor more emphasis should be laid upon them while designing selection indices for improvement of oil yield. These traits not only exhibited strong direct positive effects on oil yield per hectare but also all other associated traits have high and positive indirect effect via them. Very low magnitude of residual effect (0.0096) signifies that almost all the characters which have strong bearing on oil yield per hectare are included in the analysis. Similar work on path analysis was reported by Xiques *et al.* (1984) in *Datura candida*, Khanna and Singh (1987) in *Solanum elaegnifolium*, Singh *et al.* (1995) in scented geranium and Rampal (1996) in *Gentiana kurroo.*

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A Note on *Baccaurea courtallensis* (Muell.) Arg., (*Moottipotti*) – A Wild Edible Fruit of Western Ghats

K Joseph John[1], M Abdul Nizar[1], KC Velayudhan[1], M Unnikrishnan[2] and Z Abraham[1]

[1] *National Bureau of Plant Genetic Resources, Regional Station, Vellanikkara, Thrissur, Kerala-680 654*

[2] *Principal Scientist, Central Tuber Crops Research Institute, Sreekariyam, Thiruvananthapuram, Kerala.*

Baccaurea courtallensis (Muell.) Arg. known as *Moottippotti* in Kerala occurs in evergreen and semi-evergreen forests at lower elevations in Western Ghats and bears edible fruits. Exploration and collection of the same in few pockets of Western Ghats and preliminary observation on populations and their fruit characters *in situ* indicated existence of good amount of genetic heterogeneity within the population. A preliminary attempt to establish the species outside its niche was partially successful but indicated that it may be amenable to conservation, domestication and development as a multi-purpose tree in tropics.

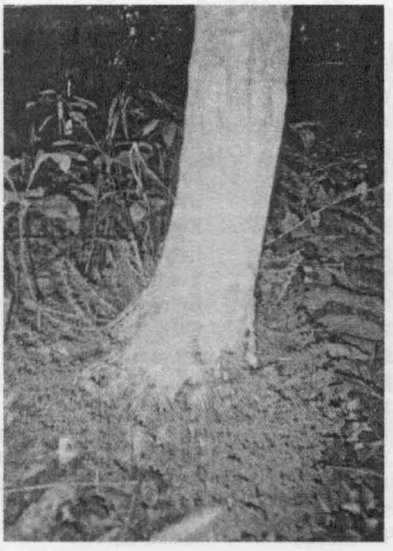
Key Words: *Baccaurea courtallensis, Moottippotti*, Multi-purpose tree, Wild edible fruit, Domestication

Baccauea courtallensis (Muell.) Arg., belonging to the family Euphorbiaceae, provides edible fruits during lean months of rainy season to the tribal people and wild animals in southern parts of Western Ghats in India. The plants are sporadically distributed in evergreen and mixed forests at lower elevations. It is a beautiful shade-loving tree that has not yet been domesticated by humans. Its occurrence along with several other minor fruit trees in Western Ghats and Andaman Islands has been reported earlier by Joseph *et al.* (2000) and Rao *et al.* (2001) respectively. It is a wild relative of cultivated 'rambai' (*B. motleyana* Muell. Arg.) of South-east Asia. The present report pertains to the taxonomy, morphology, ecology, distribution, uses and the results of preliminary attempts for its domestication.

Loureiro (1790) established the genus *Baccaurea* under the family Euphorbiaceae. Hooker (1886) reported 29 species under the genus. Of these, 16 were treated with full and seven with partial description. Five species were imperfectly known. Chakrabarty and Gangopadhyay (1997) revised the genus in the Indian subcontinent and included four wild species. Two of them are confined to tropical Himalayas. *B. courtallensis* is endemic to Western Ghats and *B. javanica* is from Andaman and Nicobar Islands. *B. courtallensis* is known as 'Moottippotti and 'Moottithoori' in Malayalam, 'Muttakkai' and 'Cholapuzhi' by 'Kaadar' tribe in Tamil and 'Kolikuki' in Kannnada. Pleasantly acidic, sweet and pinkish white aril present in the fruit is edible during the famine stricken monsoon period for taste but never as a famine food. People from plains occasionally collect and eat its fruits. Over-ripening increases acid taste of the fruits. Fruits are eaten only when people come across the bearing trees at the right time of ripening. Fruit rind is dried and used as a condiment in fish curry as it adds sour taste to the preparation (revealed by the 'Kaadar' tribe of Anamalais of Tamil Nadu). Usually, wild animals consume a lion's share of the produce. Besides its value as a fruit tree, it possesses a very shapely and beautiful crown and attractive seasonal flowers and fruit bunches thus presenting itself as a potential candidate for adoption as a multi-purpose avenue tree.

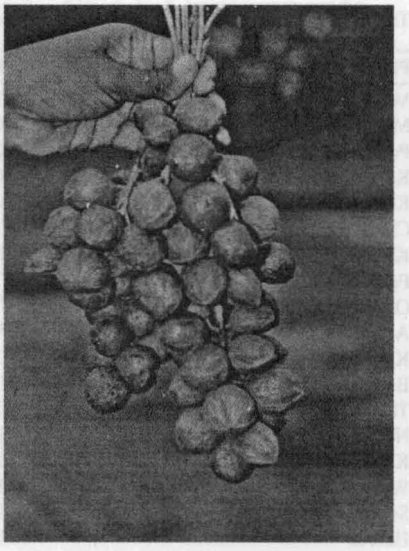
It is a small, beautiful, erect, evergreen tree especially at the time of flowering and fruiting. It grows to a height of 25-30 ft. with a narrow, erect and pyramidal canopy forming a third storey above the herbs and the tall bushy plants under the tall tropical trees. Its distribution is wide but occurs sparsely as isolated populations. Occasionally, plants are noticed along the seasonal or perennial streams in the mixed forests. Tree trunk has anomalous protuberances like in *Averrhoa bilimbi* resulting in trunki-flory and cauliflory at the base of female trees and upwards in male trees. Brilliantly crimson coloured flowers arise in clusters of inflorescence. The species is dioecious (Fig 1a and b) and usually both male and female trees occur in close proximity. Thus, it exhibits both cauli and ramiflory.

Flowering occurs during February to June and fruits ripen by May to August. Flowering trees attract swarms of common flies and fruit flies, which helps in cross-pollination. Fruiting and ripening is not very synchronous. Ripening of fruits lasts for over a month. Female flowers form a thick ring of large number of pendulous flower bunches in fascicles around the base of the trunk. At the time of fruiting it gives the appearance of a red,



(a) Female tree

(b) Male tree



(c) Ripened fruits

Fig 1: Morphology of Baccaurea courtallensis

crimson or purple coloured 1-2 feet wide circular pad being attached to the base of the trunk. Pendulous female inflorescences and bunches of fruits usually touch the ground. Number of fruits per bunch varies from 5-18 and bunch weight from 150-237 g. Fruit is globose to hemispherical in shape with a pointed tip (Fig 1c). Fruits have smooth or slightly terete angular rind. Size varies from 2.5 x 2.0 cm to 3.5 x 4.0 cm and the single fruit weighs from 4.0 to 22.0 g. Fruit colour varies from purple rose, light pink to crimson and deep reddish purple depending on the maturity and ripening stage. Observation on plants that occur in the Chimmini Wild Life Sanctuary of Thrissur Forest Division in Thrissur district in Kerala indicated that a small tree gave 1680 g of fresh fruits. Fruit rind weighed 910 g; seeds 200 g and the rest constituted the edible aril. A crude watery juice recovery of 623 ml/kg of fruits was obtained. Number of seeds per fruit varied from 1-3. In relation to the aril, seed weight was negligible. Seed colour also varied from light rose to pink.

A survey in Western Ghats indicated that *B. courtallensis* widely occur in evergreen forests and mixed forests in southern parts of Western Ghats especially in lower elevations in Thrissur, Wynad, Kozhikkode, Palakkad, Malappuram, Ernakulam, Idukki, Pathanamthitta, Kollam and Thiruvananthapuram districts of Kerala; Coorg, Dakshin Kannada, Uttar Kannada districts of Karnataka and Tirunelveli district of Tamil Nadu (Table 1).

Preliminary observation on natural population in Western Ghats clearly indicated that there is considerable variation in distribution pattern, canopy structure and size, flowering time, bearing time, fruit colour and taste. Considerable variation in a population of around 50 to 60 trees in one sq. km area near Chimmini dam in Thrissur district indicated the existence of genetic heterogeneity in the natural population within the locality. Plants in Kulathupuzha forest in Kollam district of Kerala also substantiate this. Thus there is ample scope for selecting promising and suitable types for domestication as a multi-purpose avenue tree for tropics.

An initial attempt to domesticate the plants in the Station's farm at Thrissur was moderately successful. During the year 1996, fresh seeds were excavated and sown in polybags filled with potting mixture and kept under the partial shade. The attempt was partially successful. Germination under the shaded condition of nursery (50% shade house) was successful. Transplanting of six one-year-old seedlings in one-foot deep pits filled with compost and topsoil under open sunlight (3) and under partial shade (3) was partially successful. Out of 6 seedlings that were planted all survived for three years under protective irrigation. However, only two seedlings of IC 202149 could survive in the open, which grew into 4 m. tall plants having a pyramidal canopy and dark green foliage.

The results of the above preliminary investigation on the natural population of *B. courtallensis* indicate

Table 1. Distribution of *Baccaurea* in Western Ghats

Place/forest area/wild life sanctuary	Forest Division	District	State	Forest type
Vellani hills	Thrissur	Thrissur	Kerala	Evergreen, mixed
Malakkappara	Chalakkudi	Thrissur	Kerala	Evergreen
Peringalkuthu	Chalakkudi	Thrissur	Kerala	Evergreen, mixed
Kollathirumedu	Chalakkudi	Thrissur	Kerala	Evergreen, mixed
Karanthode	Chalakkudi	Thrissur	Kerala	Evergreen, mixed
Chimmini	Thrissur	Thrissur	Kerala	Evergreen, mixed
Karulai	Nilambur	Malappuram	Kerala	Evergreen, mixed
Peechi	Thrissur	Thrissur	Kerala	Evergreen, mixed
Olakara	Thrissur	Thrissur	Kerala	Evergreen, mixed
Adivaram	Wynad	Wynad	Kerala	Evergreen, mixed
Kulathupuzha	Thenmala	Kollam	Kerala	Semi evergreen
Brymoor	Thiruvananthapuram	Thiruvananthapuram	Kerala	Mixed forest
Thenmala	Thenmala	Kollam	Kerala	Mixed forest
Nelliampathy	Nenmara	Palakkad	Kerala	Mixed evergreen forest
Kuriarkutty	Parambikkulam	Palakkad	Kerala	Mixed evergreen forest
Walayar	Palakkad	Palakkad	Kerala	Mixed evergreen forest
Subramanya	Mangalore	Mangalore	Karnataka	Evergreen
Hebree	Uduppi	Uduppi	Karnataka	Mixed forest
Sirsi	Sirsi	Uttar Kannada	Karnataka	Mixed forest
Kanikkatty	Tirunelveli	Tirunelveli	Tamil Nadu	Mixed forest
Anaikundishola	IG Wild life Sanctuary	Coimbatore	Tamil Nadu	Moist mixed forest

a scope for its conservation, domestication and development as a multi-purpose tree in humid tropics.

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Evaluation of Elite Breeding Lines of Wheat for Yield, Yield Components and Important Quality Parameters

Arti Singh and Sohan Pal
Department of Genetics and Plant Breeding, GB Pant University of Agriculture and Technology, Pantnagar-263 145 (Uttaranchal)

One hundred nineteen lines/cultivars of wheat (*Triticum aestivum* and *T. durum*) were planted in augmented design with 3 checks (PBW 343, UP 2338, WH 542). Data were recorded on 13 characters. The nature and magnitude of variability and character associations were studied. The high value of PCV was observed for grain yield whereas moderate values of PCV were obtained for grains/ear, harvest index, ear length, sedimentation value, biological yield, 1000- grain weight and plant height. Low values of PCV were observed for rest of the characters. Character association analysis revealed highly significant and positive correlation of grain yield with biological yield/plot and harvest index. Other characters which showed positive and significant correlation with yield were grains/ear, hectoliter weight and 1000-grain weight. Days to heading showed highly significant and negative correlation with grain yield. Protein content showed significant and negative correlation with harvest index. Potential donors for different characters have been identified in the present investigation.

Kew Words: Wheat, *T. aestivum*, *T. durum*, Yield components, Quality parameters

At present most of our wheat varieties are good to very good for chapati making properties. However, these varieties need further improvement if we wish to enter the international grain trade. Released Indian wheat varieties have 12 per cent protein, >78 kg/hl test weight, >550 c.c. loaf volume and 49 c.c. sedimentation value that is suited for bread purposes (Nagarajan, 2002). The endosperm of the wheat grain usually contains 7-15 per cent protein and about half of this is gluten. Different end products of wheat, as bread or biscuits cookies, noodles, semolina etc. require special grain quality for their manufacture. Wheat flour with strong gluten strength and good balance of physical dough properties are for bread making while for biscuits, cakes, pastries, soft wheat with weak gluten strength is required.

Improvement of crop depends upon the magnitude of genetic variability in economic characters, therefore, the evaluation and utilization of genetic variability in desired direction becomes extremely important in any yield improvement programme. The extent of genetic variability in a specific breeding population depends on the genotypes included in it and its selection history. In this regard, it is necessary to survey the valuable useful variability and to study the nature of association among the various plant characters. As grain yield and quality are complex characters, such studies may be useful in identifying the yield components warranting due attention during selection process. Keeping this in view, the present study was carried out to estimate the relative genetic variability for different characters, to assess the nature and magnitude of association among yield and yield contributing characters and quality parameters,

Materials and Methods

The experimental material for the present study comprised 122 genotypes of bread (*T. aestivum*) and (*T. durum*) wheat including three checks. The planting of experiment was done in augmented block design under irrigated timely sown condition. There were 7 blocks with 119 genotypes and three checks (PBW 343, UP 2338 and WH 542) in each block. The plot size consisted of 2 rows, 3 m long and 23 cm apart. Data were recorded on plot basis for days to heading, days to maturity, biological yield, grain yield, harvest index, grains/ear and 1000-grain weight. For rest of the characters data were recorded on randomly selected five plants. Protein content and sedimentation value were recorded in laboratory through special techniques. The mean values of test genotypes and checks with respect to various characters were computed and were used in analysis of variance for augmented design, PCV and character association. The analysis of variance for augmented design was done as per Federer (1961) and Federer and Raghavarao (1975).

Results and Discussion

The analysis of variance indicated significant differences among the check varieties for days to heading, plant height, ear length, grains/ear and 1000-grain weight. The check varieties did not differ for rest of the characters.

The mean squares due to blocks were non-significant for all the characters, except for days to heading. The estimation of variability is of utmost importance in a crop for the identification of genotypes which can be used to generate further variability so that the selection of desirable genotypes can be made in the segregating generations. Grain yield/ plot had highest value of PCV (21.05%), followed by grains/ ear (17.75%), harvest index (17.67%), ear-length (16.87%), sedimentation value (16.56%) and biological yield (16.33%). Higher variation for grain yield was also reported by Getachew *et al.* (1993), Dhonde *et al.* (2000) and Walia and Garg (1996). Dhonde *et al.* (2000) and Getachew *et al.* (1993) also observed large variation for grains/ear. Moderate values of PCV were noted for 1000-grain weight (13.23%), plant height (12.64%) spikelets/ear (10.90%), days to heading (10.57%) and protein content (9.4%). Korkut *et al.* (2001) reported 11.25 per cent value of PCV for plant height and 11.13 per cent for 1000-grain weight. Large variation for plant height was also reported by Dhonde *et al.* (2000). Low value of PCV were observed for other characters. Jagshoran (1995) also observed low values of PCV for days to heading and maturity. The high variability may be exploited to select superior donors for important yield and quality traits which can be used in hybridization programme to generate large variability. For the characters which have low variability such as days to maturity and hectoliter weight, additional genotypes may be evaluated or additional variability may be generated through hybridization or mutation. The genotypes significantly superior to the best check for various characters are given in Table 1. Selection of genotypes for short duration in heading and maturity may be useful to develop variety for late sown conditions because such varieties can do better in intercropping and mixed cropping. For 1000-grain weight 95399 P-1B, CM 504 P-20B and 95402 P-10B are significantly superior (> 53 g seed weight) to the best check (PBW 343). For protein content 95399 P-1B and 96078 P-37B showed significant superiority (> 11.8% protein content) over the best check (WH 542), and satisfying the threshold value of protein needed for bread quality. The genotypes carrying the protein content < 10 per cent may be used for making the biscuits, cakes and pastries. Nine genotypes were superior to best check for sedimentation value. Of these, 4 genotypes viz., ESWYT-50, IBWSNP-169, 95223P-4B and 94223 P-3B exhibited sedimentation value of > 49 c.c. Higher sedimentation value is desirable for bread-making potential of genotype (Rao, 2001). Only one genotype was significantly superior to the best check for grain yield (IBWSN P-73), harvest index (CM 504 P-20B) and grains/ear (96078 P-59B). None of the genotypes was superior to the best check for hectoliter weight and biological yield.

The study of correlations would help in selection of traits associated with highest expression of yield and secondly, it would help in improvement of one character without sacrificing the other character. The correlation coefficients among various characters are given in Table 2. Grain yield/plot showed highly significant and positive correlation with biological yield/ plot (0.549) and harvest index (0.671) and significant and positive with grains/ ear (0.189), hectoliter weight (0.211), and 1000-grain weight (0.204). Getachew *et al.* (1993) carried out correlation studies on 70 durum wheat genotypes and reported strong positive association of grain yield with all characters, except days to heading and harvest index, where as in present study protein content (-0.209), days to maturity (-0.212) and days to heading (-0.266) exhibited significantly negative correlation with grain yield. Jaglan *et al.* (1997) while studying correlation in tall vs. dwarf populations of bread wheat reported that yield showed highly significantly positive correlations with plant height, number of tillers and 1000-grain weight which is in accordance with the present investigation. Grain yield and hectoliter weight was found significantly and positively correlated, as high hectoliter weight expressed sound and mature grain.

There was positive and significant association between grain yield and 1000-grain weight and days to maturity and days to heading which is in agreement with the findings of Moghaddam *et al.* (1997). Prasad and Pandey (2000) studied character association in *Triticum durum* and reported low correlation between 1000-grain weight and yield. This indicated the limited role of 1000-grain weight in enhancing yield in case of durum wheat and the two traits were behaving independently.

The negative and highly significant correlation between grain yield and days to heading is also supported by Jaradat (1990) and Getachew *et al.* (1993). The negative correlation may prove to be boon in present day context of high intensity cropping system where short duration genotypes are necessary and urgently required to fit in crop rotation. Biological yield had positive and significant correlation with plant height, which is in conformity with the findings of Getachew

Table 1: List of genotypes significantly superior to the best check for various characters

Sl. No.	Characters	Genotypes	Best check	Value
1.	Days to heading (early)	95245P-7B	UP 2338	70.48
		95245P-10B		70.48
		95154P-2B		70.14
2.	Days to maturity (early)	95154P-2B	WH542	128.19
		HRWSN-6		128.52
		SAWSN-118		126.52
		95215P-4B		127.52
		95421P-11B		127.86
3.	Plant height (cm) (short)	CM 512 P-13B	WH 542	77.26
		CM 512 P-17B		77.46
		96078 P-16B		74.86
		96078 P-20B		77.66
		96078 P-37B		72.86
		SHAG-8		75.12
4.	Ear length (cm)	CM 463 P-1B	UP 2338	13.90
		95413P-4B		14.96
		95413P-7B		13.56
		95413P-17B		14.16
		95423P-4B		14.16
		95423P-5B		13.36
5.	Number of spikelets/ear	CM 463P-1B	WH 542	21.57
		96011P-2B	22.57	
		96011P-3B	22.57	
		96011P-8B	24.57	
		94546P-10B	22.57	
		IBWSN P-169	21.57	
6.	Number of grains/ear	96078 P-59B	WH 542	83.19
7.	Hectolitre weight (kg/hl)	PBW 343 (check)		
8.	1000-grain weight	95399 P-1B		54.59
		CM 504 P-20B		55.97
		95402 P-10B		53.84
			PBW 343 (check)	
9.	Biological yield/ plot (kg)	PBW 343 (check)		–
10.	Grain yield/plot (kg)	IBWSN P-73		1.80
		PBW 343 (check)		
11.	Harvest index (%)	CM 504 .P-20B		49.82
		PBW 343 (check)		
12.	Sedimentation value (cc)	94668 P-3B		47.71
		94546 P-10B		46.71
		ESWYT-50		55.71
		IBWSNP -169		55.71
		SAWSN-35		46.38
		95223 P-4B		49.38
		95223 P-3B		51.05
		SAWSN-165		47.05
		SAWSN-178		48.05
			PBW-343 (check)	
13.	Protein content (%)	95399 P-1B		11.82
		96078 P-37B		13.42
			(WH 542 check)	

Table 2. Correlation coefficients for different characters

Sl. Characters	Days to maturity	Plant height (cm)	Ear length (cm)	No. of spikelets/ ear	No. of grains/ ear	Hecto-litre weight (kg/hl)	1000-grain weight (g)	Biological yield/plot (kg)	Harvest index (H.I.) %	Sediment-ation value (cc)	Protein content (%)	Grain yield/ plot (kg)
1. Days to heading	0.708**	0.164	-0.000	0.543**	0.259**	-0.249**	-0.414**	0.324**	-0.589**	0.066	0.132	-0.266**
2. Days to maturity		0.030	0.063	0.425**	0.194*	-0.300**	-0.461**	0.256**	-0.450**	0.127	0.108	-0.212*
3. Plant height (cm)			0.241**	0.194*	0.096	0.322**	0.033	0.314**	-0.180*	0.291**	-0.139	0.066
4. Ear length (cm)				0.446**	0.335**	-0.210*	-0.150	0.149	-0.018	0.178*	0.062	0.084
5. No. of spikelets/ear					0.368**	-0.220*	-0.391**	0.203*	-0.344**	0.240**	-0.019	-0.179*
6. No. of grains/ear						-0.185*	-0.236**	0.331**	-0.066	0.119	0.004	0.189*
7. Hectolitre weight (kg/hl)							0.485**	-0.011	0.257**	-0.006	-0.170	0.211*
8. 1000-grain weight (g)								-0.097	0.323**	-0.121	-0.047	0.204*
9. Biological yield/plot (kg)									-0.220*	0.160	-0.053	0.549**
10. Harvest index (%)										-0.092	-0.223*	0.671**
11. Sedimentation value (cc)											0.028	0.026
12. Protein content (%)												-0.209*

** Significant at 1% level of probability
* Significant at 5% level of probability

et al. (1993). Harvest index and days to heading exhibited negative correlation, which is in agreement to the findings of Moghaddam *et al.* (1997). Harvest index had significant negative correlation with plant height. Similar results were obtained by Getachew *et al.* (1993). Thousand-grain weight exhibited significant and negative association with number of spikelets/ear. Number of spikelets/ear showed positive correlation with days to heading. Number of spikelets/ear was positively and significantly associated with ear length and plant height suggesting that more ear length will lead to higher number of spikelets/ear. Similar results were obtained by Khan *et al.* (1993). Sheikh and Singh (2001) observed strong positive correlation of harvest index with grain yield and significant negative association of harvest index with biological yield.

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Stability Analysis for Yield and its Components under Different Environmental Conditions in Pea (*Pisum sativum* L.)

RPS Dhaka[1], VK Dobhal[2] and RS Rathi[2]

[1] *Department of Agriculture Botany, Kisan Post Graduate College, Simbhaoli, Ghaziabad, CCS Meerut University, Meerut (Uttar Pradesh)*

[2] *National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110 012*

Thirty five indigenous and exotic genotypes of pea were evaluated under eight environments for stability analysis for seed yield and its components using Eberhart and Russel's (1966) model. Pooled analysis of variance for all thirteen characters indicated high differences among the genotypes and environments. The linear component was observed to be significant for all the characters suggesting that the prediction of performance of genotypes was possible across environments. Genotypes EC 341995, NIC 11249, BDJ 42-174, DMR-11 and EC 381864 were observed to be stable and high yielding under favourable conditions while genotype DMR-1 would perform better in adverse environmental conditions and thus could be utilized as donor parent to breed higher yielding line for poor environment.

Key words: *Pisum sativum*, stability, indigenous, exotic, adaptability

Stability in performance is one of the most desirable properties of a genotype for selecting as parent for any breeding programme to develop a variety suitable for wide cultivation. It is well known that different genotypes varying in their response to a series of environments are called stable. The study of G x E interaction is very important in evaluating the range of adaptability of breeding material. Sometimes the uni-location trials can also serve the purpose, provided different environments are created by planting experimental material at different dates of sowing, using various spacing and doses of fertilizers and irrigation level etc. (Luthra *et al.* 1974). With respect to fitness for agricultural purposes, specially for yield, the varieties adjusting their phenotypic state in response to change in environment so that they are able to give their near maximum economic returns are called "well buffered" varieties (Allard and Hansche, 1964). It is in this context that the present investigation was carried out to assess the stability of 35 genotypes of pea under varying environments.

Materials and Methods

The present investigation was undertaken during 1996-97 and 1997-98. The experimental material comprised of 35 exotic and indigenous genotypes including some released varieties (Table 2). The material was grown in a Randomized Block Design with three replications under eight environments which were created by using different date of sowing (10-15 November, 25-30 December) and fertility doses (N:P 20:40 and N:P 10:40). Each entry was sown in two rows, each 3 m long, and the plants were placed at 45 x 15 cm. The research trials were conducted at Kisan Post Graduate College, Simbhaoli, Ghaziabad, U.P. The observations were recorded on five randomly selected plants in each plot for seed yield and related attributes and data were subjected to stability analysis as per Eberhart and Russells (1966) model.

Results

The pooled analysis of variance for genotype and environment was highly significant for all the thirteen characters, thus indicating the presence of genetic variability in the material studied and variation in the environments under study. Ram Niwas *et al.* (1993) and Gupta *et al.* (1998) reported highly significant variance amongst the genotypes and environments for all characters studied. Muhammad *et al.* (2001) studied 11 genotypes during *rabi* 1999-98 and observed that all the parameters under study were statistically significant. The analysis of variance (Table 1) exhibited that the linear component of environment was significant for all the characters. The G x E interaction was significant for number of pods per plant, dry matter yield and seed yield per plant. The linear component of G x E was also significant for days to flowering, number of pods, number of seeds per pods, The pooled deviation observed was highly significant for all the characters. The variances due to deviation (Non-linear) were significant for all the traits reflecting considerable genetic diversity in the genotypes as has been reported earlier by Perkins and Jinks (1968). Such non-linear deviation might also be of practical

Table 1. Analysis of variance for seed yield and its components in pea.

Source	d.f.	Days to flowering	Days to green pod harvesting	Days to maturity	Plant height (cm)	No. of branches/ plant	No. of pods/ plant	Pod length (cm)	No. of pods/ node	Dry matter yield/ plaint (g)	No. of seeds/ pod	Seed yield/ plant (g)	Harvest index	100 seed weight (g)
Genotype (G)	34	86.82**	89.11**	68.53**	5764.01**	0.92**	45.74**	3.14**	0.48**	563.18**	2.31**	66.73**	169.10**	55.68**
Environment (E)	7	966.22**	1966.22**	3795.71**	10082.37**	15.02**	1530.29**	2.98**	1.24**	9055.76**	15.76**	1722.53**	2774.97**	43.08**
G X E	238	16.68	15.99	12.94	492.20	0.23	19.83**	0.21	0.08	191.40**	0.40	24.16**	80.99	4.52
E (Linear)	1	6763.61**	13762.44**	26569.09**	70575.78**	105.16**	10712.05**	20.85**	8.66**	63390.41**	110.32**	12057.74**	19424.80**	301.56**
G X E (Linear)	34	28.17**	25.66**	16.81	546.49	0.28	58.33**	0.23	0.11*	651.63**	0.67**	87.78**	118.69*	7.85**
Pooled deviation	210	14.31**	13.97**	11.94**	469.34**	0.22**	13.03**	0.20**	0.07**	111.42**	0.34**	13.17**	72.58**	3.85**
Pooled error	544	4.35	17.00	5.02	321.53	0.37	20.56	0.27	0.10	113.54	0.43	19.54	71.64	0.44

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

value to construct and test the utility of the multiple regression models more critically along with the complex mechanism of adaptation. Pan *et al.* (2001) observed that non-linear components of (G x E) interaction were high and low respectively for green pod yield.

Each genotype exhibited different stability (Table 2) for all the attributes with respect to regression coefficient (b) and deviation from regression (S^2d_i). Considering the response of genotypes to environmental changes, the variety Arkel showed early maturity with b<1 and significant S^2d_i while genotype NIC 18727 was observed to be stable with unit "b" and non significant S^2d_i. The variety HFP 4 which showed minimum plant height was stable having b<1 and non significant S^2d_i. The genotypes PLP 359, EC 341995, NIC 12860, NIC 18735 and NIC 18727 were stable for pods per plant with high mean value and non-significant S^2d_i. For pod length Arkel, Bonneville, HUDP-6 and JM 1 were observed to be stable with high mean performance which was comparable to population means, unit 'bi' and S^2d_i = 0. In general, non-linear components of G x E were present for pod length whereas it was reverse in the case of seed per pod. For grain yield per plant genotypes BDJ 42-174, NIC 11249, DMR 11, Boneville, PLP-359, Arkel, Rachna, DDR 12 and EC 381864 were observed stable as they showed higher mean performance, unit regression and S^2d_i = 0. Among these genotypes only Rachna may be cultivated under normal environment conditions while other genotypes needed better management practices for better expression of yield and related traits. Pan *et al.* (2001) have also observed that the variety Boneville was a good performer and stable for green seed weight and suitable for favourable environments.

Genotypes KPR 103, HUDP 8 and LFP 96 for number of pods per plant; KPFD 59, NIC 11249, EC 381856 for number of seeds per pod and HUDP 8, EC 381856 and NIC 11191 for grain yield showed below mean performance, unit regression coefficient and non-significant S^2d_i. This indicated that the performance of these genotypes can be improved by adopting suitable management practices and can also be used as one of the parent along with high mean performance to breed genotypes with high mean performance and wider adaptation.

Genotypes DDR 12, Bonneville, KPFD 59, Rachna and Arkel had significantly higher yield than rest of the genotypes and also exhibited unit (b = 1) regression

Table 2. Estimation of mean and stability parameters for thirteen characters in 35 genotypes of pea

Genotypes	Days to flower			Days to green pod harvest			Days to maturity			Plant height (cm)			No. of branches/plant			No. of pods/plant		
	Mean	**b_i**	**s^2d_i**	**Mean**	**b_i**	**s^2d_i**	**Mean**	**b_i**	**s^2d_i**	**Mean**	**b_i**	**s^2d_i**	**Mean**	**b_i**	**s^2d_i**	**Mean**	**b_i**	**s^2d_i**
DDR-13	74.21	0.74	-0.36	97.92	0.66	4.06	115.79	0.81	26.50*	69.10	0.66	283.73	2.80	0.75	0.41	9.26	0.87	11.10
KPF-103	76.29	0.74	0.86	98.42	0.71	11.71	117.33	0.81	9.87	102.41	0.54	-8.81	2.35	0.66	0.06	8.25	0.72	0.90
HUDP-8	76.00	1.12	3.59	100.42	0.83	-3.88	118.88	0.82	7.09	67.52	0.62	-64.94	2.38	0.71	0.17	6.99	0.59*	0.56
Arka Ajeet	73.38	0.82	-0.39	94.92	0.40	14.93	114.29	0.61*	9.14	76.21	0.41	133.86	2.38	0.69	0.05	9.32	0.49*	4.19
DMR-1	77.37	0.87	0.55	101.42	0.95	-0.13	119.42	1.04	1.13	111.98	1.13	329.25	2.92	0.85	0.22	10.75	0.61	-0.51
DDR-12	73.46	1.02	8.38	98.96	0.84	-4.48	116.96	0.81	19.24	70.00	-0.05*	-36.57	2.55	0.76	0.03	11.57	1.13	4.21
Boneville	72.50	0.71	17.91*	99.21	1.26	-4.48	117.21	1.04	5.01	79.43	0.91	83.90	2.39	0.36	0.07	12.35	0.62	-3.42
KPFD-59	73.25	1.56*	12.64	104.92	1.12	-2.81	122.21	1.13	2.94	99.96	1.22	-2.29	2.57	1.11	0.02	9.69	0.97	-1.20
Rachna	77.08	1.02	5.46	102.54	1.05	-3.60	121.08	1.09	2.07	136.62	2.02	166.89	2.94	1.18	-0.02	11.68	0.78	5.24
NIC 23636	77.29	1.27	0.15	101.29	1.23	-1.20	118.79	1.08	4.71	114.67	1.32	319.10	3.08	1.02	0.19	12.21	0.83	15.24
HUDP-6	75.54	1.27	1.16	100.33	1.07	-3.62	118.48	1.09	5.63	75.20	0.77	-24.17	2.90	1.15	0.00	9.21	0.83	-5.35
JM-1	73.38	0.91	4.21	99.96	1.11	-2.60	117.12	1.03	2.79	71.49	0.25	146.55	2.48	0.78	-0.07	10.89	0.82	-5.14
Arkel	66.92	0.81	37.63*	88.92	0.50*	22.44	109.08	0.84	7.19	61.65	0.78	-51.23	2.34	1.05	-0.05	12.21	0.95	10.10
LEP-96	83.38	1.42	3.98	107.88	1.18	3.16	121.67	0.94	3.73	54.37	0.56	-85.69	2.83	0.99	0.11	8.32	0.76	-5.23
DMR-11	74.79	1.03	0.03	99.67	1.05	-4.31	118.67	0.97	5.04	124.04	1.84	306.52	3.43	1.46	-0.01	14.90	1.70*	-0.79
HFP-4	81.88	1.47	5.95	105.38	1.36	-3.47	112.12	1.16	0.35	46.71	0.55	-91.08	2.83	1.07	-0.05	11.63	1.45*	-4.10
KPMR-144-1	78.37	0.16	99.80*	100.96	1.00	38.17	118.54	0.39	27.20*	49.22	0.53	-32.78	2.23	0.92	-0.03	10.53	0.95	-2.16
EC381864	74.88	1.03	1.03	99.62	0.92	-3.90	119.87	1.03	3.99	56.03	0.49	-90.24	2.40	1.11	0.03	11.49	1.26	12.74
BDJ-42-174	78.33	-0.01*	77.51*	99.00	0.88	49.65	119.67	1.01	49.95	124.33	1.74	554.98	3.13	1.60*	0.15	18.03	2.44*	7.67
NIC11249	78.00	1.16	66.69*	101.71	1.17	-1.50	121.12	1.07	1.83	78.10	1.71	1971.57*	2.98	1.63*	1.04	15.99	1.92*	24.23
PLP-359	76.04	1.27	3.22	102.13	1.41*	-3.42	120.08	1.25	7.97	133.04	1.37	826.95	3.81	1.18	0.22	13.49	1.11	8.62
EC381865	73.88	0.11*	8.25	103.88	1.05	137-85*	117.83	0.91	9.45	70.43	1.12	328.98	2.50	1.51	0.01	11.14	1.42*	-1.74
EC341766	73.12	1.17	10.79	97.87	0.86	3.64	116.29	0.98	9.70	96.64	1.68	-6.56	2.73	1.00	0.02	12.28	1.10	-2.34
EC27166	71.83	1.03	2.13	96.25	1.08	6.93	113.79	1.24	19.88*	90.16	0.26	46.56	2.78	0.92	-0.01	9.96	0.35*	-0.16
EC341995	75.38	0.67	22.34*	102.67	1.08	-1.80	120.50	0.98	6.38	74.44	1.53	2198.99*	2.78	1.29	0.05	15.85	1.30	12.68
EC341787	78.17	1.73	6.74	101.87	1.55*	0.94	121.12	1.25	3.05	130.85	1.22	1611.03	3.15	1.19	0.26	11.36	0.83	5.00
KNM-4	77.79	1.17	-0.06	101.67	1.08	-2.53	118.67	0.99	6.17	69.18	0.81	779.84	2.85	1.10	-0.05	11.85	1.06	10.60
NIC23625	77.67	1.21	1.55	101.04	0.92	-1.03	119.75	1.03	0.34	119.84	1.54	70.96	2.75	1.09	0.01	10.75	0.97	8.39
NIC12860	78.33	1.32	4.67	102.58	1.40	-2.17	120.21	1.22	11.77	110.30	1.13	11.89	2.57	0.51	0.02	9.32	0.60	9.00
NIC11181	73.25	0.93	2.58	99.17	1.10	-3.60	118.83	0.97	2.58	11.21	0.65	1241.65	2.76	0.88	-0.03	13.03	1.00	5.09
EC381856	73.08	0.62	9.35	99.62	0.70	2.20	117.79	0.83	9.05	54.75	0.71	178.30	2.24	0.65	-0.05	9.41	0.44*	-1.66
NIC11191	74.50	1.06	-0.16	65.17	1.14	11.78	111.71	1.15	23.87*	66.75	1.31	407.24	3.11	0.43	0.21	9.11	0.54*	-2.44
NIC18735	75.87	1.21	2.94	99.50	0.67	-0.21	118.54	0.95	7.39	122.75	1.54	860.58	2.76	0.99	0.06	13.56	1.10	33.10
NIC18727	71.21	1.06	1.29	93.29	0.98	10.70	113.54	1.12	21.99*	98.91	1.47	169.94	2.75	1.11	0.24	13.93	0.93	48.53
EC8495	76.25	1.34	28.95	98.96	0.72	31.92	119.71	0.84	29.69*	105.42	0.65	240.97	2.83	1.28	0.08	13.26	1.56*	15.33
Population mean	75.79			99.89			118.19			89.25			2.75			11.53		

(contd.)

Table 2 contd.

Genotypes	Pod length (cm)			No. of pods/node			Dry matter yield (g)			No. of seeds/pod			Seed yield/plant (g)			Harvest index			100 seed weight (g)		
	Mean	b_i	s^2d_i	Mean	b_i	s^2d_i	Mean	b_i	s^2d_i	Mean	b_i	s^2d_i	Mean	b_i	s^2d_i	Mean	b_i	s^2d_i	Mean	b_i	s^2d_i
DDR-13	5.76	0.90	0.18	1.82	0.47	-0.02	20.38	0.50*	21.27	4.03	0.27*	0.43	7.73	0.77	17.95	33.90	1.94*	20.39	18.66	2.08	3.30*
KPF-103	5.41	-0.35	0.22	1.44	2.11*	0.00	21.28	0.53	35.88	4.30	-0.18	0.04	6.55	0.53*	4.71	30.65	1.50	78.03	19.22	1.19	3.30*
HUDP-8	5.86	1.06	0.22	1.47	1.58	-0.02	17.45	0.63	-22.72	4.65	0.88	0.60	5.28	0.56	4.00	28.17	0.57	29.17	14.69	1.14	1.67
Arka Ajeet	6.12	0.95	0.01	1.82	0.55	0.02	20.87	0.33*	-18.54	4.69	0.34*	0.16	7.77	0.49*	7.84	33.99	0.93	26.45	17.30	0.93	3.82*
DMR-1	5.81	0.61	0.00	1.67	1.47	0.05	33.62	1.05	5.42	4.95	0.54	-0.04	9.66	0.61*	-0.02	31.44	0.74	117.75	18.61	0.65	1.70
DDR-12	5.91	1.27	0.10	1.85	0.87	0.03	27.12	0.89	19.29	4.84	0.59	0.03	11.01	1.31	20.02	35.95	1.31	-7.71	18.43	2.03	1.84*
Boneville	6.65	1.23	0.13	1.93	0.06	-0.01	29.09	0.64	-27.94	5.91	1.59	0.04	12.48	1.10	-1.60	40.54	1.41	12.28	16.13	0.71	2.01*
KPFD-59	5.76	0.85	-0.02	1.76	1.38	0.05	26.65	0.70	4.80	3.83	1.19	-0.05	7.08	0.91	-4.80	26.29	1.76*	-16.61	17.28	1.22	1.94*
Rachna	5.98	0.86	0.02	1.37	0.75	0.11	37.73	1.06	46.56	4.51	0.62	-0.03	10.34	0.86	-1.08	29.17	1.09	43.64	20.20	1.73	2.76*
NIC 23636	5.42	0.71	0.05	1.51	0.58	0.13	28.22	0.83	55.76	4.55	0.78	0.15	8.69	0.72	7.93	21.10	1.00	26.08	15.04	0.70	3.25*
HUDP-6	6.45	1.23	0.04	1.65	1.09	0.06	25.31	0.95	-19.62	5.02	1.87*	0.11	7.84	0.90	-4.70	30.31	0.71	28.44	15.95	0.82	1.27
JM-1	6.32	1.55	0.05	1.70	0.51	0.01	25.58	0.89	-20.97	5.25	1.12	0.75	8.80	0.75	-1.17	32.50	0.62	77.13	14.55	0.61	1.44
Arkel	7.20	2.93	0.04	1.95	0.42	0.02	23.68	0.90	-27.53	5.88	1.02	0.33	10.48	1.11	6.30	41.30	0.64	8.22	13.59	1.25	0.89
LEP-96	5.73	0.36	-0.01	1.88	0.74	0.02	23.42	0.81	-3.33	5.00	1.42	0.91	6.49	0.70	-5.21	25.75	0.86	17.07	14.29	1.25	6.76*
DMR-11	5.59	0.29	0.10	1.46	2.03*	0.02	43.32	2.01*	81.30	4.42	0.39*	0.25	12.64	1.51*	-3.36	30.72	0.83	17.83	18.88	1.55	2.27*
HFP-4	5.49	1.78	0.04	1.82	0.86	0.04	24.90	1.17	-12.60	4.23	1.22	0.33	9.60	1.55*	-4.34	33.39	1.88*	21.04	16.10	2.75*	1.58
KPMR-144-1	5.59	1.22	0.18	1.99	0.06	0.03	20.64	0.88	-9.70	4.03	1.15	-0.10	8.53	1.03	-0.86	38.49	0.75	17.90	17.85	1.88	0.39
EC381864	6.13	1.27	0.10	1.70	0.74	0.11	26.17	1.21	-29.70	4.94	1.60	0.02	11.53	1.58*	12.24	39.72	0.66	68.11	18.35	0.00	1.73
BDJ-42-174	6.26	1.70	-0.03	1.88	0.35	0.00	53.65	3.15*	507.15*	5.04	1.09	-0.10	19.81	2.96	26.70	33.50	0.80	-7.05	20.06	1.51	1.35
NIC11249	5.26	0.76	0.10	1.92	0.48	-0.01	38.94	2.19*	711.81*	3.72	1.54	0.30	12.87	1.81*	4.60	32.86	1.03	100.48	19.76	-0.72	11.28*
PLP-359	5.37	1.87	0.07	1.39	2.07*	0.03	48.08	2.11*	209.37	4.75	1.58	0.19	9.39	1.04	-1.58	24.03	1.02	84.71	14.50	0.17	0.07
EC381865	5.56	0.72	0.74	1.76	0.80	0.07	28.26	1.54	58.50	5.09	1.13	0.52	9.20	1.19	-4.75	31.04	0.72	14.51	15.66	-0.59	2.15*
EC341766	4.60	0.73	0.00	1.25	1.09	0.09	21.18	0.70	0.55	4.33	1.21	0.01	7.20	0.85	-4.19	30.62	0.69	123.81	13.33	0.37	3.83*
EC27166	4.97	0.64	0.04	1.17	0.69	0.10	20.88	0.61	-8.68	4.56	0.90	0.09	6.87	0.47*	1.64	31.61	0.23*	15.22	14.74	0.41	3.57*
EC341995	5.87	0.82	0.00	1.95	0.27	-0.02	31.30	1.60*	120.61	5.09	1.65	0.16	11.88	1.48*	7.54	36.87	0.16*	67.27	13.06	1.45	1.08
EC341787	5.29	1.17	0.13	1.40	1.31	0.06	32.62	0.95	176.31	4.55	1.10	0.15	8.36	0.88	1.36	29.99	1.33	277.50	14.70	1.64	3.59*
KNM-4	5.80	1.07	-0.04	1.91	0.52	-0.02	26.48	0.97	65.86	4.82	1.18	-0.02	9.79	1.19	4.91	35.19	1.40	8.62	16.61	1.11	0.04
NIC23625	5.65	0.52	0.10	1.55	2.47*	0.01	30.29	0.98	-27.08	4.75	1.47	0.22	7.42	0.74	15.18	23.46	0.81	74.17	15.27	0.22*	4.46*
NIC12860	4.97	0.52	0.09	1.40	1.29	0.10	26.06	0.68	37.11	4.05	0.88	0.53	6.63	0.69	11.05	24.83	1.71	9.31	16.41	0.95	2.49*
NIC11181	5.35	0.82	-0.03	1.49	2.01	-0.01	25.35	0.60	-28.39	4.35	0.54	0.10	9.17	1.00	0.30	32.94	1.22	91.40	16.35	1.95	0.92
EC381856	5.16	-0.09*	0.41	1.71	-0.26	0.13	17.14	0.33*	-26.39	3.42	0.85	0.13	4.92	0.12*	-2.72	28.72	0.34	98.89	15.83	-1.24	16.69*
NIC11191	3.73	2.44*	0.52	1.19	0.80	0.06	14.18	0.35*	120.10	4.51	0.92	0.41	3.18	0.46*	2.51	23.94	0.93	55.42	6.59	3.46*	23.25*
NIC18735	5.16	0.98	0.00	1.31	1.40	0.08	29.71	0.49	215.97*	4.28	1.09	0.30	9.16	0.74	25.18	31.49	1.70	-12.14	15.38	-0.01*	2.49*
NIC18727	4.74	0.85	0.40	1.29	1.92	0.05	26.56	1.21	254.85*	4.90	1.09	0.02	9.91	1.22	74.02	32.62	0.50	40.72	12.49	1.58	5.41*
EC8495	5.31	0.66	0.08	1.60	1.83	0.01	29.31	0.60	109.70	4.04	0.33*	0.03	9.06	1.19	18.16	27.23	1.73	76.93	15.48	1.24	5.01*
Population mean	5.61			1.63			27.87			4.61			9.17			31.50			16.04		

b_i – Regression coefficient; S^2d_i – Deviation

coefficient and non-significant deviation from regression ($S^2d_i = 0$). Thus these genotypes could be termed as high yielding, highly stable and could be recommended for general cultivation. Out of these 5 genotypes DDR 12, Boneville and Arkel showed earliness for flowering and maturity and had the lower values than the population mean. For pods per plant the mean values were higher over population mean for Boneville, Rachna and Arkel. The genotypes DDR 12, Boneville, KPFD 59 and Arkel have higher mean values over population mean for pod length and number of pods per node.

Genotypes like EC 341995, NIC 11249, BDJ 42-174, DMR-11 and EC 381864 were observed to be high yielding and stable but their corresponding 'bi' values were significantly greater than unity. This shows that these genotypes would perform better in favourable conditions and hence could be recommended for cultivation in high fertility areas and for better management practices. However, genotype like DMR 1 had mean seed yield greater than the population mean and was stable ($S^2d_i = 0$) but the 'bi' value was found significantly lower than unity. It indicated that this genotype would perform better in poor environment conditions and hence this genotype can be used as a donor parent to breed a suitable line for poor environment.

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Species Diversity and Germplasm Collection of Medicinal Plants from Western Ghats of Maharashtra

DN Mokat and BB Jadhav
Department of Agricultural Botany, Dr Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli-415 712, Dist. Ratnagiri, (Maharashtra)

Extensive explorations were undertaken for the collection of medicinal plant germplasms from 11 districts of Western Ghats of Maharashtra. Total 25 exploration tours were undertaken during the period from February 2000 to January 2002 for the collection of biodiversity of medicinal plants from Western Ghats of Maharashtra. During the exploration the passport data related to frequency, sample type, habitat, common name, source and important characteristics and use of each accession were noted. Total 552 accessions were collected. The collected seeds, vegetative materials and live materials were sent for conservation comprising of seed/fruits–261, vegetative materials–12, wild relative of crop material–15, economic plants–15, oil yielding plants–15, aromatic plants–10, live plants–284.

Key words: Germplasm, Medicinal Plants, Biodiversity

Considering the depletion in plant biodiversity at a fast rate, a need for immediate and massive efforts for collection and conservation of national genetic wealth was felt strongly. About 600 plant species belonging to 108 families are on the verge of extinction to varying degrees in India (Nayar and Sastry, 1987, 1988, 1990). On an average, 155 landraces are lost every year, globally. Whereas large area of country still remains unexplored several locations need to be revisited for intensive collections. Agro biodiversity is an important component of total biological diversity and therefore the component of collection and conservation of germplasm is an important aspect in the maintaining the present status of existing biodiversity in country.

Plants with curative properties were known to humans since ancient times. In India, out of 17,500 species of flowering plants, about 17 per cent are commercially exploited, resulting in depletion of natural populations, an urgent need to collect and conserve the diversity in the medicinal plants before it is wiped out from nature.

The vegetation of the region is interesting since all types of forests from scrub semi-evergreen to sholas, occur. Broadly, the vegetation can be categorized into semi-evergreen, evergreen, moist deciduous and dry deciduous.

Bringing more land under cultivation due to biotic pressures, commercialization of agriculture for increased production of improved cultivars and thrust on socio-economic development has led to severe loss of genetic diversity. Therefore, considering all these factors, collection and conservation of this germplasm, which evolved and adapted over a long period of time, assumes great significance. Keeping in view the background information and contribution to the resources in Western ghats of Maharashtra, a survey was undertaken during February 2000 to October 2002 in forest area of Western Ghats of Maharashtra. This study was conducted under NATP project on Sustainable Management of Plant Biodiversity with following objectives:

1. Survey and collection of medicinal and other economic plant germplasm.
2. Germplasm characterization, maintenance and regeneration.
3. Conservation of Plant Biodiversity.
4. Documentation and information management.
5. Need based human resource development (HRD).

Materials and Methods

The area surveyed during this work includes 11 districts of Maharashtra. Out of these, five constitute Konkan along the western side like Sindhudurga, Ratnagiri, Raigad, Bombay and Thane while remaining from the Deccan plateau such as Kolhapur, Sangli, Satara, Pune, Ahmadnagar and Nashik. The area of Western ghats of Maharashtra known as 'Sahyadris' lies between 15°60' to 20°75' and 72°61' to 74°60' E, covering an area of about 1,06,790 square kilometers. The average rainfall varies from 250-440 cms. Red basalt soils are frequently encountered in the area the range of soil types includes red loam, red sandy loam and red soil with clay base etc. Rice, ragi are major food crops; mango, cashew nut, jackfruit are the major fruit crops; vegetables are

cultivated wherever irrigation facilities are available, coconut, areca nut, mango, nutmeg, cashew, etc. are grown in alluvial soils.

The overall collection methods and logistics were taken into consideration. The general strategy adapted for collection of medicinal and agri-horticultural plant germplasm was based on the theory suggested by Bothmer and Seberg (1995) and Human *et al.* (1995). About 500 seeds of wild plants and 2000 seeds of cultivated plant species were collected, dried and cleaned. Total 25 explorations were conducted for collection of medicinal and other economic plant germplasm and for gathering the vital information. Remote places such as sacred grooves, sanctuaries, reserved forest, remote villages were tribal population as well as local medicine men available were selected for the explorations. The collected plant material was identified by using local flora. After identification the herbariums were sent to NBPGR, New Delhi and also maintained in Department of Agril. Botany. Data were recorded on plant parts used, its collection, processing, mode of administration, habitat, frequency, local names etc. For authentication of information and future reference, voucher specimens are collected. For the medicinal and edible use of plants earlier literature was used as reference (Satyavati *et al.* 1976).

Results and Discussion

Information collected during the exploration is presented in Table 1. As most of the collections are seed, live plants, vegetatively propagated and wild material, the sampling sites and intervals depended on the variation in the environmental and edaphic factors and the frequency of occurrence and importance of the species. Nayar and Sastry (1987, 1988, and 1990) documented the medicinal and useful plant species under various threatened categories from this region.

During the explorations, medicinal, aromatic, dye yielding, other agri-horticultural crops and their wild relatives were collected from 11 districts of Western Ghats of Maharashtra. During the time of exploration a total of 552 accessions of various germplasm were

Table 1. List of medicinal plants germplasm collected from Western Ghats of Maharashtra from February, 2000 to October, 2002

Botanical Name	Family	Frequency	Uses
Abelmoschus moschatus (L.) Medic.	Malvaceae	Occasional	Seeds are used as stimulant, antispasmodic, stomachic, tonic, carminative and aphrodisiac (medicinal, aromatic)
Abrus precatorius L.	Fabaceae	Frequent	Decoction of leaves and roots used for cold and coughs (medicinal)
Abutilon indicum (L.) Sweet.	Malvaceae	Frequent	Leaves and seeds are rich in mucilage and are used as demulcent, and laxative (medicinal)
Acacia catechu (L.f.) Willd.	Mimosaceae	Abundant	Bark used as astringent, digestive and useful for cough and diarrhea. The bark powder is sprinkled on the wound morning and evening (medicinal, dye, fuel)
Acacia fernesiana (L.) Willd	Mimosaceae	Frequent	Bark is used as astringent and demulcent. (medicinal, fuel)
Acacia nilotica (L.) Willd.	Mimosaceae	Frequent	Used extensively in sweetmeats and also in medicine for its demulcent effect (medicinal, dye, fodder, timber, fuel)
Acatinodaphne hookeri Meissn.	Lauraceae	Frequent	Infusion of leaves is used in urinary disorders and in diabetes (medicinal)
Achyranthes aspera L.	Amaranthaceae	Abundant	Useful in epilepsy, mental disorders, and wounds, colds, dog bite and conjunctivitis etc (medicinal)
Acorus calamus L.	Araceae	Occasional	Relieves flatulence, increases appetite, promotes flow of bronchial secretions and useful in asthma (medicinal)
Adhatoda vasica Nees.	Acanthaceae	Frequent	For quick relief in bronchitis (medicinal, fence)
Aegle marmelos (L.) Corr.	Rutaceae	Occasional	Used as an antidote for poison and in dysentery (medicinal, ornamental)
Ageratum conyzoides L.	Asteraceae	Abundant	Leaves are used for to cure skin diseases (medicinal)
Aloe bardadensis Mill.	Liliaceae	Frequent	Leaves are source of resinous drug, which is used mainly as purgative (medicinal)
Alpinia galanga (L.) Sw.	Zingiberaceae	Rare	Used in rheumatism, diarrhea and vomiting. (medicinal)
Andrographis paniculata (Burm.F) Wall. Ex. Ness.	Acanthaceae	Rare	Used as liver tonic (medicinal)
Argemone mexicana L.	Papaveraceae	Abundant	Roots are useful in chronic skin diseases, seed as laxative, expectorant and demulcent: juice of plant for jaundice and cutaneous affections. 2 to 3 inches long root is ground fine and given to drink with 1 cup of water for curing prolonged menstruation. Latex is mixed with equal quantity of coconut oil. The mixture is applied once a day for 3 days to cure scabies (medicinal)

Botanical Name	Family	Frequency	Uses
Argyreia hookeri Clarke	Convolvulaceae	Frequent	Used in gleets, gonorrhea and chronic ulcers (medicinal)
Aristolochia indica L.	Aristolochiaceae	Occasional	Antidote for epilepsy and in tumor healing (medicinal)
Aristolochia bracteolata Lamk.	Aristolochiaceae	Occasional	Decoction of roots is used for expelling roundworms (medicinal)
Asparagus racemosus Wild.	Asparagaceae	Abundant	Used for vigor and treatment of venereal diseases. One cup of juice of tuberous root with one tea spoonful of sugar is taken in the morning for three days for increasing breast milk (medicinal)
Atylosia scarabaeoides (L.) Benth	Fabaceae	Frequent	Used in rheumatism (medicinal)
Avicennia officinalis L.	Avicenniaceae	Frequent	Bark is astringent and roots aphrodisiac. Unripe seeds are used as poultice for boils (medicinal)
Azadirachta indica A. Juss.	Meliaceae	Frequent	Effective in treatment leprosy and skin diseases (medicinal)
Bacopa monnieri (L.) Pennell.	Scrophulariaceae	Rare	Entire plant constitutes drug which is used in insanity, epilepsy and as potent diuretic cardiotonic and nerve -tonic (medicinal)
Bambusa arundinacea (Retz.) Roxb.	Poaceae	Occasional	Useful for to cure wound, Regulation of M.C., Rheumatism etc. (medicinal)
Barleria prionits L.	Acanthaceae	Frequent	Fruits applied to aphthae of mouth (medicinal)
Begonia crenata Dry and	Begoniaceae	Occasional	Leaves are administered for active kidney function (medicinal)
Bixa orellana L.	Bixaceae	Frequent	Seeds yield a dye, which is used in colouring foodstuffs (medicinal)
Calophyllum inophyllum L.	Guttiferae	Frequent	Used in rheumatism and for skin diseases (medicinal)
Calotropis gigantea Ait.	Asclepiadaceae	Abundant	Root bark is used in dysentery, acts as substitute for ipecacuanha, diaphoretic, expectorant, emetic, and is valuable remedy in skin diseases. Tincture of leaves is used in intermittent fevers, and powdered flowers in cold, cough and asthma (medicinal)
Calycopteris floribunda (Roxb.) Poir	Combretaceae	Frequent	Leaves are laxative, astringent and used in ulcers (medicinal)
Canavalia virosa (Roxb.) Wright & Arn.	Fabaceae	Occasional	Fruit - abortive property (medicinal)
Capparis decidua (Forsk.) Edgew	Capparidaceae	Rare	Top shoots and young leaves are used as plaster for boils and swellings, in powder from to relieve toothache. Bark is considered useful for cough and asthma. Root bark is given is intermittent fevers (medicinal)
Cassia fistula L.	Caesalpiniaceae	Abundant	Fruit pulp is used as purgative (medicinal)
Cassia tora L.	Caesalpiniaceae	Abundant	Leaves are used in ringworm and other skin diseases (medicinal)
Celastrus paniculata Willd.	Celastraceae	Occasional	Seeds are laxative, stimulant, and aphrodisiac and used in leprosy, gout and rheumatism (medicinal)
Celosia argentea L.	Amaranthaceae	Abundant	Seeds are useful in blood diseases and mouth sores, and for diseases of eye (medicinal)
Centella asiatica (L.) Urb	Apiaceae	Frequent	Used in anti-diarrhoeal preparations, promotes memory and useful in skin diseases (medicinal)
Cinnamomum zeylanicum Blume	Lauraceae	Abundant	It is used as astringent, stimulant and carminative, and also for checking nausea and vomiting (medicinal)
Cissampelos pereira L.	Menispermaceae	Frequent	Root decoction in combination with other herbs in useful in all types of fevers and body pains (medicinal)
Clitoria ternatea L.	Papilionaceae	Frequent	Seeds are used as purgative and roots as cathartic, diuretic and purgative. One-cup decoction is taken morning and evering to cure fever and joint pains (medicinal)
Cocculus hirsutus (L.) Diels	Menispermaceae	Abundant	Used in chronic rheumatism and venereal diseases. Extreact of stems and roots is sedative, hypertensive, cardio tonic and spasmolytic (medicinal)
Costus speciosus (Koen. ex Retz.) Sm.	Costaceae	Rare	Precursor of steroids including sex hormones and oral contraceptives (medicinal)
Cymbopogon citratus	Poaceae	Frequent	Yields aromatic oil called lemon-grass oil. Leaves are taken as a substitute for tea, as a refreshing beverage (medicinal)
Datura metal L.	Solanaceae	Frequent	Used as stimulant for central nervous system and expectorant, antispasmodic, demulcent (medicinal)
Dichrostachys cinerea (L.) Wt. & Arn.	Mimosaceae	Rare	Root used in rheumatism and renal troubles (medicinal)
Eclipta prostrata L.	Asteraceae	Abundant	Plant juice in combination with aromatics is administered for caterrhal jaundice. Also used in hair oils (medicinal)
Embelia ribes Burm.	Myrsinaceae	Rare	Fuits are used as an anthelmintic, and astringent (medicinal)
Embelia tsjeriam-cottom A.DC.	Myrsinaceae	Frequent	Its fuits are used as an antispasmodic and anthelmintic.(medicinal)
Euphorbia hirta L.	Euphorbiaceae	Abundant	Used in bronchial affections, cough, asthma, and in removing worms in children and in bowel complaints. Latex of plant is applied on warts (medicinal)
Gloriosa superba L.	Liliaceae	Rare	Used as an anthelmintic, and leaf juice is reported to kill lice in hair (medicinal)

Botanical Name	Family	Frequency	Uses
Gymnema sylvestre (Roxb.) Br.	Asclepiadaceae	Rare	Leaf powder is used for redusing blood sugar and root paste for eye inflammations (medicinal)
Helicteres isora L.	Sterculiaceae	Frequent	Bark is employed for diarrhoea, dysentery and biliousness (medicinal)
Hemidesmus incidus (L.) R.Br.	Asclepiadaceae	Frequent	Roots are used for rheumatism, skin diseases, and syphilis (medicinal)
Holarrhina antidysenterica (Roth) Wall.	Apocynaceae	Anundant	Decoction made of stem bark mixed with Bael fuit is used for dysentery, leaf juice for joint pains and piles (medicinal)
Hygrophila auriculata (Schum.) Heine	Acanthaceae	Frequent	Leaves seeds and roots are used as diuretic, and also for jaundice, dropsy, rheumatism and diseases of urino-genital tract (medicinal)
Hyptis suaveolens (L.) Poit	Lamiaceae	Abundant	Used for eye troubles (medicinal)
Ipomea pes-capre (L.) Sweet.	Convulaceae	Occasional	Whole plant, alterative, astringent, diuretic, laxative, Stomachic and tonic (medicinal)
Ixora coccinea L.	Rubiaceae	Abundant	Roots are sedative, stomachic and used in diarrhoea and dysentry. Flowers are used for treating dysentery, leucorrhoea and catarrhal bronchitis (medicinal)
Madhuca longifolia (L.) Macb.	Sapotaceae	Frequent	Flowers are used in manufacture of alcohol and in treatment of coughs, colds and bronchitis. Bark is used for rheumatism, ulcers, itches, bleeding and spongy gums, and tonsillitis. Roots are applied to ulcers (medicinal, oul yielding, industrial etc.)
Mallotus philippinensis (Lamk) Muell. Arg.	Euphorbiaceae	Frequent	Fuit yields a dye called kamala, used for colouring foodstuff and silk. fuit powder is used as anthelmintic and fruit paste is used along with geneily oul against leprosy (medicinal, dye)
Marsdenia volubilis (L.F.) Cooke	Asclepidaceae	Rare	Use for controlling skin disease (medicinal, fuel)
Memicylon umbellatum Burn.	Melastomataceae	Frequent	Leaf extract used for controlling skin diseases. (medicinal, fuel)
Mimosa pudica L.	Mimosaceae	Abundant	Leaves and roots are used for diabetes, filariasis, whooping cough and sterilization in women (medicinal)
Mimusops elengi L.	Sapotaceae	Frequent	Bark of stem & fruit used for teeth and gum problem. (medicinal)
Momordica charantia L.	Cucurbitaceae	Frequent	Leaves and fruits are used in diabetes, diarrhoea, fevers, and high blood pressure (medicinal)
Mucuna pruriens (L.) DC.	Febaceae	Rare	Roots and seeds are used for elephantiasis, spermatorrhoea and paralysis (medicinal)
Murraya koenigii (L.) Spreng.	Rutaceae	Frequent	Essential oil extracted from plant parts is used in perfumes and soaps. Leaves are used for diarrhoea and dysentery. Root juice is given for renal pain (medicinal, spice)
Nerium indicum Mill.	Apocynaceae	Frequent	Dried leaves are an effective cardiac stimulant. Root is externally applied as a paste against ringworm's (medicinal)
Ocimum americanum L.	Lamiaceae	Frequent	Seeds are diuretic and tonic and also used in the preparation of a cooling drink (medicinal)
Ocimum basilicum L.	Lamiaceae	Frequent	Seeds are used in dysentery and chronic diarrhoea. (medicinal)
Ocimum sanctum L.	Lamiaceae	Abundant	The juice or infusion of the leaves is useful in bronchitis, catarrh, digestive complaints: applied locally on ringworm and other skin diseases (medicinal)
Oroxylum indicum (L.) Vent.	Bigonaceae	Rare	Roots are used for controlling body temperature, piles and tonic (medicinal)
Osmunda regalis L.	Osmundaceae	Rare	The plant is used as a tonic and styptic; used for rickets.(medicinal)
Oxalis corniculata L.	Oxalidaceae	Abundant	Fresh juice of the plant cures dyspepsia, piles, anemia and tympanitis. An infusion of the leaves is used to remove opacity of the cornea. Plant having astringent and antiseptic property (medicinal)
Jatropha curcas L.	Euphorbiaceae	Frequent	Used as purgative, tender twigs are reported to be used for cleaning teeth (medicinal)
Jatropha gossypifolia L.	Euphorbiaceae	Rare	An ether extract of shoots is reported to have antibiotic activity against *E. coli* (medicinal)
Lantana camara L.	Verbenaceae	Abundant	Bark is astringent and used as lotion in impetiginous eruptions, leprous ulcers and obstinate ulcers. Leaves are boils and applied for swelling and pains of body (medicinal)
Lasiosiphon eriocephalus Decne	Thymelaeceae	Frequent	Leaves are applied to swelling and contusions.(medicinal)
Leea macrophylla Roxb. ex Hornem	Leeaceae	Abundant	Roots are used as remedy for ringworm, and in cure of guineaworm (medicinal)
Limonia accidissima L.	Rutaceae	Occasional	Fuits are used in fever and roots as purgative (medicinal)
Pandanus odoratissimum L.F.	Pandanaceae	Occasional	Used in leprosy, smallpox, scabies and diseases of heart and brain (medicinal)
Peperomia pelluciada (L.) .B. & HK.	Piperaceae	Occasional	Crushed leaves are used for headache and fever; also for abdominal pain (medicinal)

Botanical Name	Family	Frequency	Uses
Phyllanthus emblica L.	Euphorbiaceae	Frequent	Used as urine purifier, for control of white discharge, Hypertension, Blood pressure, Brain tonic etc. (medicinal)
Phyllanthus fraternus Webster	Euporbiaceae	Anundant	Plant is used of stomachache, diarrhoea, dysentry and urinogenital disorders. Fresh roots are used for jaundice (medicinal)
Phyllanthus reticulatus Poir.	Euporbiaceae	Abundant	Used as diuretic and cooling. Decoction of root is given to children for cough and catarrh (medicinal)
Physalis minima L	Solanaceae	Abundant	Used for to cure gonorrhea (medicinal)
Piper longum L.	Piperaceae	Abundant	Used as carminative, diuretic, analgesic, and stomachic and in rheumatism (medicinal)
Piper nigrum L.	Piperaceae	Abundant	Used as stimulant, carminative and stomachic (medicinal)
Plumbago zeylanica L.	Plumbaginaceae	Frequent	Root is an appetizer, used in skin diseases, diarrhoea, and piles. Milky juice is used as application in scabies and unhealthy ulcers (medicinal)
Pongamia pinnata (L.) Pierre	Fabaceae	Abundant	The oil extracted from the seeds are used by local people as a good remedy on scabies (medicinal)
Portulaca oleracea L.	Portulacaceae	Abundant	Plant is used for scurvy, liver diseases, spleen, kidney, bladder, cardio-vascular diseases, and dysentery and as blood purifier (medicinal)
Pterocarpus marsupium Roxb.	Papilionaceae	Frequent	Stem is used in diarrhoea and for toothache. Bruised leaves are applied on sores and boils (medicinal)
Randia dumetorum Lamk.	Rubiaceae	Frequent	Pulp of fruit is given in dysentery (medicinal, insecticidal)
Rauvalfia serpentina (L.) Benth. ex Kurz.	Apocynaceae	Rare	Root extracts are employed for relief from nervous disorders, intestinal troubles, easing delivery and in hypertension (medicinal)
Rauvolfia tetraphylla L.	Apocynaceae	Frequent	An extract of plant mixed with castor oil is prescribed for chronic skin diseases (medicinal)
Remusatia vivipara (Roxb.) Schott.	Araceae	Rare	Used against itching (medicinal)
Ricinus communis L.	Euphorbiaceae	Frequent	Applied in sores, boils and rheumatic swellings (medicinal, fodder, oil yielding)
Rubia cordifolia L.	Rubiaceae	Frequent	Decoction of leaves and stems used as vermifuge (medicinal)
Ruta graveolens L.	Rutaceae	Occasional	Used as anathematic, antispasmodic and antiepileptic. Herb is used in hysteria; extract is useful for earache and toothache (medicinal)
Santalum album L.	Santalaceae	Frequent	Wood paste is use of diabetes wounds, menorrhagia, headaches and contraception (medicinal, oil yielding)
Sapindus emarginatus Vahl.	Sapindaceae	Abundant	Used for treating colic due to indigestion, diarrhoea, and paralysis of the limbs and lumbago. Roots and bark are used as mild expectorant and demulcent (medicinal)
Sarca asoca (Roxb.) de Wilde	Caesalpiniaceae	Rare	Stem bark is used as an astringent in excessive menstruation and as a uterine sedative (medicinal)
Scilla indica Roxb.	Liliaceae	Abundant	Employed in dropsy, rheumatism and skin troubles also used as expectorant, stimulant and cardio-tonic in small doses. Squill is used chiefly in chronic bronchitis and asthma (medicinal)
Securingea leucophyrus (Willd.) Muell.	Euphorbiaceae	Frequent	Paste of leaves combined with tobacco, is used to destroy worms in sores (medicinal, leaf used in fishing)
Semecarpus anacardium L.F.	Anacardiaceae	Abundant	Oil from seed used for Rheumatism, cough.(medicinal,oil yielding)
Solanum indicum L.	Solanaceae	Occasional	Roots are carminative and expectorant. Fruits laxative and digestive (medicinal)
Solanum nigrum L.	Solanaceae	Frequent	Leaves are used for constipation, jaundice, piles, uncers and fissures in the mouth and root powder for whooping cough (medicinal)
Sphaeranthus indicus L.	Asteraceae	Occasional	Plant powder is used to hasten labour pains and fruits for chicken pox and mumps (medicinal)
Sterculia urens Roxb.	Sterculiaceae	Frequent	Bark powder given to women to facilitate delivery (medicinal, oil yielding)
Strychnos nux-vomica L.	Loganiaceae	Rare	Stem bark used for menorrhagia, leprosy and snakebite, seed paste for corne and hair fall and juice of fresh wood is used for cholera, fevers and dysentery (medicinal)
Tamarindus indica L.	Caesalpinae	Frequent	An infusion of leaves is reported to be cooling and useful in bilious fever. A poultice of fresh leaves is useful in swelling and boils, and for relieving pain (medicinal)
Tephrosia purpurea (L.) Pers.	Papilionaceae	Frequent	Powdered leaves are smoked for relief from asthma and cough (medicinal)

Botanical Name	Family	Frequency	Uses
Terminalia arjuna (Roxb.) Wight & Arn.	Combretaceae	Occasional	Powdered bark is reported to relive hypertension, and also has diuretic and tonic effect in cirrhosis of liver (medicinal, timber)
Terminalia bellerica (Gaertn.) Roxb.	Combretaceae	Abundant	Fruits are used for indigestion and contraception (medicinal, timber)
Terminalia chebula Retz.	Combretaceae	Abundant	Fuits are used for conjunctivitis, diarrhoea, dysentery and piles (medicinal, timber, fuel)
Tinospora cordifolia (Wild). Miers	Menispermaceae	Frequent	Stems are used for cough and cold, cuts and wounds, diabetes, fevers, paralysis, snake bite, obesity and to prevent old age. Stem decoetion as hair tonic brain tonic and vaginal cleaning (medicinal)
Trichosanthes bracteata (Lamk.) Voigt	Curcurbitaceae	Occasional	Fruit powder used on sores (medicinal)
Tylophora indica (Brum.f.) Merr.	Asclepiadaceae	Frequent	Root are used in asthma, bronchitis whooping cough, dysentery, diarrhoea and rheunalism (medicinal)
Uraria picta (Jacq.) Desv. ex DC	Papilionaceae	Occasional	Decoetion of roots is given in colds and fevers. Leaves are antiseptic and used in gonorrhea. Roots and pods are used for prolapse of anus in children (medicinal)
Urena labata L.	Malvaceae	Abundant	A root is used as diuretic (medicinal)
Vanda tassellata (Roxb.) Hook ex G.Don	Orchidaceae	Frequent	Roots are used for curing rheunatism and bronchitis. Leaves are used for fever, juice of leaves is also used for ear troubles (medicinal)
Vernonia cinerea (L.) Less.	Asteraceae	Abundant	An infusion of plant with quinine is used forezema and ringworm. Decoction of root is given in diarrhoea and stomachache. Flowers are used for rheumatism (medicinal)
Vetiveria zizoinoides	Poaceae	Occasional	Roots yield essential oil called veiver oil, which is used in cosmetics and perfumes. Oil is used in colic, flatulence, vomiting, rheumetism and sprains (medicinal, oil yielding)
Viscum album L.	Viscaceae	Frequent	Used against hypertension, hysteria, epilepsy and ear diseases (medicinal)
Vitex negundo L.	Verbenaceae	Abundant	Leaves are used as tonic, also smoked for headaches, and applied to rheumatic swelling of joints (medicinal, oil yielding)
Molluva spicata Dalz.	Caesalpiniaceae	Frequent	Roots are used for pneumonia, bark for skin trouble (medicinal)
Withania somnifera Dun.	Solanaceae	Rare	Roots seeds and fruits are used in arthritis, asthma, bronchitis, cancer, leucorrhoea, spermatorrhoea and impotency (medicinal)
Woodfordia fruiticosa (L.) Kurz.	Lythraceae	Frequent	Dried flower acts as astringent and stimulant (medicinal, dye yielding)
Wrightia tinctoria R.Br.	Apocynaceae	Rare	Bark and seeds are used in flatulence, cough and bilious troubles (medicinal, dye yielding)

collected comprising 261 seed/fruits accessions, 12 vegetative materials, 15 wild relatives of crop plants, 15 economic plants, 15 oil yielding plants, 10 aromatic plants and 284 live plants. These were sent for conservation to National Gene Bank (NBPGR), New Delhi. All these accessions were identified by using local floras (Cooke, 1958; Kulkarni, 1988; Lakshminarsimhan and Sharma 1991; Singh and Karthikeyan 2000; Sharma *et al.* 1996). Large diversity was found among species such as *Carisa carandus*, *Holarrhena antidysentrica*, *Semecarpus anacardium*, *Terminalia chebula*, *Syzygium cumini*, *Mimosops elengi* etc. The information about medicinal uses, method of consumption and local name was also documented. Vegetative and live materials available were also collected. The 21 species characterized on the basis of days for germination and morphological characters. The seedlings of important medicinal plants were collected and maintained in the university campus during this period.

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Genetic Divergence for Yield and its Component Traits in Pomegranate (*Punica granatum* L.)

Room Singh, KK Meena and SK Singh
Division of Fruits and Horticultural Technology, Indian Agricultural Research Institute, New Delhi-110 012

Twenty four genotypes of pomegranate, both exotic and indigenous were studied for genetic divergence for a set of eight traits by using Mahalanobis D^2 statistic. The genotypes were grouped into five clusters. The genotypes did not show any relation to the geographical diversity. Based on genetic divergence and superior cluster means, it is predicted that the crosses between genotypes from cluster IV and V may result in superior types.

Key Words: Pomegranate, Genotypes, Genetic divergence, Hybridization

Pomegranate (*Punica granatum* L.) is the most important minor fruit crop grown in the arid and semi-arid regions of the country. The foothills of Himachal Pradesh and Jammu and Kashmir have also accumulated wide range of variability in land races of pomegranate. Area of its cultivation is spreading to different climatic regions in the country due to its hardy nature, low maintenance cost and good yield. It is imperative to emphasize the need to develop location-specific superior cultivars. To cater these demands, large scale and long ranging breeding programmes are necessary. Choosing genetically diverse genotypes is a pre-requisite for any plant breeding programme because, it enables the expansion of genetic base to develop superior types. The use of Mahalanobis' D^2 statistic based on quantitative traits to estimate the genetic divergence has been emphasized by several workers (Bhattacharya *et al.*, 1979; Singh and Singh, 1980; Gadekar *et al.*, 1992) to fomulate the hybridization programme before effecting the actual crosses. Relatively little information is available in pomegranate. Therefore, present study was undertaken to measure the genetic diversity among pomegranate genotypes for yield and its related components to identify the suitable parent(s) for hybridization for yield improvement.

Materials and Methods

The experimental material consisted of 24 pomegranate genotypes collected from Mahatma Phule Krishi Vidyapeeth, Rahuri, District Ahmednagar (Maharashtra). However, they were different as per their centre of origin. The experiment was laid out in a randomized block design with three replications during 1999-2000 and 2000-01 at the experimental orchard of Fruits and Horticultural Technology Division, IARI, New Delhi. The recommended cultural practices were followed. Observations were recorded on three random plants per genotype in each replication for 8 quantitative characters viz., plant height, E-W and N-S plant spread, duration of dormancy, flowering and maturity, number of fruits per plant and yield. The mean values were subjected to Mahalanobis' D^2 statistic to measure genetic divergence and the clusters were formed by Tocher's Method (Rao, 1952).

Results and Discussion

The analysis of variance showed highly significant differences among the genotypes for all the eight characters. On the basis of D^2 analysis, all the 24 genotypes were grouped into five clusters (Table 1). The maximum number of genotypes were in cluster II (10 genotypes), while cluster IV included the minimum number of genotypes (2 genotypes). The clustering of genotypes from different ecogeographical locations into one cluster could be attributed to the possible form of exchange of breeding materials or even varieties from one place to another (Sharma and Hooke, 1997). This may also be due to the fact that the unidirectional selection practiced for a particular trait in several places produced similar phenotypes, which were aggregated in one cluster irrespective of their geographic origin. On the other hand, many genotypes originating from one place were scattered over different clusters. Such genetic diversity among the genotypes of common geographic origin could be due to factors like; heterogeneity, genetic architecture of the populations, past history of selection, developmental traits and degree of general combining ability (Murty and Arunachalam, 1966).

The intra and inter-cluster divergence among the genotypes were of varying magnitude (Table 2). It may be seen that the intra-cluster distance was the highest for cluster II followed by cluster V while, cluster IV showed the minimum intra-cluster distance. The maximum

Table 1. Cluster classification of pomegranate genotypes for morphological and yield characters

Cluster	Genotypes included	No. of genotypes
I.	Jallore Seedless, Bassein Seedless, Jyoti, Muscat	4
II.	Siah Shirin, Achik Dana, Gul-e-Shah, Sur Sakkar, Speen Danedar, Speen Sakarin, Kali Shirin, Ak Anar, Khog, Shirin Anar	10
III.	P-23, Dholka, G-137, Bedana Sadana	4
IV.	Ganesh, Jodhpur Red	2
V.	Alandi, Kandhari, Kazak Anar, P-26	4

Table 2. Inter and intra-cluster distances (D2 values) for morphological and yield characters

Cluster	I	II	III	IV	V
I	1.590	3.586	3.034	4.894	3.493
II		1.997	3.681	4.394	2.757
III			1.140	2.937	3.630
IV				0.904	4.227
V					1.906

Bold letters denote the intra-cluster divergence (D^2) or average distance of cluster from cluster centroids

Table 3. Cluster means of pomegranate genotypes for different morphological and yield characters

Cluster	Plant height	Plant spread (m) (E-W)	(N-S)	Duration of dormancy (days)	Flowering duration (days)	Duration from fruits set to maturity (days)	Number of fruits per plant	Yield per plant (kg)
I	2.42	1.80	1.82	0.00	23.00	126.33	25.50	6.19
II	2.89	1.89	1.86	**63.20**	25.40	**144.03**	39.80	6.25
III	2.74	2.20	2.12	0.00	**37.25**	128.33	26.58	6.69
IV	**3.15**	**2.62**	**2.50**	0.00	28.50	133.33	29.00	7.26
V	2.70	2.00	1.97	32.00	23.50	134.58	**45.00**	**10.01**

Bold letters denotes the highest mean value within a column

inter-cluster distance was noted between cluster I and IV (4.894) followed by between II and IV (4.394). The distance between cluster II and V was the minimum (2.757) indicating close relationship between these clusters. Higher the genetic distance between the clusters, wider is the genetic diversity between genotypes. Similar findings were recorded by Dasgupta and Das (1984) and Jatasara and Paroda (1983) in wheat.

The cluster means for each character are presented in Table 3. The cluster V showed the highest mean values for the number of fruits per plant and yield. The highest mean for the plant height and E-W and N-S plant spread was observed in genotypes of cluster IV. The minimum values for all the eight traits were noted in cluster I genotypes. The comparisons of various methods for selecting the parents for hybridization in common bread wheat have been made by Bhatt (1973) which confirms the present findings.

On the basis of divergence, it is suggested that the maximum heterosis and good recombinants could be obtained in the crosses between genotypes of cluster IV and V. This information would be useful to the breeders, who are engaged in the varietal improvement programmes of pomegranate.

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Correlation and Path Coefficient Studies in Pomegranate (*Punica granatum* L.) Germplasm

KK Meena and Room Singh
Division of Fruits and Horticultural Technology, Indian Agricultural Research Institute, New Delhi-110 012

Twenty four genotypes were taken in a randomized block design with three replications to estimate the correlation and path analysis among ten characters. The correlation studies revealed that the characters viz., weight of 100 arils, juice content, total soluble solids, total sugars and ascorbic acid content showed highly significant positive correlation with the average fruit weight and among themselves both at phenotypic and genotypic levels. The path coefficient analysis at genotypic level revealed that the total sugars had the maximum positive direct effect, while juice content showed the minimum positive indirect effect via seed content on average fruit weight. Whereas, the maximum negative direct effect on average fruit weight was noted for the seed content.

Key Words: Pomegranate, Correlation, Path analysis

Pomegranate (*Punica granatum* L.) is valued for its refreshing juice with nutritional and medicinal properties. Its fruits also have excellent keeping quality with pleasant flavour and attractive colour. The aril is the edible portion, containing about 50 to 55 per cent juice content, which is rich source of sugars, ascorbic acid and several minerals (Prasad and Mali, 2000). For successful hybridization programme with efficient utilization of the resources and the knowledge of association of different characters is the most useful requisite (Desai *et al.*, 1992).

The character association and path coefficient analysis helps in indirect selection for the required trait. However, reports on evaluation of pomegranate germplasm are quite frequent in literature, yet an attempt has been made in the present study to know the correlation coefficient and path analysis for average fruit weight and other characters.

Materials and Methods

The experimental material comprised of twenty four genotypes, which were evaluated in a randomized block design with three replications maintaining a spacing of 5 m x 5 m during 1999-2000 and 2000-2001 at the experimental orchard of the Division of Fruit and Horticultural Technology, Indian Agricultural Research Institute, New Delhi. Observations were recorded on three randomly selected plants for ten characters viz., average fruit weight, seed content, weight of 100 arils, weight of 100 seeds, juice content, total soluble solids, acidity, total sugars, ascorbic acid and tannin contents. The mean values were used to compute the analysis of variance and covariance as prescribed by Panse and Sukhatme (2000). The correlation coefficient analysis among different characters was computed as method suggested by Al-Jibouri *et al.* (1958), while path analysis was worked out as per model given by Dewey and Lu (1959).

Results and Discussion

The phenotypic and genotypic correlation coefficients among average fruit weight and other characters are presented in Table 1. All the traits showed highly significant correlations, both positive and negative with average fruit weight and among themselves. Furthermore, the genotypic associations were higher in magnitude than the corresponding association at phenotypic level (Pandey and Bist, 1998). The genotypic correlation chiefly results from linkage, pleiotropic actions of genes and effect of selection. They acted either individually or jointly. It is therefore, necessary to have precise information to choose appropriate average fruit weight and quality contributing characters in pomegranate improvement programmes.

The genotypic correlations were further partitioned into direct and indirect effects to establish the cause and effect relationship among average fruit weight and its component characters. The results of path analysis at genotypic level are presented in Table 2. The genotypic path coefficient analysis indicated that the total sugars had the maximum positive direct effect on the average fruit weight followed by ascorbic acid content. Whereas, juice content and weight of 100 arils via seed content exhibited positive indirect effect on the average fruit weight. Thus, significant positive correlations were also observed for these characters with average fruit weight. Therefore, these traits deserve top most consideration

Table 1. Estimates of phenotypic (p) and genotypic (g) correlation coefficient for fruit weight and quality characters in pomegranate genotypes

Character		Average fruit weight	Seed content (%)	Weight of 100 arils (g)	Weight of 100 seeds (g)	Juice content (%)	TSS (° Brix)	Acidity (%)	Total sugars (%)	Ascrobic acid (mg per 100 ml juice)	Tannins (mg per 100 ml juice)
Average fruit weight (g)	p	1.00	-0.935**	0.903**	-0.902**	0.845**	0.624**	-0.733**	0.668**	0.802**	-0.690**
	g	1.00	-0.949**	0.915**	-0.924**	0.913**	0.829**	-0.740**	0.734**	0.888**	-0.695**
Seed content (%)	p		1.00	-0.939**	0.940**	-0.895**	-0.595**	0.697**	-0.608**	-0.807**	0.735**
	g		1.00	-0.959**	0.970**	-0.968**	-0.788**	0.711**	-0.663**	-0.902**	0.745**
Weight of 100 arils (g)	p			1.00	-0.948**	0.901**	0.674**	-0.750**	0.695**	0.816**	-0.771**
	g			1.00	-0.980**	0.984**	0.927**	-0.764**	0.775**	0.920**	-0.786**
Weight of 100 seeds (g)	p				1.00	-0.865**	-0.675**	0.734**	-0.681**	-0.787**	0.796**
	g				1.00	-0.952**	-0.896**	0.756**	-0.759**	-0.896**	0.811**
Juice content (%)	p					1.00	0.642**	-0.748**	0.560**	0.814**	-0.731**
	g					1.00	0.895**	-0.812**	0.658**	0.981**	-0.783**
TSS (° Brix)	p						1.00	-0.683**	0.649**	0.605**	-0.554**
	g						1.00	-0.898**	0.934**	0.902**	-0.728**
Acidity (%)	p							1.00	-0.639**	-0.729**	0.554**
	g							1.00	-0.692**	-0.805**	0.564**
Total sugars (%)	p								1.00	0.542**	-0.514**
	g								1.00	0.643**	-0.565**
Ascorbic acid (mg per 100 ml juice)	p									1.00	-0.632**
	g									1.00	-0.710**
Tannins (mg per 100 ml juice)	p										1.00
	g										1.00

** Significant at 1% level

Table 2. Genotypic path coefficient analysis (direct and indirect effects) for average fruit weight (g) and other characters

Character	Seed content (%)	Weight of 100 arils (g)	Weight of 100 seeds (g)	Juice content (%)	TSS (° Brix)	Acidity (%)	Total sugars (%)	Ascrobic acid (mg per 100 ml juice)	Tannins (mg per 100 ml juice)	Genotypic correlation with average fruit weight (g)
Seed content (%)	**-1.141**	0.776	0.118	-0.181	0.084	0.001	-0.303	-0.278	-0.027	-0.949**
Weight of 100 arils (g)	1.094	**-0.809**	-0.120	0.184	-0.099	-0.001	0.354	0.284	0.028	0.915**
Weight of 100 seeds (g)	-1.106	0.793	**0.122**	-0.178	0.096	0.001	-0.347	-0.276	-0.029	-0.924**
Juice content (%)	1.105	-0.796	-0.116	**0.187**	-0.096	-0.001	0.301	0.302	0.028	0.913**
TSS (° Brix)	0.899	-0.750	-0.109	0.167	**-0.107**	-0.001	0.427	0.278	0.026	0.829**
Acidity (%)	-0.811	0.618	0.092	-0.152	0.096	**0.001**	-0.316	-0.248	-0.020	-0.740**
Total sugars (%)	0.756	-0.627	-0.093	0.123	-0.100	-0.001	**0.457**	0.198	0.020	0.735**
Ascorbic acid (mg per 100 ml juice)	1.029	-0.745	-0.109	0.183	-0.097	-0.001	0.294	**0.308**	0.026	0.888**
Tannins (mg per 100 ml juice)	-0.850	0.637	0.099	-0.146	0.078	0.001	-0.258	-0.219	**-0.036**	-0.695**

Residual effect: 0.0556; Bold letters denote direct effects
** Significant at 1% level

in the selection programmes for the improvement of average fruit weight in pomegranate. These results are in consonance with the findings of Desai *et al.* (1994) and Karale and Desai (2000). As regards the residual effect, it was seen that apart from the variables under study, there could be certain factors influencing the average fruit weight as was evident from the estimates of the residual effect of + 0.0556.

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Genetic Analysis of Yield and its Component Traits in Barley

Yogendra Sharma[1], SN Sharma[2] and P Joshi[3]

[1] *National Bureau of Plant Genetic Resource Regional Station, Phagli, Shimla-171 004 (Himachal Pradesh) [E-mail: yogi8372@indiatimes.com]*

[2] *Agriculture Research Station, Rajasthan Agricultural University, Durgapura, Jaipur-302 015 (Rajasthan), India.*

[3] *Department of Plant Breeding and Genetics, Rajasthan Agricultural University, SKN College of Agriculture, Jobner, Jaipur-303 329 (Rajasthan)*

Combining ability analysis in six-rowed barley (*Hordeum vulgare* L.) involving 10 diverse parents and their 45 F_1's and F_2's progenies indicated significant differences among the parents for gca and crosses for sca for all the characters studied. The gca and sca components of variance were significant for all the traits. The gca:sca ratio showed that among the two types of genetic effects, the non-additive gene effects were more important in comparison to additive gene effects in controlling the inheritance of the characters under study. Among the parents RD 2052, RD 2503 and BL 2 were the best general combiners for grain yield and average to high combiners for other important traits. The best specific crosses for grain yield were BL 2 x ISBYT 17, RD 2503 x RD 2585, BL 2 x ISBYT 4, RD 2052 x BL 2, RD 2508 x ISBYT 4, RD 2053 x RD 2552, RD 2035 x RD 2052 and RD 2035 x BL 2 in both F_1 and F_2 generations. To ensure further increase in grain yield, combinations of desirable yield components is advocated. The exploitation of additive and non-additive gene actions through bi-parental mating and/or diallel selective mating systems are suggested for tangible advancement of grain yield in barley.

Key words: Barley, Variety, Gene Effects, Heterosis, Yield Components

Introduction

In India, barley (*Hordeum vulgare* L.) is grown on more than 7.28 lakh hectares, with a production of more than 14.56 lakh tones with productivity of 20.01 q/ha. In India, barley is grown as a rainfed or residual moisture crop. Barley is used as human food either for bread making or traditional recipes. The major use of barley grains is in the production of malt. Barley cultivation in India is now becoming oriented towards industrial utilization. For improving breeding population a thorough knowledge of gene action, heritability of the characters and genetic contents of the parents is needed. Improvement in breeding population achieved by reconstructions of genotypes, which is frequently accomplished by introduction of alien genes through hybridization followed by directional selection for that decision, should be made about the choice if the desirable parents for hybridization as superior segregates could result only from specific cross combinations involving apparently desirable parents. This emphasizes the necessity of testing the parent for their combining abilities. The isolation of superior and transgressive segregates in the advance generations equal or superior to the F_1 depends up on the type of gene action predominantly responsible for the expression of the characters. Several mating designs and models, which provide estimates of the effects and variances due to combining ability, are available and each of them has its advantages and disadvantages. The diallel method of analysis was developed in order to provide information on the genetic architecture of the breeding material, which helps in the identification of the parents/crosses to be including in a future breeding programme for tangible advancement of crops. The diallel analysis also provides a unique opportunity to test a number of lines in all possible combinations. Thus, the main objective of present studies was to identify best combining parents and their crosses on the basis of their general and specific combining ability for yield and its component traits under normal sown environment for further amelioration of grain yield in barley.

Materials and Methods

Ten varieties of six-rowed barley (*Hordeum vulgare* L.) namely, RD 2035, RD 2052, RD 2503, RD 2508, RD 2552, RD 2585, RD 387, BL 2, ISBYT 4 and ISBYT 17 were crossed in all possible combinations excluding reciprocals. The 10 parents and their resulting 45 F_1's and 45 F_2's were grown in a randomized block design with three replications at Asalpur Research Farm of SKN College of Agriculture, Jobner, Jaipur, Rajasthan. Plots of parents and F_1s consisted of two rows of 2 m length while each plot of F_2 consisted of four rows with the spacing of 30 cm between rows and 10 cm between plants. Ten competitive plants in parents and F_1's and 30 plants in F_2 progenies were selected randomly for

recording observations on ten characters namely, days to heading (75%), plant height (cm), tillers per plant, flag leaf area (cm^2), spike length (cm), number of spikelets per spike, number of grains per spike, 1000-grain weight (g), harvest index (%) and grain yield per plant (g).

The mean of each plot was used for statistical analysis. The data were first subjected to the usual analysis followed for a randomized block design for pooled environments as well as for individual environment (Panse and Sukhatme, 1967). The combining ability analyses were carried out following Method II, Model I of Griffing's (1956).

Results and Discussions

Analysis of variance indicated significant differences among parents for all the characters. Similarly the differences among F_1 hybrids and F_2 progenies were found significant for all the traits indicating the presence of diversity in the material (Table 1). The significant differences between parents vs F_1s and parent vs F_2s were also found for all the traits revealed the existence of heterosis and inbreeding expression. Significant differences among genotypes for grain yield and its related traits in different sets of materials were also reported by Kudla *et al.*, (1988), Leistrumaite (1989), Bhatnagar and Sharma (1995) and Sharma *et al.*, (2002).

Analysis of variance for combining ability revealed that the variance due to general combining ability (gca) and specific combining ability (sca) were highly significant for all the traits studied in both F_1 and F_2 generations. Thus, both kinds of gene effects figured important in controlling the inheritance of all the characters studied. However, the gca:sca ratio tilted normally in favour of sca in all the traits in both F_1 and F_2 generations indicating the preponderance of non-additive gene effects in the genetic control of the traits (Table 2). The present findings thus supported the reports of Madic (1996), El-Seidy (1997), Bouzerzour and Djakoune (1998) and Sharma *et al.* (2002), which clearly indicated that non-additive genetic variance as the main component of genetic variance of various economic traits in barley. However, preponderance of additive effects were reported by Kalashnik and Smyalovskaya (1986) and Yang and Lu (1991) and role of both additive and non-additive effects were also reported by Choo *et al.* (1988) and Bhatnagar

Table 1. Analysis of variance showing mean squares for parents, F_1s and F_2s for different characters of barley

Characters	Replication	Genotype	Parents	F_1	F_2	P vs F_1	P vs F_2	Error
d.f.	2	99	9	44	44	1	1	198
Days to heading	2.90	55.97**	72.85**	48.88**	56.83**	209.60**	216.03**	8.63
Plant height	19.43	218.24**	227.90**	228.95**	202.98**	526.88**	258.98**	26.81
Tillers per plant	0.18	1.71**	0.70**	1.40**	1.80**	18.53**	20.92**	0.32
Flag leaf area	0.07	0.74**	2.03**	0.60**	0.54**	4.95**	3.56**	0.24
Spike length	0.43	0.98**	1.13**	0.80**	0.81**	16.30**	12.85**	0.51
Number of spikelets per spike	3.22	69.99**	21.03**	75.21**	68.00**	434.62**	259.83**	7.85
Number of grains per spike	2.65	69.68**	18.57**	79.88**	66.23**	297.70**	168.65**	5.48
1000-grain weight	0.18	15.30**	22.14**	14.81**	11.33**	144.11**	51.69**	1.59
Harvest index	2.71	8.06**	3.49**	7.36**	6.58**	144.72**	66.05**	1.37
Grain yield per plant	1.38	34.77**	4.85**	32.26**	29.44**	681.94**	491.85**	1.35

* and ** Significant at 5 and 1 per cent level, respectively

Table 2. Analysis of variance for combining ability for different characters of barley

Characters	Source							
	GCA		SCA		Error		GCA/SCA	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
d.f.	9		45		108		–	
Days to heading	39.06**	44.83**	14.53**	16.01**	1.37	2.07	0.205	0.241
Plant height	228.90**	207.22**	47.93**	41.83**	7.32	7.71	0.516	0.586
Tillers per plant	0.91**	1.13**	0.46**	0.56**	0.07	0.08	0.103	0.105
Flag leaf area	0.73**	0.73**	0.22**	0.19**	0.03	0.03	0.288	0.412
Spike length	0.54**	0.61**	0.35**	0.31**	0.08	0.08	0.084	0.159
Number of spikelets per spike	19.07**	15.15**	25.32**	22.46**	2.49	2.77	-0.023	-0.031
Number of grains per spike	18.67**	13.37**	25.74**	21.40**	1.94	2.07	-0.025	-0.035
1000-grain weight	13.13**	12.02**	4.75**	3.15**	0.53	0.65	0.165	0.296
Harvest index	4.77**	4.81**	2.75**	1.90**	0.42	0.47	0.073	0.169
Grain yield per plant	16.61**	15.99**	12.57**	9.83**	0.40	0.47	0.028	0.055

** Significant at 1 per cent level.

and Sharma (1995) for grain yield and its component characters in barley.

The estimates of general combining ability (gca) effects revealed that among parents RD 2052, Rd 2503 and BL 2 were the best general combiners for grain yield and good to average combiner for most of the yield component characters (Table 3). However, rest of the parents were poor combiner for grain yield and average to poor general combiners for most of the yield contributing traits. Parent RD 2508 was the best general combiners for dwarfness, spike length, number of spikelets (F_1), number of grains per spike and 1000-grain weight. Parent RD 2035 was good general combiner for early heading (F_1), flag leaf area and 1000-grain weight. Almost similar trends of parents for general combining ability effects were observed in both F_1 and F_2 generations. Parent RD 2052 was also good general combiner for early heading, dwarfness, tillers per plant, flag leaf area, spike length, number of spikelets (F_1), number of grains per spike (F_1), 1000-grain weight and harvest index. RD 2503 was good combiner for dwarf ness, tillers per plant, number of grains per spike (F_1), 1000-grain weight (F_1), and harvest index. Parent BL 2 was the best general combiner for flag leaf area, number of spikelets (F_1), number of grains per spike (F_1), and harvest index (F_1). Parents RD 2552, RD 2585, RD 387, ISBYT 4 and ISBYT 17 were observed poor general combiners for grain yield as well as for yield components under study. Apparently therefore, there is still further scope for improving upon the combining ability for component traits, as none of high combiners for grain yields was a high combiner or at least an average combiner for all the desirable traits.

High gca effects are mostly due to additive gene effects or additive x additive interaction effects as earlier reported for Griffing (1956). In view of this, breeders may utilize the good general combiners in specific breeding programme for amelioration of grain yield in barley. It seems feasible, therefore, that the gca rank for grain yield is related to the gca for the useful yield components. It is, therefore, recommended that breeder should breed for superior combining ability for the component traits with an ultimate objective to improve the over all gca for grain yield in barley. The parents

Table 3. Estimates of general combining ability effects for different characters of barley

Parent	Days to heading		Plant height		Tillers per plant		Flag leaf area		Spike length	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
RD-2035	1.144**	-3.056**	-2.087*	-1.712	0.080	0.214*	0.218**	0.238**	0.107	0.143
RD-2052	-3.772**	-3.000**	-3.783**	-3.317**	0.458**	0.482**	0.414**	0.353**	0.252**	0.264**
RD-2503	1.256**	-0.139	-2.546**	-2.243*	0.369**	0.403**	0.031	0.123*	0.158	0.181*
RD-2508	-1.800**	-0.694	-3.494**	-3.310**	-0.234**	-0.256**	-0.029	-0.102	0.229*	0.233*
RD-2552	-0.133	2.222**	-1.435	-1.295	-0.370**	-0.322**	-0.151*	-0.293**	-0.230*	-0.254**
RD-2585	1.450**	1.972**	10.790**	10.575**	0.050	0.030	-0.249**	0.243**	0.035	0.027
RD-387	2.283**	1.889**	-1.318	-0.982	-0.161	-0.224*	-0.215**	-0.156**	-0.331**	-0.346**
BL-2	0.061	-0.778	3.130**	2.049*	0.158	0.165	0.354**	0.358**	0.140	0.128
ISBYT-4	-1.106**	0.278	-1.047	-1.248	-0.281**	-0.385**	-0.220**	-0.084	-0.136	-0.129
ISBYT-17	0.617	1.306**	1.790**	1.783*	-0.067	-0.106	-0.152*	-0.195**	-0.222*	-0.246**
SE (g_i) ±	0.320	0.394	0.741	0.760	0.072	0.077	0.047	0.047	0.077	0.077
SE (g_i-G_j)±	0.478	0.587	1.104	1.133	0.108	0.115	0.070	0.070	0.115	0.115
	Number of spikelets per spike		Number of grains per spike		1000-grain weight		Harvest index		Grain yield per plant	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
RD-2035	0.096	-0.778	0.447	-0.669	0.925**	1.118**	0.379	0.310	-0.026	0.015
RD-2052	1.566**	0.945	1.663**	0.718	0.761**	0.688**	1.007**	1.122**	1.863**	1.872**
RD-2503	1.318*	0.377	1.216*	0.275	0.538**	0.402	0.621**	0.424*	1.324**	1.004**
RD-2508	0.835	1.150*	0.955*	1.092*	1.422**	1.328**	0.055	-0.232	0.506*	0.423
RD-2552	-0.826	-0.074	-1.023*	0.200	-1.601**	-1.525**	-0.513*	-0.390	-1.020	-0.770**
RD-2585	0.785	0.831	0.688	0.769	-0.894**	-0.764**	-0.137	0.033	-0.025	-0.122
RD-387	-2.343**	-2.105**	-2.323**	-2.032**	-0.370	-0.354	-1.193**	-1.004**	-1.828**	-1.949**
BL-2	0.649	1.344*	0.186	1.294**	0.393	0.347	0.363	0.636**	0.990**	1.207**
ISBYT-4	-1.179*	-0.700	-1.076*	-0.867	0.347	0.229	-175	-0.292	-0.793**	-0.721**
ISBYT-17	-0.901	-0.989	-0.734	-0.780	-1.521**	-1.169**	-1.408*	-0.607*	-0.991**	-0.958**
SE (g_i)±	0.432	0.456	0.382	0.394	0.199	0.222	0.178	0.188	0.173	0.188
SE (g_i-G_j)±	0.644	0.680	0.569	0.587	0.297	0.330	0.265	0.280	0.258	0.280

** and ** Significant at 5 and 1 per cent level, respectively

RD 2052, RD 2503, and BL 2 could be utilized extensively in the hybridization programme to accelerate the pace of genetic improvement of grain yield in six rowed barley under heat stress environment.

In order to synthesize a dynamic population with most of the favourable gene accumulated, it will be pertinent to make use of the aforesaid parents, which are good general combiner for several characters, in multiple crossing programmes. Apart from conventional breeding methods resting slowly upon additive or additive x additive type of gene action, population improvement appears to be hopeful alternative. Diallel selective mating system of Jensen (1970) is a good technique, which delays quick fixation of gene complexes, permit break down of linkage, general fostering of recombination and concentration of favorable genes / gene complexes, into central gene pool, by a series of multiple crosses.

Normally the sca effects do not contribute tangibly in the improvement of self-fertilizing crops, except where commercial exploitation of heterosis is feasible. The sca represent the dominance and epistatic interaction, which can be related with heterosis. However, in self-pollinated crops like barley, the additive x additive type of interaction component is fixable in later generations. Breeder's interest, therefore, vests in obtaining transgressive segregants through crosses and producing more potent homozygous lines. Jinks and Jones (1958) emphasized that the superiority of the hybrids might not indicate their, ability to yields transgressive segregants, rather sca would provide satisfactory criteria.

The estimates of specific combining ability (sca) revealed that out of 45 crosses, 25 crosses in F_1's and 21 crosses in F_2's were found to be good specific combiners for grain yield. It is noteworthy that 21 crosses showed positive and significant sca effects for grain yield in both F_1 and F_2 generations. The generation effects were also noticed in the sca effects of the crosses. The highest positive significant sca effect was exhibited by the cross BL 2 x ISBYT 17 in both the generations. Other good combinations, which showed significant sca effects for grain yield in both the generations were RD 2503 x RD 2585, BL 2 x ISBYT 4, RD 2052 x BL 2, RD 2508 x ISBYT 4, RD 2503 x RD 2552, RD 2035, RD 2052, RD 2035 x BL 2, RD 2052 x RD 2552, RD 2508 x RD 2552 and RD 2508 x RD 387 in both F_1 and F_2 generations. These crosses were higher yielder and also in most of the crosses one of the parents involved was good combiner indicated that such combinations are expected to throw desirable transgressive segregants. All the best crosses for grain yield also showed average to high sca effects for most of the yield components. It is, therefore, recommended that new materials should be used in future breeding programmes for recombining the desirable traits in the envisaged elite genotypes.

It is noteworthy that the crosses, which exhibited consistently positive sca in both generations, also exhibited positive significant heterosis. Thus, the results of the present study indicated some relationship between sca effects and heterosis. It is, therefore, suggested that sca performance may be considered as a criterion for selecting the best crosses in barley. It may also be worthwhile to attempt bi-parental mating in the segregating generation among selected crosses to permit superior recombinations. All the important crosses involving parents with high x average, average x average and average x poor general combiners, indicated that non-additive type of gene actions, which are unfixable in nature were involved in selected cross combinations.

The study demonstrates that both additive (fixable) and non-additive (non-fixable) components of genetic variances were involved in governing the inheritance of almost all the quantitative and quality traits although additive genetic variance was predominant. Therefore, bi-parental mating and/or diallel selective mating which may allow inter-mating of the selects in different cycles and exploit both additive and non-additive gene effect could be useful in the genetic improvement of the characters of six rowed barley. Inclusion of F_1 hybrids showing high sca and having parents with good gca, into multiple crosses, could also prove a worthwhile approach for tangible advancement of grain yield in six-rowed barley.

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Important Crop Germplasm Introduced into India During 2002

RV Singh, Deep Chand, Vandana Tyagi, Nidhi Verma, SP Singh and BS Dhillon
Germplasm Exchange Division, National Bureau of Plant Genetic Resources, Pusa Campus, New Delhi-110012

The paper contains the information about promising introductions made for various biotic, abiotic stresses and other value added traits during 2002. Overall, 22,193 accessions in 95 crops were introduced from 42 countries/International Agricultural Research Institutes.

Key Words: Exotic germplasm, Biotic, abiotic stresses

Introduction of exotic germplasm has contributed significantly in the development of Indian agriculture. Many important introductions have been utilized directly as varieties while others have played a pivotal role in the improvement of different crops. Exotic germplasm/ varieties have contributed to superior varieties notable among which are CPAN 1796, PBW 33, Raj 911 in wheat; BG 105, BG 108, Himani in barley, Barkat in rice; Vijay composite selection in pearl millet; Co. 1, K-1 in sunflower; BG 261, Pusa 244 in chickpea; Pusa Phalguni, Aseem, Rituraj in cowpea; MACS 13, NRC 7 in soybean; Pusa Harbhajan, Arpna, Utra in pea and many others. The information on the germplasm introduced by NBPGR during 2002 carrying genes for various biotic, abiotic stresses and other value addition traits are presented in Table 1.

Table 1. Promising introductions made during 2002

Crop name/EC No.	Country	Salient features	Distribution
		A. Biotic stress resistant/tolerant	
Oryza sativa (Paddy) EC 494302-43	IRRI, Phillipines	Resistant to rice blast *(Pyricularia grisea)*	• IGAU, Raipur, Chattisgarh
• Var. Suitou fujisaka-5 EC-494446	Japan	Resistant to rice blast *(Pyricularia grisea)*	• DRR, Hyderabad, Andhra Pradesh • NBPGR-RS, Cuttack, Orissa
Triticum aestivum (Wheat) • Var. Bruehl EC 498860	USA	Resistant to stripe rust *(Puccinia striiformis)*, speckled snow mould *(Typhula* spp.) and dwarf bunt *(Tilletia controversa)*	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
EC 498861-62	Canada	Hard red spring wheat with Lr 21 and Lr 34 Leaf rust resistance genes	• Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
Zea nays (Maize) • Var. EPM-6 EC 497581	USA	Resistant to corn earworm *(Heliothis zea)*, flinty or popcorn type	• Directorate of Maize Research, New Delhi • NBPGR, New Delhi
Hordeum vulgare (Barley) • Var. Niska EC 498168	Canada	Resistant to the spot form of net blotch *(Cohliobolus sativum)*, covered smut *(Ustilago hordei)* false loose smut *(Ustilago nigra)*	• NBPGR, New Delhi
Cicer arietinum (Chick pea) • Var. Evans EC 499759	USA	Resistant to Ascochyta blight *(Ascochyta rabiei)*	• IIPR, Kanpur, Uttar Pradesh • IARI, New Delhi • NBPGR-RS, Akola, Maharashtra
Glycine max (Soybean) (490206-208)	USA	Resistant to Phytophthora rot *(Phytophthora sojae)* and white mould *(Sclerotina sclertiorum)*	• NRC soybean, Indore, Madhya Pradesh
• Var. Kottman EC 493757	USA	Carries the RPSK and RPSS 3 genes for resistance to Phytophthora rot *(Phytophthora sojae)*	• NRC soybean, Indore, Madhya Pradesh
• Var. TN-5-95 EC 498112	USA	Resistant to soybean cyst nematode *(Heterodera glycines)*, stem canker *(Diaporthe phaseolorum)*, Frog eye leaf spot *(Cercospora sojina)* and Moderately resistant to sudden death syndrome *(Fusarium solani)*	• NRC soybean, Indore, Madhya Pradesh

Contd.

Crop name/EC No.	Country	Salient features	Distribution
Vigna radiata (Mung bean) EC 501566-71	AVRDC, Taiwan	Resistant to powdery mildew *(Erysiphe polygonii)* and yellow mosaic virus (YMV)	• PC, MULLaRP, IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
Vigna unguiculata (Cowpea) EC 493644, EC 493648-49, EC 493652, 493655, EC 493658-61	UK	Resistant to black eye cowpea mosaic virus (BICMV)	• Kerala Agricultural University, Thrissur, Kerala
EC 493645-57	UK	Resistant to Cowpea aphid-borne mosaic virus	• Kerala Agricultural University, Thrissur, Kerala
• Var. California black EC 496737	USA	Resistant to fusarium wilt *(Fusarium oxysporum)* and root knot nematode *(Meliodigyne* sp.)	• PC (Arid legumes), CAZRI, Jodhpur, Rajasthan • NBPGR, New Delhi
Phaseolus vulgaris (French bean) Var. AC Scarlet EC 498445	Canada	Tolerant to common bacterial blight *(Xanthomonas axonopodis)* and bean common mosaic virus (BCMV) possessing the I gene	• IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
• Var. Rojo chiquito EC 502154-58	USA	Resistant to seed-borne poty virus, bean common mosaic virus (BCMV), bean common mosaic necrosis virus (BCMNV), stem blight and rust	• IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
EC 506078	USA	Multiple disease resistance and has dominant I gene resistant to BCMV, complete resistance to curly top virus (CTV)	• IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
Pisum sativum (Pea) EC 499761	USA	Resistant to poedery mildew *(Erysiphe polygonii)* and fusarium wilt race-1 *(Fusarium oxysporum)*	• IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
• Var. Joel EC 499762	USA	Resistant to race 1 of fusarium wilt *(Fusarium oxysporum)*, pea enation mosaic virus (PSbMV)	• IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
Gossypium hirsutum (Cotton) • Var. PSB-CT 9 EC 493755	IRRI, Phillipines	Resistant against leaf hopper and resistant to pink bollworm *(Heliothos armigera)*	• CICR, Nagpur
EC 499886-887	USA	Resistant to cotton leaf curl virus (CLCV)	• Monsanto India Ltd., New Delhi
Lycopersicon esculentum (Tomato) EC 497213-21	AVRDC, Taiwan	Resistant to tomato mosaic virus and tomato leaf curl virus	• Hort. College and Research Institute, Coimbatore, Tamil Nadu
EC 510445-450	AVRDC, Taiwan	Resitant to tomato yellow leaf curl virus, tomato Mosaic virus, race 1-2 of Fusarium wilt *(Fusarium oxysporum lycopersii)* and grey leaf spot *(Stemphyllium solani)*	• NBPGR-RS, Hyderabad Andhra Pradesh
Capsicum annum (Chilli) EC 497628-640	AVRDC, Taiwan	Resistant to bacterial wilt *(Clavibacter michiganensis)*	• IIVR, Varanasi, Uttar Pradesh • HPKV, Palampur, Himachal Pradesh
EC 498405-417	Korea	Resistant to bacterial wilt *(Clavibacter michiganensis)*	• HPKV, Palampur, Himachal Pradesh
Medicago sativa (Lucerne) • Var. Shaw, Ladak-65 EC 499771-72	USA	Resistant to AApharomyces root rot, northern root knot nematode, pea aphid, spotted aphid, Vertici neem wilt and anthracnoni	• IGFRI, Jhansi, Uttar Pradesh
		B. Abiotic stress resistant/tolerant	
Oryza sativa (Rice) EC 494242-301 EC 511744-760	IRRI, Phillipines	Germplasm tolerant to saline soil	• Pt. Jawaharlal Nehru College of A&R Instt., Karaikal, Kerala • CSSRI, Karnal, Haryana • RAU, Bihar

Crop name/EC No.	Country	Salient features	Distribution
Hordeum vulgare (Barley) • Var. Peregrine EC 497614	Canada	Lodging resistant	• Directorate of Wheat Research Karnal, Haryana • NBPGR, New Delhi
EC 501046-47	USA	Lodging resistant, fodder type	• IGFRI, Jhansi, Uttar Pradesh • Directorate of Wheat Research, Karnal, Haryana • NBPGR, New Delhi
Glycine max (Soybean) EC 492128	USA	Lodging resistant	• NRC, Soybean, Indore, Madhya Pradesh
Vigna unguiculata (Cowpea) • Var. California black EC 496737	USA	Heat tolerant	• IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
Phaseolus vulgaris (French bean) • Var. AC Scarlet EC 498445	Canada	Lodging resistant	• IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
Pisum sativum (Pea) Var. Fallon EC 499761	USA	Lodging resistant	• IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
Lycopersicon esculentum (Tomato) EC 501573-85	AVRDC, Taiwan	Heat tolerant	• AAU, Assam • IIVR, Varanasi, Uttar Pradesh • NBPGR, New Delhi
		C. Value added and agronomic traits	
Oryza sativa (Rice) • Var. Mochi EC 494446-47	Japan	Glutinous rice	• Directorate of Rice Research, Hyderabad, Andhra Pradesh • NBPGR-RS, Cuttack, Orissa
Zea mays (Maize) EC 497580	USA	High *in vitro* dry matter digestibility, white cobs and yellow kernels with good grain quality	• IGFRI, Jhansi, Uttar Pradesh • Directorate of Maize Research, New Delhi • NBPGR, New Delhi
Hordeum vulgare (Barley) • Var. Niska EC 498168	Canada	A smooth awned, semi dwarf barley	• Directorate of Wheat Research Karnal, Haryana • NBPGR, New Delhi
• Var. Washford EC 501046	USA	Forage barley used primarily for hay production, also for grazing, haylage and Silage for ruminant livestock, mid late maturity	• IGFRI, Jhansi, Uttar Pradesh • Directorate of Wheat Research Karnal, Haryana • NBPGR, New Delhi
Sorghum bicolor (Sorghum) EC 496845-854	Canada	Multicut sorghum for fodder purposes	• NDRI, Karnal, Haryana
Cicer arietinum (Chickpea) EC 499759	USA	Long seeded 'kabuli' type, early maturing suitable for canning industry	• IIPR, Kanpur, Uttar Pradesh • IARI, New Delhi • NBPGR, New Delhi
Glycine max (Soybean) EC 497964	USA	High yielding, mid maturity with indeterminate habit, high protein contents	• NRC Soybean, Indore Madhya Pradesh
Lens culinaris (Lentil) • Var. Mason EC 499760	USA	Large seeded (wt. 7 g/100 seed), seed coat light as preferred in market, and high yielding	• NBPGR, New Delhi
Phaseolus vulgaris (French bean) • Var. AC Scarlet	Canada	High yielding, medium seeded, seed wt. 25-40 g/100 seed	• IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
EC 502154-58	USA	Upright determinate type and high yielding	• IIPR, Kanpur, Uttar Pradesh

Contd.

Crop name/EC No.	Country	Salient features	Distribution
			• NBPGR, New Delhi
EC 506078	USA	Upright short vine growth habit, midseason Maturity and most unique feature is retention of a bright red colour after cooking	• IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
Pisum sativum (Pea) • Var. Fallon EC 499761	USA	Bold seeded, upright growth habit, high yielding straight pods, blunt ended and contains 6-7 seeds	• IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
Vigna radiata (Mung bean) EC 501566-68	AVRDC, Taiwan	Early maturing type	• IIPR, Kanpur, Uttar Pradesh • NBPGR, New Delhi
Macrotyloma uniflorum (Horsegram) EC 501564-65	Ethiopia	Early determinate type suitable for maize intercropping	• Gramin Vikas Trust, Bhopal, Madhya Pradesh • AICRP on Arid Legumes, Jodhpur, Rajasthan • NBPGR-RS, Thrissur, Kerala
Gossypium hirsutum (Cotton) EC 501573-584	Mexico	Ultra high strength genetic line (high fibre strength)	• CICR, Nagpur
EC 493751-754	IRRI, Philippines	High ginning outturn	• CICR, Nagpur
EC 493755-756	IRRI, Philippines	High gossypol content, high ginning outturn	• CICR, Nagpur
Capsicum annum (Chilli) EC 497628-640	AVRDC, Taiwan	High yielding lines	• IIVR, Varanasi, Uttar Pradesh • HPKV, Palampur, Himachal Pradesh
• Var. Posidla type bajjo EC 501588	AVRDC, Taiwan	High carotenoid content	• IIVR, Varanasi, Uttar Pradesh • NBPGR-RS, Hyderabad, Andhra Pradesh
Lycopersicon esculentum (Tomato) EC 498863-865	USA	Compact determinate growth habit, fruits are firm and crack resistant, processig application	• IIVR, Varanasi, Uttar Pradesh • NBPGR, New Delhi
Sesbania afraspera EC 507728	IRRI, Philippines	Profuse nodulation type	• PC (UU & UEP), • NBPGR, New Delhi
Sesbania cannabina EC 507726	IRRI, Philippines	High nitrogen content lines	• PC (UU & UEP), NBPGR, New Delhi

The NBPGR is continuing its efforts to identify promising germplasm through literature search and personal contacts; and to introduce the same for utilization by Indian plant breeders.

SHORT COMMUNICATION

Rice Donors for Submergence Tolerance Collected from Super Cyclone Devastated Areas of Orissa

BC Patra and RK Sarkar
Central Rice Research Institute, Cuttack-753006 (Orissa)

One hundred and twenty accessions of rice germplasm were collected from the super cyclone devastated areas of Orissa after two months of natural calamity to salvage the landraces and the traditional varieties from the remnants of ratoon crops. The collected germplasm lines were tested for submergence tolerance. Two cultivars namely Khoda (CRRI accession no. 36470, IC no. 283020) and Khadara (CRRI accession no. 36476, IC no. 283026) were found to be tolerant and were comparable with internationally recognised tolerant check FR 13A.

Key Words : *Oryza sativa* L., Germplasm, Submergence tolerance

The Orissa coast was hit by the worst ever super cyclone in the last year of the 20th century on 29-30th October 1999 causing severe loss to human life and property. The coastal districts were completely devastated. The rice cultivation in the region, which was in the maturity stage, was completely wiped out by the wind followed by heavy downpour. In order to salvage the landraces and the traditional varieties from the remnants of ratoon crop, five rescue explorations to the worst affected districts were launched after two months of the natural calamity by this Institute in collaboration with National Bureau of Plant Genetic Resources to collect and conserve the valued germplasm getting extinct. Through this mission the senior author collected about 120 accessions of rice germplasm from the super cyclone devastated areas. In rice gene pool, getting a submergence tolerant line is very few. However, well known germplasm lines like FR 13A, FR 43B were identified long back. Due to bad combining ability and other undesirable agronomic characters, successful breeding to develop new high yielding cultivars with submergence tolerance is not yet succeeded (Mallik, 2000). Searching for alternate source for this character is in high demand. Therefore, the materials were tested for submergence tolerance.

The germplasm were grown under normal condition with recommended package of practices to characterise and document the agro-morphological traits. For screening against submergence tolerance, the seeds were direct seeded in specially designed field cement tanks (40 x 8 m) with known submergence tolerant (e.g. FR 13A) and susceptible (e.g. IR 42) cultivars as checks. In the year 2000, the submergence experiment was conducted in augmented design whereas in 2001, it was done in randomised block design. Twenty one-day-old seedlings were submerged for 12 days under 80 cm of water followed by normal conditions with 10 cm of water. Survival count was taken visually after 10 days of withdrawal of submergence.

Identification of diverse gene sources for desired traits and their incorporation into the promising cultivars are the most effective way to tackle the adverse situations. The collected germplasm were screened for their valuable traits like submergence tolerance in the experimental fields of the Institute. Almost all the cultivars succumbed to submergence except two landraces, which were collected from Cuttack district. These two cultivars having collectors' number 'PD-27' and 'PD-33' (temporarily given by the collectors' name) withstood complete submergence even if their leaf tips remained below the water surface for more than 12 days. The names of these two landraces are 'Khoda' and 'Khadara', respectively. The elongation ability of these two landraces is as good as the international submergence tolerance check 'FR 13A' (Table 1). After submergence these two landraces maintained their leaf integrity measured in terms of chlorophyll content and were like 'FR 13A' and far better than susceptible check

Table 1. Effect of submergence on elongation and survival percentage

Name of the cultivars	Plant Height (cm)			Survival
	BS	AS	Elongation	(%)
Khoda	29	68	39	100
Khadara	28	70	42	96
FR 13A (Tolerant-check)	30	72	40	100
IR 42 (Susceptible-check)	20	68	48	15

BS= before submergence; AS= after submergence

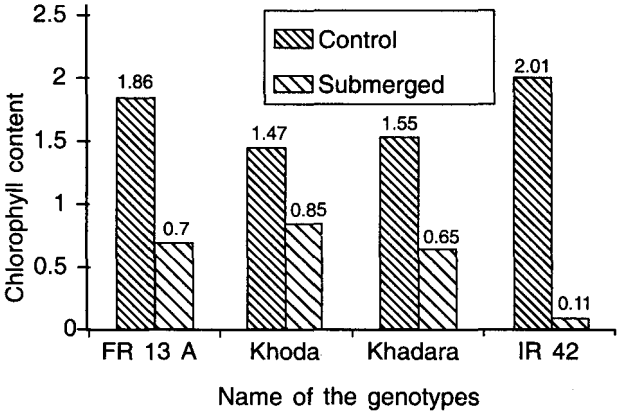

Fig.1: Effect of submergence on chlorophyll content (mg g^{-1} fresh leaves)

'IR 42' (Figure 1). Lower elongation and maintenance of higher amount of chlorophyll during submergence is associated with submergence tolerance (Sarkar and Bera 1997, Sarkar *et al.* 2001). They are better than 'FR 13A' in terms of seed quality and have no awn. 'FR 13A' was identified more than three decades ago. But developing submergence tolerant cultivars using 'FR 13A' as a parent has not yet become fruitful. These new genotypes with better seed quality and better agronomic traits would definitely improve the breeding efficiency in developing submergence tolerant cultivars. True submergence tolerant lines are not many in rice genetic stock. Identification of these two lines is given us hope and extended the scope for further research to develop high yielding submergence tolerant rice varieties.

The cv. Khoda was collected from the farmer Sri Debali Parida's field in village-Brahmanigaon of Block-Baranga whereas cv. Khadara was collected from Sri Gandharba Samal's field in village-Raghunathpur of Cuttack Sadar Block. Both the cultivars are lowland, deep-water and of long duration group. These collections have also been characterized morpho-agronomically in accordance with IRRI-IPGRI descriptor. The data show that they are similar in most of the morpho-agronomic characters like having pubescent leaf blade; blade colour and basal leaf sheath colour green; leaf angle horizontal; ligules 2-cleft, white; collar colour green; auricle colour being green; culm angle intermediate; internode's colour

Table 2. Agro-morphological traits of the landraces

Characters	PD 27 (Khoda)	PD 33 (Khadara)
Leaf length (cm)	43.4	47.4
Leaf width (cm)	0.9	1.1
Ligule length (cm)	1.9	1.9
Culm length (cm)	112.7	112.1
Culm number	7.2	8.2
Panicle length (cm)	24.5	25.9
15 days seedling height (cm)	20.5	21.4
Panicle weight (gm)	3.54	2.87
Grain length (mm)	8	9
Grain breadth (mm)	3	3
l/b ratio	2.66	3.00
1000 grain weight (gm)	26.4	28.4
Grain size	Extra long	Extra long
Grain shape	Medium	Medium
Maturity duration (days)	155	160

green; culm moderately strong; flag leaf and panicle intermediate; secondary branching low; panicle well exserted, panicle axis droopy, awning zero; apiculus, sterile lemma and stigma colour white. The mean quantitative characters of both the genotypes also show that both are almost alike (Table 2).

Required quantities of seeds have been deposited in the long-term storage of NBPGR, New Delhi as well as in the National Active Collection Centre of CRRI, Cuttack. The NBPGR has assigned the National identity to these materials with IC No. 283020 (Khoda) and IC No. 283026 (Khadara) whereas CRRI has given its own AC. No. 36470 and 36476, respectively. These two identified, valued cultivars will be submitted to the Germplasm Registration Committee of NBPGR for keeping them registered in the context of present day IPR regime etc.

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Plant Germplasm Registration Notice*

The Germplasm Registration Committee of ICAR in its X[th] meeting held on 20[th] February 2003 at National Bureau of Plant Genetic Resources, New Delhi approved the registration of following 47 germplasm lines/ genetic stocks of the 132 proposals considered.

Cytogenetic Stocks of Wheat (*Triticum aestivum* L.)

GS Sethi and P Plaha
Department of Plant Breeding and Genetics, Ch. Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya Palampur-176062 (Himachal Pradesh)

RL 4 ***(INGR No 03001; IC 296923)***

RL 4 is a cytogenetic stock of wheat, *T. aestivum* having 1R(1D) substitution from triticale. This line was isolated from advanced generation of cross between 'TL68' triticale and 'Sonalika' wheat. It was developed through pedigree selection at the Department of Plant Breeding and Genetics, Ch. Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur.

The plant has erect growth habit with an average height of 78 cm. There is no anthocyanin pigmentation in coleoptile and leaf sheath. Grain is red in colour with semi-hard texture and compressed cheeks with an average 1000-grain weight of 28 g. It starts heading around 108 days and matures by 158 days.

RL 83 ***(INGR No. 03002; IC 296924)***

RL 83 is a cytogenetic stock of wheat, *T. aestivum* having 7R(7D) substitution from triticale. The line was isolated from advanced generation of cross between triticale and bread wheat with pedigree, 'TL161' *Triticale* and 'Sonalika' wheat respectively. It was developed through pedigree selection at the Department of Plant Breeding and Genetics, Ch. Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur.

The plant has erect growth habit with average height of 76 cm. There is no anthocyanin pigmentation in coleoptile and leaf sheath, but auricle is pigmented at flag leaf stage. Grain is amber coloured with semi-hard texture and compressed cheeks with an average 1000-grain weight of 28 g. The genetic stock starts heading in 108 days and matures in around 158 days.

Karnal Bunt Resistant Lines of Wheat (*Triticum turgidum var. durum* Desf.)

Indu Sharma, GS Mahal and Sarvjeet Singh
Wheat Section, Department of Plant Breeding, Punjab Agricultural University, Ludhiana-141 004 (Punjab)

Karnal bunt disease of wheat caused by *Tilletia indica* Mitra is a major bottleneck in wheat export. Durum wheats, in general, score very less disease under natural conditions on account of morphological resistance (long awns, hairy glumes and densely arranged spikelets) and are comparable to bread wheat for physiological resistance. The durum wheat lines proposed for registration were developed and tested for Karnal bunt resistance using syringe inoculation method (Warham *et al.*, 1986; Sharma *et al.*, 2000) for identification of physiological resistance against Karnal bunt at the Punjab Agricultural University (PAU), Ludhiana.

D 482 ***(INGR No. 03003; IC 296426)***

D 482 is a Karnal bunt resistant genotype of wheat with a new genetic background. It was developed from the cross between MEMO'S' and JAIRAJ following pedigree method at the Department of Plant Breeding, Punjab Agricultural University, Ludhiana. It remained free from Karnal bunt from 1997 to 2001 and scored only 0.8 percent disease during 2002.

* Communicated by: Dr. A.K. Singh, Member Secretary, Plant Germplasm Registration Committee, Head, Conservation Division, NBPGR, New Delhi-110 012

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* Communicated by: Dr. A.K. Singh, Member Secretary, Plant Germplasm Registration Committee, Head, Conservation Division, NBPGR, New Delhi-110 012

The genotype has spreading growth habit at seedling stage with purple pigmentation in the auricle and light green foliage. It has an average plant height of 93 cm. with medium spikes and pubescent glume and matures in 160 days. Grains are of amber colour and have vitreousness. The line is high yielding with an average yield of 47.4 quintals per hectare. It has good quality characters, such as good grain appearance (5.7), hectoliter weight (79.5 Kg/ha), protein content (12%), sedimentation value (25 ml.), yellow berry (26.3%) and beta-carotene content (6.3 ppm). It is also resistant to brown and yellow rusts (Table 1).

D 873 *(INGR No. 03004; IC 296427)*

D 873 is Karnal bunt resistant genotype of wheat in a different genetic background. Crossing between DWL 7307 and PDW 222, followed by pedigree selection resulted in development of this line at the Department of Plant Breeding, Punjab Agricultural University, Ludhiana. The line is maintaining resistance against Karnal bunt under artificial inoculation conditions since its identification in 1997. It has remained disease free for five years and developed only 1.4 percent infection during 2001.

The genotype is erect at seedling stage with dark green leaves and purple pigmentation on auricle. The spikes are medium in length with blackish awns. Grains are amber coloured and hard. It matures in 156 days with an average plant height of 96 cm. It has easy threshability with acceptable agronomic traits. It is also free from brown rust (Table 1).

D 879 *(INGR No. 03005; IC 296428)*

D 879 is a Karnal bunt resistant line with a different genetic background. It was developed by pedigree method of selection from the cross between CPAN 6036 and DWL 7307 at the Department of Plant Breeding, Punjab Agricultural University, Ludhiana. It did not develop the disease for four years (1997-2000) and only in the years 2002 and 2001 infection was recorded to the levels of 1.0 and 2.3 percent respectively.

The genotype has intermediate growth habit at the seedling stage. Plants are 97 cm. in height and bear purple auricles, dark green foliage with blackish awns. It matures in 155 days and produces amber coloured bold grains that can be easily threshed. It is agronomically promising and free from brown rust (Table 1).

D 895 *(INGR No. 03006; IC 296429)*

D 895 is a Karnal bunt resistant wheat line with a different genetic background. The genotype was developed at the Department of Plant Breeding, Punjab Agricultural University, Ludhiana by a cross between PDW 222 and

Table 1. Yield and other characteristics of D 482, D 873, D 879 and D 895

Year	Trial	Location	Yield (q/ha)	Percentage Increase Over PBW34 / PDW233	Rusts		Leaf blight	Days to heading
					Yellow	Brown		
D 482								
1994-95	Station	1	71.2	19.3	0	0	–	117
1995-96	IVT	10	45.5	3.9	0	0	3	107
1996-97	State	3	50.2	0.6	0	0	–	119
1996-97	AVT	15	46.6	3.3	0	3	3	111
Mean		29	47.4	3.7	–	–	–	–
D 873			**Percentage increase over PDW 233**					
1995-96	Station	1	52.2	19.7	5S	0	–	113
1996-97	State	3	44.5	–	5S	0	–	114
Mean		4	46.4	–	–	–	–	–
D 879								
1995-96	Station	1	45.3	3.9	10S	0	–	108
1996-97	Station	1	49.3	–	10S	0	–	113
Mean		2	47.3	–	–	–	–	–
D 895								
1995-96	Station	1	46.3	12.7	5S	0	–	109
1996-97	Station	1	58.0	12.4	10S	0	–	115
1997-98	Station	3	43.8	1.4	20S	0	–	102
Mean		5	47.1	5.8	–	–	–	–

Raj 6419 followed by pedigree selection method. The line remained free from Karnal bunt for 5 years (1997-2001) and only in 2002 recorded an infection of 3.3 percent.

The genotype has intermediate growth habit at the seedling stage, with an average plant height of 90 cm. and has white auricle and light green foliage. Spikes are medium in size with white awns. It matures in 156 days. The grains are amber in colour and hard with medium threshability. It is a high yielding line with an average yield of 47.1 q./ha. Also, it is resistant to brown rust (Table 1).

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Sharma I, GS Nanda, GS Mahal, and GS Dhindsa (2000) Status of Karnal bunt resistant durum wheats and triticale and their reaction to rusts. *Crop Improvement* **27(1)**: 99-103.

Hill Bunt Immune Line of Wheat (*Triticum aestivum* L.) VL 798 (INGR No. 03007; IC 296431)

Jag Shoran and AK Sharma[1]; Lakshmi Kant, SK Pant and JC Bhatt[2]; SK Rana[3]

1. Directorate of Wheat Research, Karnal-132 001, (Haryana)

2. Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora-263 601, (Uttaranchal)

3. Ch. Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062, (Himachal Pradesh)

VL 798 is a spring wheat genotype possessing immunity for hill bunt disease. It was developed at the Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS), Almora, Uttranchal through application of pedigree selection method on crosses involving CPAN 3004/ CPAN 1922/ PBW 65 as the parents. It has semi-spreading growth habit with an average plant height of 110 cm. with seven effective tillers per plant, 20 spikelets per spike and green coleoptile colour. It takes an average of 172 days to mature. The brown coloured ears produce amber coloured grains with intermediate plumpness and 36 g. 1000-grain weight. The average seed yield per plant is 8.44 g.

In addition, this genetic stock expressed high resistance to brown rust when tested under artificial epiphytotic conditions in All India Coordinated Trials from 1996-97 to 1998-99 with an average coefficient of infection of 3.2. It has been found well adapted to Northern Hill Zone conditions with recommended package of practices.

References

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DWR, Progress Report (2000) Vol. V (Crop Protection), pp. 78.

High Grain Weight and Protein Wheat (*Triticum aestivum* L.) Selection 111 *(INGR No. 03008; IC 296469)*

Dalmir Singh

Ex-Principal Scientist, Genetics Division, Indian Agricultural Research Institute, New Delhi-110 012

Selection 111 is a high kernel weight (65-70 g./ 1000-grain weight) genotype of wheat with protein content of 15 to 16 percent on dry seed weight basis. The genotype was isolated from the segregating populations of the crosses involving monosomic 5B of var. Pb. C 591, rust resistant rye and var. Sonalika at the Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi. First monosomic 5B (2n=41) of var. Pb. C 591 was crossed with rust resistant rye (2n=14) and their F_1 hybrids deficient for chromosome 5B (2n=27) were crossed with var. Sonalika (2n=42). In the subsequent generations, selfing and selections were followed, yielding several recombinants, of which Selection 111 was one with high grain weight and protein content. Aneuploid analysis using monosomics of var. Chinese Spring revealed the location of these traits on chromosome 1A (Singh and Joshi, 1987; Singh *et al.*, 1988; Singh, 1984).

The line is slightly taller than var. Sonalika and matures at the same time as that of Sonalika. It possesses bold spike with 21 to 23 spikelets. The grain yield is superior to Sonalika. It has good root system providing tolerance to lodging. In rotation with paddy, it has been observed that Selection 111 can yield 40-45 quintals of grain per hectare.

Raj 6419 followed by pedigree selection method. The line remained free from Karnal bunt for 5 years (1997-2001) and only in 2002 recorded an infection of 3.3 percent.

The genotype has intermediate growth habit at the seedling stage, with an average plant height of 90 cm. and has white auricle and light green foliage. Spikes are medium in size with white awns. It matures in 156 days. The grains are amber in colour and hard with medium threshability. It is a high yielding line with an average yield of 47.1 q./ha. Also, it is resistant to brown rust (Table 1).

References

Warham EJ (1986) Karnal bunt disease of wheat-A literature review. *Tropical Pest Management* **32 (3)**: 229-242.

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Hill Bunt Immune Line of Wheat (*Triticum aestivum* L.) VL 798 (INGR No. 03007; IC 296431)

Jag Shoran and AK Sharma[1]; Lakshmi Kant, SK Pant and JC Bhatt[2]; SK Rana[3]

1. Directorate of Wheat Research, Karnal-132 001, (Haryana)

2. Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora-263 601, (Uttaranchal)

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In addition, this genetic stock expressed high resistance to brown rust when tested under artificial epiphytotic conditions in All India Coordinated Trials from 1996-97 to 1998-99 with an average coefficient of infection of 3.2. It has been found well adapted to Northern Hill Zone conditions with recommended package of practices.

References

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DWR, Progress Report (2000) Vol. V (Crop Protection), pp. 78.

High Grain Weight and Protein Wheat (*Triticum aestivum* L.) Selection 111 *(INGR No. 03008; IC 296469)*

Dalmir Singh

Ex-Principal Scientist, Genetics Division, Indian Agricultural Research Institute, New Delhi-110 012

Selection 111 is a high kernel weight (65-70 g./ 1000-grain weight) genotype of wheat with protein content of 15 to 16 percent on dry seed weight basis. The genotype was isolated from the segregating populations of the crosses involving monosomic 5B of var. Pb. C 591, rust resistant rye and var. Sonalika at the Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi. First monosomic 5B (2n=41) of var. Pb. C 591 was crossed with rust resistant rye (2n=14) and their F_1 hybrids deficient for chromosome 5B (2n=27) were crossed with var. Sonalika (2n=42). In the subsequent generations, selfing and selections were followed, yielding several recombinants, of which Selection 111 was one with high grain weight and protein content. Aneuploid analysis using monosomics of var. Chinese Spring revealed the location of these traits on chromosome 1A (Singh and Joshi, 1987; Singh *et al.*, 1988; Singh, 1984).

The line is slightly taller than var. Sonalika and matures at the same time as that of Sonalika. It possesses bold spike with 21 to 23 spikelets. The grain yield is superior to Sonalika. It has good root system providing tolerance to lodging. In rotation with paddy, it has been observed that Selection 111 can yield 40-45 quintals of grain per hectare.

Raj 6419 followed by pedigree selection method. The line remained free from Karnal bunt for 5 years (1997-2001) and only in 2002 recorded an infection of 3.3 percent.

The genotype has intermediate growth habit at the seedling stage, with an average plant height of 90 cm. and has white auricle and light green foliage. Spikes are medium in size with white awns. It matures in 156 days. The grains are amber in colour and hard with medium threshability. It is a high yielding line with an average yield of 47.1 q./ha. Also, it is resistant to brown rust (Table 1).

References

Warham EJ (1986) Karnal bunt disease of wheat-A literature review. *Tropical Pest Management* **32 (3)**: 229-242.

Sharma I, GS Nanda, GS Mahal, and GS Dhindsa (2000) Status of Karnal bunt resistant durum wheats and triticale and their reaction to rusts. *Crop Improvement* **27(1)**: 99-103.

Hill Bunt Immune Line of Wheat (*Triticum aestivum* L.) VL 798 (INGR No. 03007; IC 296431)

Jag Shoran and AK Sharma[1]; Lakshmi Kant, SK Pant and JC Bhatt[2]; SK Rana[3]

1. Directorate of Wheat Research, Karnal-132 001, (Haryana)

2. Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora-263 601, (Uttaranchal)

3. Ch. Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062, (Himachal Pradesh)

VL 798 is a spring wheat genotype possessing immunity for hill bunt disease. It was developed at the Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS), Almora, Uttranchal through application of pedigree selection method on crosses involving CPAN 3004/ CPAN 1922/ PBW 65 as the parents. It has semi-spreading growth habit with an average plant height of 110 cm. with seven effective tillers per plant, 20 spikelets per spike and green coleoptile colour. It takes an average of 172 days to mature. The brown coloured ears produce amber coloured grains with intermediate plumpness and 36 g. 1000-grain weight. The average seed yield per plant is 8.44 g.

In addition, this genetic stock expressed high resistance to brown rust when tested under artificial epiphytotic conditions in All India Coordinated Trials from 1996-97 to 1998-99 with an average coefficient of infection of 3.2. It has been found well adapted to Northern Hill Zone conditions with recommended package of practices.

References

DWR, Progress Report (1999) Vol. V (Crop Protection), pp. 67.

DWR, Progress Report (2000) Vol. V (Crop Protection), pp. 78.

High Grain Weight and Protein Wheat (*Triticum aestivum* L.) Selection 111 *(INGR No. 03008; IC 296469)*

Dalmir Singh

Ex-Principal Scientist, Genetics Division, Indian Agricultural Research Institute, New Delhi-110 012

Selection 111 is a high kernel weight (65-70 g./ 1000-grain weight) genotype of wheat with protein content of 15 to 16 percent on dry seed weight basis. The genotype was isolated from the segregating populations of the crosses involving monosomic 5B of var. Pb. C 591, rust resistant rye and var. Sonalika at the Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi. First monosomic 5B (2n=41) of var. Pb. C 591 was crossed with rust resistant rye (2n=14) and their F_1 hybrids deficient for chromosome 5B (2n=27) were crossed with var. Sonalika (2n=42). In the subsequent generations, selfing and selections were followed, yielding several recombinants, of which Selection 111 was one with high grain weight and protein content. Aneuploid analysis using monosomics of var. Chinese Spring revealed the location of these traits on chromosome 1A (Singh and Joshi, 1987; Singh *et al.*, 1988; Singh, 1984).

The line is slightly taller than var. Sonalika and matures at the same time as that of Sonalika. It possesses bold spike with 21 to 23 spikelets. The grain yield is superior to Sonalika. It has good root system providing tolerance to lodging. In rotation with paddy, it has been observed that Selection 111 can yield 40-45 quintals of grain per hectare.

References

Singh D (1984) Exploitation of chromosome 5B mechanism in transferring desirable traits from rye to bread wheat. Ph. D. Thesis submitted to P.G. School, IARI, New Delhi, 1984.

Singh D and BC Joshi (1987) Aneuploid analysis of seed weight in a wheat-rye recombinant, *Indian J Genet.* **47**: 239-242

Singh D, BC Joshi, HC Bansal, K Batra and R Kumar (1988) Aneuploid analysis for protein content in a wheat-rye recombinant. *Indian J. Genet.* **48**: 49-52.

A New Source of Rust Resistance in Wheat (*Triticum aestivum* L.) Selection 212 *(INGR No. 03009; IC 296470)*

Dalmir Singh

Ex-Principal Scientist, Genetics Division, Indian Agricultural Research Institute, New Delhi-110 012

Selection 212 is a genotype with leaf and stem rust resistance genes present on the same chromosome. Also, it is resistant to all the pathogens of leaf and stem rusts of wheat. It was isolated from the segregating generations of the three way crosses involving monosomic 5B of var. Chinese Spring (2n=41), *Secale cereale* (2n=14) and var. Sonalika (2n=42) at the Division of Genetics, Indian Agriculture Research Institute (IARI), New Delhi. The monosomic 5B of var. Chinese Spring was crossed with a rust resistant mutant of rye and their F_1 hybrids deficient for chromosome 5B (2n-27) were backcrossed with var. Sonalika. In the subsequent generations, selfing and selections were followed, which yielded several recombinants with desirable traits, of which Selection 212 was one of the promising selections for rust resistance. The Selection 212 was tested for rust resistance for several generations at Wellington (Tamil Nadu), a hot spot for rust disease. Aneuploid analysis using monosomics of var. Chinese Spring revealed the location of linked genes for leaf and stem rust resistance on chromosome 2B (Sharma & Sharma, 2001; Singh, 1999).

The genotype has amber coloured grains, long spike with height and maturity similar to var. Sonalika. Its rust resistances are easily transferable.

References

Singh D (1999) Homologous induced resistance from *Secale cereale* to hexaploid wheat and its genetics. Proc. Symp. Crop Improvement for Food Security (eds. R.K. Behl, M.S. Punia and B.P.S. Lather), SSARM Hisar, 1999.

Sharma JB and D Singh (2001) Chromosome location of leaf and stem rust resistance genes in a wheat-rye recombinant line 'Selection-212'. *Indian J. Genet.* **61**: 16-18.

Genic Male Sterile Wheat *(Triticum aestivum* L.) P-mst, Genic Male Sterile *(INGR No. 03010; IC 296479)*

Dalmir Singh

Ex-Principal Scientist, Genetics Division, Indian Agricultural Research Institute, New Delhi-110 012

P-mst genotype is a genic male sterile line with resistance to stem rust. It was isolated from the F_3 progenies derived from cross between Selection 212 (Wheat-rye recombinant possessing resistance to leaf and stem rusts of wheat) and HD 2009 (an Indian rust susceptible wheat). Inheritance studies revealed that the male sterility is being controlled by single recessive gene (Singh 2000, 2001). Aneuploid analysis using monosomics of var. Chinese Spring revealed the location of this gene on chromosome 4A (Singh and Biswas, 2002).

The P-mst genotype is about 110 cm. tall. It possesses long spike with 21 to 23 spikelets. The expression of genic male-sterility is caused due to the conversion of anthers into fully fertile ovaries. Since the phenomenon of anther conversion into ovaries is incomplete, therefore male-sterility is partial, thus it is designated as partial genic male-sterility (P-mst). It produces about 10 percent dented seeds, which are capable of producing male-sterile plants in the next generation. Its vegetative growth is slow resulting in late maturity. It is free from wheat rusts. Its hybrids with var. PBW 343 produced 40 percent higher yield than var. PBW 343.

References

Singh D (2000) Inheritance of novel partial male sterility in hexaploid wheat. Annual Wheat Newsletter. **47**: 74-76.

Singh D (2001) Breeding behaviour and inheritance of genic male-sterility in hexaploid wheat. Wheat Inf. Serv. **49**: 19-21.

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Singh D (1984) Exploitation of chromosome 5B mechanism in transferring desirable traits from rye to bread wheat. Ph. D. Thesis submitted to P.G. School, IARI, New Delhi, 1984.

Singh D and BC Joshi (1987) Aneuploid analysis of seed weight in a wheat-rye recombinant, *Indian J Genet.* **47**: 239-242

Singh D, BC Joshi, HC Bansal, K Batra and R Kumar (1988) Aneuploid analysis for protein content in a wheat-rye recombinant. *Indian J. Genet.* **48**: 49-52.

A New Source of Rust Resistance in Wheat (*Triticum aestivum* L.) Selection 212 *(INGR No. 03009; IC 296470)*

Dalmir Singh

Ex-Principal Scientist, Genetics Division, Indian Agricultural Research Institute, New Delhi-110 012

Selection 212 is a genotype with leaf and stem rust resistance genes present on the same chromosome. Also, it is resistant to all the pathogens of leaf and stem rusts of wheat. It was isolated from the segregating generations of the three way crosses involving monosomic 5B of var. Chinese Spring (2n=41), *Secale cereale* (2n=14) and var. Sonalika (2n=42) at the Division of Genetics, Indian Agriculture Research Institute (IARI), New Delhi. The monosomic 5B of var. Chinese Spring was crossed with a rust resistant mutant of rye and their F_1 hybrids deficient for chromosome 5B (2n-27) were backcrossed with var. Sonalika. In the subsequent generations, selfing and selections were followed, which yielded several recombinants with desirable traits, of which Selection 212 was one of the promising selections for rust resistance. The Selection 212 was tested for rust resistance for several generations at Wellington (Tamil Nadu), a hot spot for rust disease. Aneuploid analysis using monosomics of var. Chinese Spring revealed the location of linked genes for leaf and stem rust resistance on chromosome 2B (Sharma & Sharma, 2001; Singh, 1999).

The genotype has amber coloured grains, long spike with height and maturity similar to var. Sonalika. Its rust resistances are easily transferable.

References

Singh D (1999) Homologous induced resistance from *Secale cereale* to hexaploid wheat and its genetics. Proc. Symp. Crop Improvement for Food Security (eds. R.K. Behl, M.S. Punia and B.P.S. Lather), SSARM Hisar, 1999.

Sharma JB and D Singh (2001) Chromosome location of leaf and stem rust resistance genes in a wheat-rye recombinant line 'Selection-212'. *Indian J. Genet.* **61**: 16-18.

Genic Male Sterile Wheat *(Triticum aestivum* L.) P-mst, Genic Male Sterile *(INGR No. 03010; IC 296479)*

Dalmir Singh

Ex-Principal Scientist, Genetics Division, Indian Agricultural Research Institute, New Delhi-110 012

P-mst genotype is a genic male sterile line with resistance to stem rust. It was isolated from the F_3 progenies derived from cross between Selection 212 (Wheat-rye recombinant possessing resistance to leaf and stem rusts of wheat) and HD 2009 (an Indian rust susceptible wheat). Inheritance studies revealed that the male sterility is being controlled by single recessive gene (Singh 2000, 2001). Aneuploid analysis using monosomics of var. Chinese Spring revealed the location of this gene on chromosome 4A (Singh and Biswas, 2002).

The P-mst genotype is about 110 cm. tall. It possesses long spike with 21 to 23 spikelets. The expression of genic male-sterility is caused due to the conversion of anthers into fully fertile ovaries. Since the phenomenon of anther conversion into ovaries is incomplete, therefore male-sterility is partial, thus it is designated as partial genic male-sterility (P-mst). It produces about 10 percent dented seeds, which are capable of producing male-sterile plants in the next generation. Its vegetative growth is slow resulting in late maturity. It is free from wheat rusts. Its hybrids with var. PBW 343 produced 40 percent higher yield than var. PBW 343.

References

Singh D (2000) Inheritance of novel partial male sterility in hexaploid wheat. Annual Wheat Newsletter. **47**: 74-76.

Singh D (2001) Breeding behaviour and inheritance of genic male-sterility in hexaploid wheat. Wheat Inf. Serv. **49**: 19-21.

Singh D and PK Biswas (2002) Monosomic analysis of genic male-sterility in hexaploid wheat. Wheat Inf. Serv., **95**: 1-3.

Loose Smut Resistant Line of Wheat (*Triticum aestivum* L.) VL 639 *(INGR No. 03011; IC 296480)*

Jag Shoran and AK Sharma[1]; Lakshmi Kant, SK Pant and JC Bhatt[2]

1. Directorate of Wheat Research, P.O. Box 158, Agarsain Road, Karnal-132 001 (Haryana)

2. Department of Plant Breeding and Department of Pathology, Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora-263 601 (Uttaranchal)

VL 639 has high degree of resistance against loose smut of wheat. This material was developed at Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS), Almora. (Uttranchal), through pedigree selection method of breeding on a cross between VL 421 and CPAN 1535.

VL 639 is spring wheat having intermediate growth habit with white glume colour. Its average plant height is 91cm. with an average of four effective tillers per plant and 20 spikelets per spike. It takes an average of 162 days to mature. It has white ears with amber coloured grains having 1000-grain weight of 46 g. The average seed yield per plant is 8 g.

This strain was identified as a resistant genetic stock for loose smut in the All India Co-ordinated Wheat Improvement Programme (AICWIP). Further the resistance was confirmed during 1999-2000 in multiple disease-screening nursery of the AICWIP.

Reference

Directorate of Wheat Research, Progress Report (2001) Vol. V (Crop Protection). pp 64.

Bold Seeded and Protein Rich Durum Wheat (*Triticum durum* Desf.) *Bawaji (INGR No. 03012; IC 296483)*

Sushila Kundu

Directorate of Wheat Research (DWR), Karnal-132 001 (Haryana)

Bawaji is a high protein, bold seeded durum wheat selection from a local landrace, *Bawaji* collected from the farmer's field in southern Uttar Pradesh. The collection was handed over to Directorate of Wheat Research (DWR), Karnal for evaluation and further selections. It was evaluated under the project on Maintenance of Biodiversity in Wheat at DWR, Karnal.

The selection has been identified for its long, bold grain and high protein content. This genotype was evaluated for three years at DWR farms under normal agronomic practices. Table 1a & b summaries the details of its morphological and agronomic features respectively.

Design of experiment was augmented. *Bawaji* is tall type durum wheat that matures in 140-150 days. Stem is medium strong and susceptible to lodging, and yellow and brown rust. It is more adapted to central zone and rainfed conditions.

Table 1a. Morphological data of *Bawaji*

Growth habit	Erect	Growth habit	Erect
Anthocyanin pigmentation of		**Ear characters**	
Auricle	Purple	Ear colour	WhiteEar
Auricle pubescence	Absent	shape	Tapering
Foliage colour (boot stage)	Green	Ear density	Dense
		Ear length	Medium
		Awn colour	Black
Leaf length	Long	Awn length	Long
Leaf breadth	Broad	Outer glume pubescence	Densely pub.
Days to heading	91	Glume shoulder shape	Round
Days to maturity	145	Glume beak	Medium
Waxiness at ear emergence		**Grain characters**	
Leaf blade	Nil	Colour	Amber
Leaf sheath	Present	Texture	Hard
Ear	Nil	Shape	Elliptical
Peduncle	Present	Brush hair length	Long
		Crease	Deep
		Germ width	Medium

Table 1b. Agronomic features of *Bawaji*

Character	1999-2000	2000-01	2001-02	Mean	SE
Days to heading	97.0	96.0	87.0	93.0	0.29
Days to maturity	154	145	145	148	0.36
Height (cm.)	118	125	122	121.6	0.44
Spike length (cm.)	12.0	124	11.6	12.0	0.08
Spikelets no./ spike	20	20	20	20	0.09
No. of seeds/ spike	34	48	34	39	0.57
Protein content (%)	14.71	14.48	14.53	14.57	0.05
Flag leaf length (cm.)	34.5	32.8	36.1	34.5	0.06
Flag leaf breadth (cm.)	2.2	2.32	2.3	2.27	0.11
Thousand grain weight (g.)	72.17	68.04	70.0	70.07	0.29

References

Kundu S, SK Singh, Rajender Pal and Shailesh K Singh (2002) Wheat Germplasm Catalogue-II (Elite Genotypes). Research Bulletin No. 11 pp. 55, Directorate of Wheat Research, Karnal, India.

Loose Smut Resistant Line of Wheat (*Triticum aestivum* L.) VL 639 *(INGR No. 03011; IC 296480)*

Jag Shoran and AK Sharma[1]; Lakshmi Kant, SK Pant and JC Bhatt[2]

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VL 639 is spring wheat having intermediate growth habit with white glume colour. Its average plant height is 91cm. with an average of four effective tillers per plant and 20 spikelets per spike. It takes an average of 162 days to mature. It has white ears with amber coloured grains having 1000-grain weight of 46 g. The average seed yield per plant is 8 g.

This strain was identified as a resistant genetic stock for loose smut in the All India Co-ordinated Wheat Improvement Programme (AICWIP). Further the resistance was confirmed during 1999-2000 in multiple disease-screening nursery of the AICWIP.

Reference

Directorate of Wheat Research, Progress Report (2001) Vol. V (Crop Protection). pp 64.

Bold Seeded and Protein Rich Durum Wheat (*Triticum durum* Desf.) *Bawaji (INGR No. 03012; IC 296483)*

Sushila Kundu

Directorate of Wheat Research (DWR), Karnal-132 001 (Haryana)

Bawaji is a high protein, bold seeded durum wheat selection from a local landrace, *Bawaji* collected from the farmer's field in southern Uttar Pradesh. The collection was handed over to Directorate of Wheat Research (DWR), Karnal for evaluation and further selections. It was evaluated under the project on Maintenance of Biodiversity in Wheat at DWR, Karnal.

The selection has been identified for its long, bold grain and high protein content. This genotype was evaluated for three years at DWR farms under normal agronomic practices. Table 1a & b summaries the details of its morphological and agronomic features respectively.

Design of experiment was augmented. *Bawaji* is tall type durum wheat that matures in 140-150 days. Stem is medium strong and susceptible to lodging, and yellow and brown rust. It is more adapted to central zone and rainfed conditions.

Table 1a. Morphological data of *Bawaji*

Growth habit	Erect	Growth habit	Erect
Anthocyanin pigmentation of		**Ear characters**	
Auricle	Purple	Ear colour	WhiteEar
Auricle pubescence	Absent	shape	Tapering
Foliage colour (boot stage)	Green	Ear density	Dense
		Ear length	Medium
		Awn colour	Black
Leaf length	Long	Awn length	Long
Leaf breadth	Broad	Outer glume pubescence	Densely pub.
Days to heading	91	Glume shoulder shape	Round
Days to maturity	145	Glume beak	Medium
Waxiness at ear emergence		**Grain characters**	
Leaf blade	Nil	Colour	Amber
Leaf sheath	Present	Texture	Hard
Ear	Nil	Shape	Elliptical
Peduncle	Present	Brush hair length	Long
		Crease	Deep
		Germ width	Medium

Table 1b. Agronomic features of *Bawaji*

Character	1999-2000	2000-01	2001-02	Mean	SE
Days to heading	97.0	96.0	87.0	93.0	0.29
Days to maturity	154	145	145	148	0.36
Height (cm.)	118	125	122	121.6	0.44
Spike length (cm.)	12.0	124	11.6	12.0	0.08
Spikelets no./ spike	20	20	20	20	0.09
No. of seeds/ spike	34	48	34	39	0.57
Protein content (%)	14.71	14.48	14.53	14.57	0.05
Flag leaf length (cm.)	34.5	32.8	36.1	34.5	0.06
Flag leaf breadth (cm.)	2.2	2.32	2.3	2.27	0.11
Thousand grain weight (g.)	72.17	68.04	70.0	70.07	0.29

References

Kundu S, SK Singh, Rajender Pal and Shailesh K Singh (2002) Wheat Germplasm Catalogue-II (Elite Genotypes). Research Bulletin No. 11 pp. 55, Directorate of Wheat Research, Karnal, India.

Brown, Black and Yellow Rust Resistant Wheat (*Triticum aestivum* L.) Lines

D Datta, SK Nayar, M Prashar and SC Bhardwaj
Directorate of Wheat Research, Regional Station, Flowerdale-171002, Shimla (Himachal Pradesh)

FLW1 *(INGR No. 03013; IC 296487)*

FLW1 is a line with resistance to brown and black rusts in a new genetic background. Comparative details on its reaction against the three rusts are summarized in Table 1. It was developed through pedigree selection from a cross between UP 2338 and CENTURK at Directorate of Wheat Research, Regional Station, Flowerdale, Shimla. It is a dwarf, awnless, late maturing genotype with non-amber grains and 42 g. 1000-grain weight. Plant type and ear heads are inferior to the check, PBW 343. Similarly, the tillers per meter row and yield per meter row are low as compared to PBW 343.

FLW2 *(INGR No. 03014; IC 296488)*

FLW2 is a line resistant to brown and black rusts and moderately resistant to yellow rust. Comparative details on its reaction against the three rusts are summarized in Table 2. It was developed through pedigree selection from the cross between PBW 343 and Blue Boy II at Directorate of Wheat Research (DWR), Regional Station, Flowerdale, Shimla. It possesses *Lr 24, Lr 26, Sr 24, Sr 31 and Yr 9* genes and an additional resistance factor to yellow rust. It is slightly taller and late maturing than PBW 343 and has non-amber grains with 1000-grain weight of 37 g. Tillers per meter row and yield per meter row are at par with PBW 343.

Table 1. Comparative reaction of FLW1 against Brown, Black and Yellow rust

Genetic Stock/ Parents	Field Data		Seedling Resistance Test			Genes Postulated
		Brown Rust				
	Wellington 01	Karnal 02	77-2	77-5	104 - 2	–
FLW1	R	R	I	I	R	*
UP 2338	50S	30S	I	S	S	*Lr26*
CENTURK	R	–	R	R	R	*
		Black Rust				
	Wellington 01	Karnal 02	122	40-1		–
FLW1	5MR	0	I	MR		*
UP 2338	10MR	0	R	R		*Sr31*
CENTURK	0	0	R	I		–
		Yellow Rust				
	Wellington 01	Karnal 02	P	46S119		–
FLW1	R	15S	S	S		–
UP 2338	R	50S	I	S		*Yr9*
CENTURK	50S	–	S	S		–

* = Gene for resistance not known; R = Resistant; MR = Moderately resistant; S=Susceptible; 0 = Free from rust/no rust response; I= Immune; M = Ascertained with molecular marker; + = Additional resistance factor

Table 2. Comparative reaction of FLW 2 against Brown, Black and Yellow rusts

Genetic Stock/ Parents	Field Data		Seedling Resistance Test			Genes Postulated
		Brown Rust				
	Wellington 01	Karnal 02	77-2	77-5	104-2	
FLW2	Resistant	Resistant	R	R	R	*Lr24, Lr26* (M)
PBW 343	Resistant	15S	I	S	S	*Lr26*
Blue Boy II	Resistant	–	R	R	R	*Lr24*
		Black Rust				
	Wellington 01	Karnal 02	122	40-1		
FLW2	5MR	0	R	MR		*Sr2, Sr24, Sr31* (M)
PBW 343	10MR	0	R	R		*Sr31*
Blue Boy II	40S	–	0	S		*Sr24*
		Yellow Rust				
	Wellington 01	Karnal 02	P	46S119		
FLW2	Resistant	Resistant	R	R		*Yr9 (M)+*
PBW 343	Resistant	Resistant	I	I		*Yr9+*
Blue Boy II	50S	–	S	S		–

Abbreviations similar to Table 1

FLW3 *(INGR No. 03015; IC 296489)*

FLW3 is a line immune to yellow rust and resistant to black rust. Comparative details on its reaction against the three rusts are summarized in Table 3. It was developed through application of pedigree selection method on a cross between UP 2338 and CHINA 84-40022 at DWR, Regional Station, Flowerdale, Shimla. It possesses *Lr 26, Sr 31 and Yr 9* and an additional resistance factor for yellow rust. It is dwarf type with maturity similar to that of PBW 343. The grains are amber coloured with 1000-grain weight of 40 g. Tillers per meter row and yield per meter row are at par with PBW 343.

FLW4 *(INGR No. 03016; IC 296490)*

FLW4 is a line resistant to brown and black rusts in different genetic background. Comparative details on its reaction against the three rusts are summarized in Table 4. It was developed through pedigree selection method on the cross between PBW 343 and ARKAN at Directorate of Wheat Research (DWR), Regional Station, Flowerdale, Shimla. It contains *Lr 24, Lr 26, Sr 2, Sr 24, Sr 31* and *Yr 9* genes. The plant type and ear head are inferior to the check, PBW 343 with short stature, medium maturity and non-amber grains and 1000-grain weight of 33 g. Tillers per meter row and yield per meter row are also low compared to PBW 343.

FLW5 *(INGR No. 03017; IC 296491)*

FLW5 is a line resistant to brown and black rusts in a different genetic background. Comparative details on its reaction against the three rusts are summarized in Table 5. It contains *Lr 24, Lr 26, Sr 2, Sr 24, Sr 31* and *Yr 9* genes. It was developed through pedigree selection from the cross a between UP 2338 and ARKAN at Directorate of Wheat Research (DWR), Regional Station, Flowerdale, Shimla. It is short-statured, late maturing with non-amber grains and 1000 grain-weight

Table 3. Comparative reaction of FLW 3 against Brown, Black and Yellow rusts

Genetic Stock/ Parents	Field Data		Seedling Resistance Test			Genes Postulated
		Brown Rust				
	Wellington 01	Karnal 02	77-2	77-5	104-2	
FLW3	60S	60S	I	S	S	*Lr26* (M)
UP 2338	50S	30S	I	S	S	*Lr26*
China84-40022	60S	–	I	S	S	–
		Black Rust				
	Wellington 01	Karnal 02	122	40-1		
FLW3	15MR	0	R	R		*Sr31*
UP 2338	10MR	0	R	R		*Sr31*
China84-40022	0	–	0	S		–
		Yellow Rust				
	Wellington 01	Karnal 02	P	46S119		
FLW3	R	R	I	I		*Yr9* (M)*
UP 2338	R	50S	I	S		*Yr9*
China84-40022	R	–	I	I		*

Abbreviations similar to Table 1.

Table 4. Comparative reaction of FLW 4 against Brown, Black and Yellow rusts

Genetic Stock/ Parents	Field Data		Seedling Resistance Test			Genes Postulated
		Brown Rust				
	Wellington 01	Karnal 02	77-2	77-5	104 - 2	
FLW4	R	R	I	I	R	*Lr24, Lr26* (M)
PBW 343	R	15S	I	S	S	*Lr26*
ARKAN	R	R	R	R	R	*Lr24*
		Black rust				
	Wellington 01	Karnal 02	122	40-1		
FLW4	5MR	0	I	R		*Sr2, Sr24, Sr31* (M)
PBW 343	10MR	0	R	R		*Sr31*
ARKAN	0	0	R	I		*Sr24+*
		Yellow rust				
	Wellington 01	Karnal 02	P	46S119		
FLW4	R	20S	R	R		*Yr9* (M)
PBW 343	R	R	I	S		*Yr9+*
ARKAN	60S	60S	S	S		–

Abbreviations similar to Table 1.

Table 5. Comparative reaction of FLW 5 against Brown, Black and Yellow rusts

Genetic Stock/ Parents	Field Data		Seedling Resistance Test			Genes Postulated
		Brown rust				
	Wellington 01	Karnal 02	77-2	77-5	104 - 2	
FLW5	R	R	I	R	R	*Lr24, Lr26*
UP 2338	50S	30S	I	S	S	*Lr26*
ARKAN	R	R	R	R	R	*Lr24*
		Black rust				
	Wellington 01	Karnal 02	122	40-1		
FLW5	5MR	0	I	I		*Sr2, Sr24, Sr31+*
UP 2338	10MR	0	R	R		*Sr31*
ARKAN	0	0	R	I		*Sr24+*
		Yellow rust				
	Wellington 01	Karnal 02	P	46S119		
FLW5	R	40S	I	0		*Yr9*
UP 2338	R	50S	I	S		*Yr9*
ARKAN	60S	60S	S	S		-

Abbreviations similar to Table 1.

of 42 g. The number of tillers and yield per meter row are low as compared to PBW 343.

References

Anonymous (2002) Development and evaluation of rust resistant genetic stocks. *Methaensis* **22(3)**: 5-7.

Datta D and SK Nayar (2002) Widening of genetic base for rust resistance in Indian wheats. DWR Progress Report 2001-2002, Germplasm Resources Unit. *Crop Improvement.* **Vol. V**: 39-40.

Cytogenetic Stocks in Wheat Incorporating Genes from Various *Triticum* Species

HS Dhaliwal, Harjit Singh, P Chhuneja and TS Grewal

Department of Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab)

Leaf and Stripe Rust Resistant Substitution Line of Wheat (*Triticum aestivum* L.): PAU wheat *geniculata* 1 *(INGR No. 03018; IC 296432)*

PAU wheat *geniculata* 1 is a cytogenetic stock with 5M-5D substitution, having leaf and stripe rust resistance. It is an interspecific derivative developed at the Punjab Agricultural University, Ludhiana from a cross between *T. aestivum* cv. WL 711, susceptible to leaf as well as stripe rust and accession 3547 of *Aegilops geniculata* (syn. *Aegilops ovata*), a tetraploid non-progenitor species having UUMM genomes with leaf and stripe rust resistance. The F_1 was backcrossed to WL 711, the recurrent parent and was then selfed up to F_9/F_{10} generations. The BC_3F_{10} derivative is a disomic substitution of chromosome 5M of *Aegilops geniculata* for 5D of wheat, which has been confirmed through C-banding and molecular marker analysis (Dhaliwal *et al.*, 2002a). This derivative is resistant to individual pathotypes of leaf rust viz. 12-2, 77-1, 77-2, 77-5, 104-2 and stripe rust viz. 46S102, 46S103 and 46S119 at the seedling stage. This substitution line is completely resistant to both the rusts under natural field conditions (Dhaliwal *et al.*, 2002b). The 5M-5D-substitution line is slightly taller than the recipient parent WL711 with broader spikes and susceptible to lodging. It has partially round shaped, bold amber grains.

References

Dhaliwal HS, P Chhuneja, RK Gill, RK Goel and H Singh (2002) Introgression of disease resistance genes from related species into cultivated wheat through interspecific hybridization. *Crop Improvement* **29**: 1-18

Dhaliwal HS, Harjit Singh and M William (2002b) Transfer of rust resistance from *Aegilops ovata* into bread wheat (*Triticum aestivum* L.) and molecular characterisation of resistant derivatives. *Euphytica* **126:** 153-159.

Leaf Rust, Powdery Mildew and Cereal Cyst Nematode Resistant Substitution Line of Wheat (*Triticum aestivum* L.): PAU wheat *triuncialis* 1 *(INGR No. 03019; IC 296436)*

PAU wheat-*triuncialis* 1 is a cytogenetic stock with 5U-5A substitution incorporating genes conferring resistance to powdery mildew, cereal cyst nematode and slow

Table 5. Comparative reaction of FLW 5 against Brown, Black and Yellow rusts

Genetic Stock/ Parents	Field Data		Seedling Resistance Test			Genes Postulated
		Brown rust				
	Wellington 01	Karnal 02	77-2	77-5	104 - 2	
FLW5	R	R	I	R	R	*Lr24, Lr26*
UP 2338	50S	30S	I	S	S	*Lr26*
ARKAN	R	R	R	R	R	*Lr24*
		Black rust				
	Wellington 01	Karnal 02	122	40-1		
FLW5	5MR	0	I	I		*Sr2, Sr24, Sr31+*
UP 2338	10MR	0	R	R		*Sr31*
ARKAN	0	0	R	I		*Sr24+*
		Yellow rust				
	Wellington 01	Karnal 02	P	46S119		
FLW5	R	40S	I	0		*Yr9*
UP 2338	R	50S	I	S		*Yr9*
ARKAN	60S	60S	S	S		-

Abbreviations similar to Table 1.

of 42 g. The number of tillers and yield per meter row are low as compared to PBW 343.

References

Anonymous (2002) Development and evaluation of rust resistant genetic stocks. *Methaensis* **22(3)**: 5-7.

Datta D and SK Nayar (2002) Widening of genetic base for rust resistance in Indian wheats. DWR Progress Report 2001-2002, Germplasm Resources Unit. *Crop Improvement.* **Vol. V**: 39-40.

Cytogenetic Stocks in Wheat Incorporating Genes from Various *Triticum* Species

HS Dhaliwal, Harjit Singh, P Chhuneja and TS Grewal

Department of Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab)

Leaf and Stripe Rust Resistant Substitution Line of Wheat (*Triticum aestivum* L.): PAU wheat *geniculata* 1 *(INGR No. 03018; IC 296432)*

PAU wheat *geniculata* 1 is a cytogenetic stock with 5M-5D substitution, having leaf and stripe rust resistance. It is an interspecific derivative developed at the Punjab Agricultural University, Ludhiana from a cross between *T. aestivum* cv. WL 711, susceptible to leaf as well as stripe rust and accession 3547 of *Aegilops geniculata* (syn. *Aegilops ovata*), a tetraploid non-progenitor species having UUMM genomes with leaf and stripe rust resistance. The F_1 was backcrossed to WL 711, the recurrent parent and was then selfed up to F_9/F_{10} generations. The BC_3F_{10} derivative is a disomic substitution of chromosome 5M of *Aegilops geniculata* for 5D of wheat, which has been confirmed through C-banding and molecular marker analysis (Dhaliwal *et al.*, 2002a). This derivative is resistant to individual pathotypes of leaf rust viz. 12-2, 77-1, 77-2, 77-5, 104-2 and stripe rust viz. 46S102, 46S103 and 46S119 at the seedling stage. This substitution line is completely resistant to both the rusts under natural field conditions (Dhaliwal *et al.*, 2002b). The 5M-5D-substitution line is slightly taller than the recipient parent WL711 with broader spikes and susceptible to lodging. It has partially round shaped, bold amber grains.

References

Dhaliwal HS, P Chhuneja, RK Gill, RK Goel and H Singh (2002) Introgression of disease resistance genes from related species into cultivated wheat through interspecific hybridization. *Crop Improvement* **29**: 1-18

Dhaliwal HS, Harjit Singh and M William (2002b) Transfer of rust resistance from *Aegilops ovata* into bread wheat (*Triticum aestivum* L.) and molecular characterisation of resistant derivatives. *Euphytica* **126:** 153-159.

Leaf Rust, Powdery Mildew and Cereal Cyst Nematode Resistant Substitution Line of Wheat (*Triticum aestivum* L.): PAU wheat *triuncialis* 1 *(INGR No. 03019; IC 296436)*

PAU wheat-*triuncialis* 1 is a cytogenetic stock with 5U-5A substitution incorporating genes conferring resistance to powdery mildew, cereal cyst nematode and slow

rusting. It is an interspecific derivative developed at the Punjab Agricultural University, Ludhiana from a cross between *T. aestivum* cv. WL 711 (resistant to leaf rust, powdery mildew, Karnal bunt) and accession 3549 of a tetraploid non-progenitor species *Aegilops triuncialis* (UUCC; resistance to cereal cyst nematode). The F_1 was backcrossed to WL 711, the recurrent parent and was then selfed up to F_9/F_{10} generations. This BC_2F_{10} derivative is a disomic substitution of chromosome 5U of *Aegilops triuncialis* for 5A of wheat and has the characteristic spelta head due to the loss of wheat chromosome 5A (Harjit Singh *et al.*, 2000). At the seedling stage it is resistant to individual pathotypes of leaf rust viz. 12-2, 77-1, 77-2, 77-5 and 104-2. This derivative has gene(s) conferring slow rusting for leaf rust (10MS) as compared to 60S in the recipient parent under natural field conditions (Dhaliwal *et al.*, 2002). In addition to leaf rust resistance this substitution line is also resistant to powdery mildew and cereal cyst nematode. The 5U-5A-substitution line is slightly late in maturity as compared to the recipient parent and has longer and lax spikes, difficult to thresh. It has very bold, but soft grains.

References

Harjit Singh, H Tsujimoto, PK Sakhuja, T Singh and HS Dhaliwal (2000) Transfer of resistance to wheat pathogens from *Aegilops triuncialis* into bread wheat. *Wheat Inf. Serv.* **91**: 5-10.

Dhaliwal HS, P Chhuneja, RK Gill, RK Goel and H Singh (2002a) Introgression of disease resistance genes from related species into cultivated wheat through interspecific hybridization. *Crop Improvement* **29**: 1-18.

Leaf Rust and Karnal Bunt Resistant Disomic Addition Line of Wheat (*Triticum aestivum* L.): PAU wheat *triuncialis* 4 *(INGR No. 03020; IC 296439)*

PAU wheat *triuncialis* 4 is cytogenetic stock/addition line of an acrocentric chromosome of *Aegilops triuncialis,* with Karnal bunt and leaf rust resistance. It is an interspecific derivative developed at Punjab Agriculture University, Ludhiana from a cross between *T. aestivum* cv. WL711 (resistant to leaf rust, powdery mildew, Karnal bunt) and accession 3549 of a tetraploid non-progenitor species *Aegilops triuncialis* (UUCC; cereal cyst nematode resistant). The F_1 was backcrossed to WL711, the recurrent parent and was then selfed up to F_9/F_{10} generations. This BC_2F_{10} derivative is an additional line of an acrocentric chromosome from *Aegilops triuncialis* in addition to a translocated chromosome with short arm from *Aegilops triuncialis* (Harjit Singh *et al.*, 2000). This derivative is highly resistant to leaf rust. This genetic stock is also resistant to Karnal bunt (Dhaliwal *et al.*, 2002). This addition line has height and maturity similar to that of recipient parent WL711, but has slightly narrower heads and exhibits a low degree of sterility.

References

Harjit Singh, H Tsujimoto, PK Sakhuja, T Singh and HS Dhaliwal (2000) Transfer of resistance to wheat pathogens from *Aegilops triuncialis* into bread wheat. *Wheat Inf. Serv.* **91**: 5-10.

Dhaliwal HS, P Chhuneja, RK Gill, RK Goel and H Singh (2002a) Introgression of disease resistance genes from related species into cultivated wheat through interspecific hybridization. *Crop Improvement* **29**: 1-18.

Near Isogenic Leaf Rust Resistant Line of Wheat (*Triticum aestivum* L.)

HS Dhaliwal, Harjit Singh, P Chhuneja and TS Grewal
Department of Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab)

PAU HD2329-KLM3b *(INGR No. 03021; IC 296442)*

PAU HD2329-KLM3B is a near isogenic line incorporating leaf rust resistance gene from Kharchia Local mutant-KLM3B in the wheat cv. HD2329. It was developed at the Punjab Agricultural University, Ludhiana through backcrossing with KLM3B, reported to be an induced rust resistant mutant in rust susceptible *T. aestivum* cultivar Kharchia Local developed by Dr RN Sawhney of Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi. Most probably it resulted from an out-crossing with some alien rust resistant stock. During genetic analysis KLM3B was found to be non-allelic to *Lr*9, an alien leaf rust resistant gene (Dhillon, 1999). In crosses with rust susceptible cultivar Lal Bahadur, KLM3B was found to posses monogenic dominant leaf rust resistance. During C-banding analysis, the long arm of chromosome 2B seemed to be involved in alien translocation. This near isogenic line PAU HD2329-KLM3B is totally resistant to leaf rust under natural field conditions. In addition to the leaf rust resistance it is also tolerant to stripe rust under field conditions.

rusting. It is an interspecific derivative developed at the Punjab Agricultural University, Ludhiana from a cross between *T. aestivum* cv. WL 711 (resistant to leaf rust, powdery mildew, Karnal bunt) and accession 3549 of a tetraploid non-progenitor species *Aegilops triuncialis* (UUCC; resistance to cereal cyst nematode). The F_1 was backcrossed to WL 711, the recurrent parent and was then selfed up to F_9/F_{10} generations. This BC_2F_{10} derivative is a disomic substitution of chromosome 5U of *Aegilops triuncialis* for 5A of wheat and has the characteristic spelta head due to the loss of wheat chromosome 5A (Harjit Singh *et al.*, 2000). At the seedling stage it is resistant to individual pathotypes of leaf rust viz. 12-2, 77-1, 77-2, 77-5 and 104-2. This derivative has gene(s) conferring slow rusting for leaf rust (10MS) as compared to 60S in the recipient parent under natural field conditions (Dhaliwal *et al.*, 2002). In addition to leaf rust resistance this substitution line is also resistant to powdery mildew and cereal cyst nematode. The 5U-5A-substitution line is slightly late in maturity as compared to the recipient parent and has longer and lax spikes, difficult to thresh. It has very bold, but soft grains.

References

Harjit Singh, H Tsujimoto, PK Sakhuja, T Singh and HS Dhaliwal (2000) Transfer of resistance to wheat pathogens from *Aegilops triuncialis* into bread wheat. *Wheat Inf. Serv.* **91**: 5-10.

Dhaliwal HS, P Chhuneja, RK Gill, RK Goel and H Singh (2002a) Introgression of disease resistance genes from related species into cultivated wheat through interspecific hybridization. *Crop Improvement* **29**: 1-18.

Leaf Rust and Karnal Bunt Resistant Disomic Addition Line of Wheat (*Triticum aestivum* L.): PAU wheat *triuncialis* 4 *(INGR No. 03020; IC 296439)*

PAU wheat *triuncialis* 4 is cytogenetic stock/addition line of an acrocentric chromosome of *Aegilops triuncialis,* with Karnal bunt and leaf rust resistance. It is an interspecific derivative developed at Punjab Agriculture University, Ludhiana from a cross between *T. aestivum* cv. WL711 (resistant to leaf rust, powdery mildew, Karnal bunt) and accession 3549 of a tetraploid non-progenitor species *Aegilops triuncialis* (UUCC; cereal cyst nematode resistant). The F_1 was backcrossed to WL711, the recurrent parent and was then selfed up to F_9/F_{10} generations. This BC_2F_{10} derivative is an additional line of an acrocentric chromosome from *Aegilops triuncialis* in addition to a translocated chromosome with short arm from *Aegilops triuncialis* (Harjit Singh *et al.*, 2000). This derivative is highly resistant to leaf rust. This genetic stock is also resistant to Karnal bunt (Dhaliwal *et al.*, 2002). This addition line has height and maturity similar to that of recipient parent WL711, but has slightly narrower heads and exhibits a low degree of sterility.

References

Harjit Singh, H Tsujimoto, PK Sakhuja, T Singh and HS Dhaliwal (2000) Transfer of resistance to wheat pathogens from *Aegilops triuncialis* into bread wheat. *Wheat Inf. Serv.* **91**: 5-10.

Dhaliwal HS, P Chhuneja, RK Gill, RK Goel and H Singh (2002a) Introgression of disease resistance genes from related species into cultivated wheat through interspecific hybridization. *Crop Improvement* **29**: 1-18.

Near Isogenic Leaf Rust Resistant Line of Wheat (*Triticum aestivum* L.)

HS Dhaliwal, Harjit Singh, P Chhuneja and TS Grewal
Department of Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab)

PAU HD2329-KLM3b *(INGR No. 03021; IC 296442)*

PAU HD2329-KLM3B is a near isogenic line incorporating leaf rust resistance gene from Kharchia Local mutant-KLM3B in the wheat cv. HD2329. It was developed at the Punjab Agricultural University, Ludhiana through backcrossing with KLM3B, reported to be an induced rust resistant mutant in rust susceptible *T. aestivum* cultivar Kharchia Local developed by Dr RN Sawhney of Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi. Most probably it resulted from an out-crossing with some alien rust resistant stock. During genetic analysis KLM3B was found to be non-allelic to *Lr*9, an alien leaf rust resistant gene (Dhillon, 1999). In crosses with rust susceptible cultivar Lal Bahadur, KLM3B was found to posses monogenic dominant leaf rust resistance. During C-banding analysis, the long arm of chromosome 2B seemed to be involved in alien translocation. This near isogenic line PAU HD2329-KLM3B is totally resistant to leaf rust under natural field conditions. In addition to the leaf rust resistance it is also tolerant to stripe rust under field conditions.

PAU WL711-KLM3B *(INGR No. 03022; IC 296443)*

PAU WL711-KLM3B is a near isogenic line having leaf rust resistance gene from Kharchia Local mutant -KLM3B in the wheat cv. WL711. It was developed at the Punjab Agricultural University, Ludhiana through backcrossing with KLM3B, reported to be an induced rust resistant mutant in rust susceptible *T. aestivum* cultivar Kharchia Local developed by Dr RN Sawhney of Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi. Most probably it resulted from an out-crossing with some alien rust resistant stock. During genetic analysis KLM3B was found to be non-allelic to *Lr*9, an alien leaf rust resistant gene (Dhillon, 1999). In crosses with rust susceptible cultivar Lal Bahadur, KLM3B was found to posses monogenic dominant leaf rust resistance. During C-banding analysis, the long arm of chromosome 2B seemed to be involved in alien translocation. This near isogenic line PAU WL711-KLM3B is totally resistant to leaf rust under natural field conditions and tolerant to stripe rust under field conditions.

References

Dhillon N (1999) Molecular tagging of leaf rust resistance genes in wheat (*Triticum aestivum*) using PCR based markers (M.Sc. dissertation).

Leaf Rust, Stripe Rust and Powdery Mildew Resistant Line of Wheat (*Triticum durum* Desf.) PAU *durum–araraticum* 1 *(INGR No. 03023; IC 296446)*

HS Dhaliwal, Harjit Singh, P Chhuneja and TS Grewal
Department of Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab)

PAU *durum-araraticum* 1 is a leaf rust, adult plant stripe rust (APR) and powdery mildew resistant interspecific derivative. It was developed at the Punjab Agricultural University, Ludhiana from a cross between *T. durum* cv. Malvi Local, susceptible to leaf rust and stripe rust and accession 4692 of *T. araraticum* (AAGG) resistant to leaf rust, stripe rust and powdery mildew. F_1 was backcrossed to Malvi Local, the recurrent parent and then selfed up to F_9/F_{10} generation. BC_2F_{10} derivative had normal chromosome number (2n=28) and regular pairing. This interspecific derivative is resistant to individual pathotypes of leaf rust viz. 12-2, 77-1, 77-2 and 77-5 at the seedling stage, but it is susceptible to stripe rust pathotypes 46S102, 46S103 and 46S119. The genotype is completely resistant to leaf rust, stripe rust and powdery mildew under natural field conditions (Dhaliwal *et al.*, 2002). Therefore, this line seems to possess a gene conferring resistance to powdery mildew in addition to the leaf rust resistance gene, which is effective at seedling and at adult plant stage, and an APR gene for stripe rust resistance. It is taller than Malvi Local and is slightly late in maturity. It has small, amber and vitreous grains.

References

Dhaliwal HS, P Chhuneja, RK Gill, RK Goel and H Singh (2002a) Introgression of disease resistance genes from related species into cultivated wheat through interspecific hybridization. *Crop Improvement* **29**: 1-18.

Leaf and Stripe Rust Resistant Wheat (*Triticum aestivum* L.) PAU wheat *monococcum* 1 *(INGR No. 03047; IC 296440)*

HS Dhaliwal, Harjit Singh, P Chhuneja and TS Grewal
Department of Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab)

PAU wheat *monococcum* 1 is a genetic stock with leaf rust resistance transferred from *T. monococcum.* This interspecific derivative having leaf rust and adult plant stripe rust (APR) resistance was developed at the Punjab Agricultural University, Ludhiana from a cross between an amphiploid (*T. durum* cv. PBW114 x *T. monococcum,* accession 14087) and *T. aestivum* cultivar WL 711. A rust resistant BC_1F_3 progeny was backcrossed to WL 711 and two progenies having leaf rust resistance gene from *T. monococcum* were identified. These rust

PAU WL711-KLM3B *(INGR No. 03022; IC 296443)*

PAU WL711-KLM3B is a near isogenic line having leaf rust resistance gene from Kharchia Local mutant -KLM3B in the wheat cv. WL711. It was developed at the Punjab Agricultural University, Ludhiana through backcrossing with KLM3B, reported to be an induced rust resistant mutant in rust susceptible *T. aestivum* cultivar Kharchia Local developed by Dr RN Sawhney of Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi. Most probably it resulted from an out-crossing with some alien rust resistant stock. During genetic analysis KLM3B was found to be non-allelic to *Lr*9, an alien leaf rust resistant gene (Dhillon, 1999). In crosses with rust susceptible cultivar Lal Bahadur, KLM3B was found to posses monogenic dominant leaf rust resistance. During C-banding analysis, the long arm of chromosome 2B seemed to be involved in alien translocation. This near isogenic line PAU WL711-KLM3B is totally resistant to leaf rust under natural field conditions and tolerant to stripe rust under field conditions.

References

Dhillon N (1999) Molecular tagging of leaf rust resistance genes in wheat (*Triticum aestivum*) using PCR based markers (M.Sc. dissertation).

Leaf Rust, Stripe Rust and Powdery Mildew Resistant Line of Wheat (*Triticum durum* Desf.) PAU *durum–araraticum* 1 *(INGR No. 03023; IC 296446)*

HS Dhaliwal, Harjit Singh, P Chhuneja and TS Grewal
Department of Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab)

PAU *durum-araraticum* 1 is a leaf rust, adult plant stripe rust (APR) and powdery mildew resistant interspecific derivative. It was developed at the Punjab Agricultural University, Ludhiana from a cross between *T. durum* cv. Malvi Local, susceptible to leaf rust and stripe rust and accession 4692 of *T. araraticum* (AAGG) resistant to leaf rust, stripe rust and powdery mildew. F_1 was backcrossed to Malvi Local, the recurrent parent and then selfed up to F_9/F_{10} generation. BC_2F_{10} derivative had normal chromosome number (2n=28) and regular pairing. This interspecific derivative is resistant to individual pathotypes of leaf rust viz. 12-2, 77-1, 77-2 and 77-5 at the seedling stage, but it is susceptible to stripe rust pathotypes 46S102, 46S103 and 46S119. The genotype is completely resistant to leaf rust, stripe rust and powdery mildew under natural field conditions (Dhaliwal *et al.*, 2002). Therefore, this line seems to possess a gene conferring resistance to powdery mildew in addition to the leaf rust resistance gene, which is effective at seedling and at adult plant stage, and an APR gene for stripe rust resistance. It is taller than Malvi Local and is slightly late in maturity. It has small, amber and vitreous grains.

References

Dhaliwal HS, P Chhuneja, RK Gill, RK Goel and H Singh (2002a) Introgression of disease resistance genes from related species into cultivated wheat through interspecific hybridization. *Crop Improvement* **29**: 1-18.

Leaf and Stripe Rust Resistant Wheat (*Triticum aestivum* L.) PAU wheat *monococcum* 1 *(INGR No. 03047; IC 296440)*

HS Dhaliwal, Harjit Singh, P Chhuneja and TS Grewal
Department of Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab)

PAU wheat *monococcum* 1 is a genetic stock with leaf rust resistance transferred from *T. monococcum.* This interspecific derivative having leaf rust and adult plant stripe rust (APR) resistance was developed at the Punjab Agricultural University, Ludhiana from a cross between an amphiploid (*T. durum* cv. PBW114 x *T. monococcum,* accession 14087) and *T. aestivum* cultivar WL 711. A rust resistant BC_1F_3 progeny was backcrossed to WL 711 and two progenies having leaf rust resistance gene from *T. monococcum* were identified. These rust

PAU WL711-KLM3B *(INGR No. 03022; IC 296443)*

PAU WL711-KLM3B is a near isogenic line having leaf rust resistance gene from Kharchia Local mutant -KLM3B in the wheat cv. WL711. It was developed at the Punjab Agricultural University, Ludhiana through backcrossing with KLM3B, reported to be an induced rust resistant mutant in rust susceptible *T. aestivum* cultivar Kharchia Local developed by Dr RN Sawhney of Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi. Most probably it resulted from an out-crossing with some alien rust resistant stock. During genetic analysis KLM3B was found to be non-allelic to *Lr*9, an alien leaf rust resistant gene (Dhillon, 1999). In crosses with rust susceptible cultivar Lal Bahadur, KLM3B was found to posses monogenic dominant leaf rust resistance. During C-banding analysis, the long arm of chromosome 2B seemed to be involved in alien translocation. This near isogenic line PAU WL711-KLM3B is totally resistant to leaf rust under natural field conditions and tolerant to stripe rust under field conditions.

References

Dhillon N (1999) Molecular tagging of leaf rust resistance genes in wheat (*Triticum aestivum*) using PCR based markers (M.Sc. dissertation).

Leaf Rust, Stripe Rust and Powdery Mildew Resistant Line of Wheat (*Triticum durum* Desf.) PAU *durum–araraticum* 1 *(INGR No. 03023; IC 296446)*

HS Dhaliwal, Harjit Singh, P Chhuneja and TS Grewal
Department of Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab)

PAU *durum-araraticum* 1 is a leaf rust, adult plant stripe rust (APR) and powdery mildew resistant interspecific derivative. It was developed at the Punjab Agricultural University, Ludhiana from a cross between *T. durum* cv. Malvi Local, susceptible to leaf rust and stripe rust and accession 4692 of *T. araraticum* (AAGG) resistant to leaf rust, stripe rust and powdery mildew. F_1 was backcrossed to Malvi Local, the recurrent parent and then selfed up to F_9/F_{10} generation. BC_2F_{10} derivative had normal chromosome number (2n=28) and regular pairing. This interspecific derivative is resistant to individual pathotypes of leaf rust viz. 12-2, 77-1, 77-2 and 77-5 at the seedling stage, but it is susceptible to stripe rust pathotypes 46S102, 46S103 and 46S119. The genotype is completely resistant to leaf rust, stripe rust and powdery mildew under natural field conditions (Dhaliwal *et al.*, 2002). Therefore, this line seems to possess a gene conferring resistance to powdery mildew in addition to the leaf rust resistance gene, which is effective at seedling and at adult plant stage, and an APR gene for stripe rust resistance. It is taller than Malvi Local and is slightly late in maturity. It has small, amber and vitreous grains.

References

Dhaliwal HS, P Chhuneja, RK Gill, RK Goel and H Singh (2002a) Introgression of disease resistance genes from related species into cultivated wheat through interspecific hybridization. *Crop Improvement* **29**: 1-18.

Leaf and Stripe Rust Resistant Wheat (*Triticum aestivum* L.) PAU wheat *monococcum* 1 *(INGR No. 03047; IC 296440)*

HS Dhaliwal, Harjit Singh, P Chhuneja and TS Grewal
Department of Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab)

PAU wheat *monococcum* 1 is a genetic stock with leaf rust resistance transferred from *T. monococcum.* This interspecific derivative having leaf rust and adult plant stripe rust (APR) resistance was developed at the Punjab Agricultural University, Ludhiana from a cross between an amphiploid (*T. durum* cv. PBW114 x *T. monococcum,* accession 14087) and *T. aestivum* cultivar WL 711. A rust resistant BC_1F_3 progeny was backcrossed to WL 711 and two progenies having leaf rust resistance gene from *T. monococcum* were identified. These rust

resistant progenies have normal chromosome number (2n = 42) and pairing (Dhaliwal *et al.*, 2002). The progenies are resistant to the leaf rust pathotype 77-5 at the seedling stage and are completely resistant to leaf rust in the field conditions. Genetic analysis in crosses with rust susceptible cultivar indicated that a single dominant gene controls the leaf rust resistance. In addition to leaf rust resistance, one of these lines also has an APR gene conferring stripe rust resistance. Molecular analysis indicated that the *monococcum* gene for leaf rust resistance transferred to the wheat chromosome 1A is linked to SSR marker Xgwm136 (Vasu *et al.*, 2001). This derivative has a plant type similar to that of WL711.

References

Dhaliwal HS, P Chhuneja, RK Gill, RK Goel and H Singh (2002a) Introgression of disease resistance genes from related species into cultivated wheat through interspecific hybridization. *Crop Improvement* **29**: 1-18.

Lines Incorporating High Molecular Weight Glutenin Subunits from Different *Triticum* spp. into Durum Wheat (*Triticum durum* Desf.)

HS Dhaliwal, Harjit Singh, P Chhuneja and TS Grewal
Department of Genetics and Biotechnology, Punjab Agricultural University, Ludhiana-141 004 (Punjab)

PAU HMW *GLU-A1-1* (INGR No. 03024; IC 296452)

PAU HMW *Glu-A1-1* is a genetic stock having high molecular weight (HMW) glutenin subunits with high SDS sedimentation value transferred from *Triticum boeoticum* into durum wheat *Triticum durum*. It was developed at the Punjab Agricultural University, Ludhiana from a cross between *T. durum* cv. PBW 34 and *T. boeoticum* acc. 4873 (A^bA^b). The F_1 was backcrossed to PBW 34, the recurrent parent. The transfer of HMW glutenin subunits coded by *Glu-A1* locus from *T. boeoticum* to *T. durum* was validated by SDS-PAGE of half seed. The donor *T. boeoticum* acc. 4873 had a HMW glutenin 1Ax subunit of low mobility and a series of less prominent subunit (bands) of faster mobility including one dominant band of Ay subunit. The mobility of HMW glutenin subunit coded by *Glu-A1x* allele was between 1Ax1 and 1Dx2 glutenin subunits of bread wheat. The Ay subunit had mobility intermediate between those of 1Bx7 and 1By8 of bread wheat. These two subunits coded by *Glu-A1* locus have been transferred in this interspecific derivative. With the transfer of these subunits the SDS micro-sedimentation value of the derivative has increased by 51 percent over and above the recurrent *T. durum* cv. PBW 34 (Dhaliwal *et al.*, 2002; Randhawa *et al.*, 1995, 1997).

PAU HMW *GLU-A1-7 (INGR No. 03025; IC 296458)*

PAU HMW *Glu-A1-7* is a genetic stock having high molecular weight (HMW) glutenin subunits with high SDS sedimentation value transferred from *Triticum urartu*. It has been developed at the Punjab Agricultural University, Ludhiana from a cross between *T. durum* cv. PBW 34 and *T. urartu* acc. 5340 (AA). The F_1 was backcrossed to PBW 34, used as the recurrent parent. The transfer of HMW glutenin subunits coded by *Glu-A1* locus from *T. urartu* to *T. durum* was confirmed by SDS-PAGE of half seed. The donor *T. urartu* acc. 5340 had two HMW glutenin subunits Ax and Ay. The mobility of HMW glutenin subunit coded by *Glu-A1x* allele was between 1Ax1 and 1Dx2 glutenin subunits of bread wheat. The Ay subunit had faster mobility than the 1Dy12 of bread wheat. These two subunits coded by *Glu-A1* locus have been transferred in this interspecific derivative. With the transfer of these subunits SDS micro-sedimentation value of the derivative has increased by 46 per cent over and above the recurrent parent *T. durum* cv. PBW 34 (Dhaliwal *et al.*, 2002; Randhawa *et al.*, 1995, 1997).

PAU HMW *GLU-A1-8 (INGR No. 03026; IC 296459)*

PAU HMW *Glu-A1-8* is a genetic stock having high molecular weight (HMW) glutenin subunits with high SDS sedimentation value transferred from *Triticum dicoccoides*. It has been developed at the Punjab Agricultural University, Ludhiana from a cross between *T. durum* cv. PBW 34 and *T. dicoccoides* acc. 4632 (AABB). The F_1 was backcrossed to PBW34, used as the recurrent parent and selfed upto BC_2F_6. The transfer of HMW glutenin subunits coded by *GluA1* locus from *T. dicoccoides* to *T. durum* was validated by SDS-PAGE of half seed. The mobility of Ax subunit of donor *T. dicoccoides* acc. 4632 was similar to 1Ax1 glutenin

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subunit of bread wheat and that of Ay is between subunit 1Ax1 and 1Ax2 of bread wheat. These two subunits coded by *Glu-A1* locus have been transferred from *T. dicoccoides* in this interspecific derivative. With the transfer of these subunits SDS micro-sedimentation value of the derivative has increased by 38 percent over and above the recurrent *T. durum* cv. PBW 34 (Dhaliwal *et al.*, 2002; Randhawa *et al.*, 1995, 1997).

PAU HMW *GLU-A1-15 (INGR No. 03027; IC 296466)*

PAU HMW *Glu-A1-15* is a genetic stock having high molecular weight (HMW) glutenin subunits with high SDS sedimentation value transferred from *Triticum araraticum*. It has been developed at the Punjab Agricultural University, Ludhiana from a cross between *T. durum* cv. PBW 34 and *T. araraticum* acc. 4724 (AAGG). The F_1 was backcrossed to PBW 34, used as the recurrent parent and selfed upto BC_2F_6. The transfer of HMW glutenin subunits coded by *Glu-A1* locus from *T. araraticum* to *T. durum* was confirmed by SDS-PAGE of half seed. The donor *T. araraticum* acc. 4724 had a HMW glutenin Ax subunit of mobility slower than 1Ax1 of bread wheat, whereas Gx had mobility between 1Ax1 and 1Dx2. and mobility of Ay and Gy was between 1Dx5 and 1Bx7. One or two subunits coded by *Glu-A1* locus have been transferred in this interspecific derivative. With the transfer of these subunits SDS microsedimentation value of the derivative has increased by 20 percent over and above the recurrent *T. durum* cv. PBW 34 (Dhaliwal *et al.*, 2002; Randhawa *et al.*, 1995, 1997).

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Genetic Stock in Wheat (*Triticum aestivum* L.) with Superior Yield Components Giant 3 *(INGR No. 03028; IC 296529)*

NVPR Ganga Rao, V Mahajan, S Nagarajan and Jag Shoran
Directorate of Wheat Research, Karnal-132 001 (Haryana)

Giant 3 is a genetic stock with long spike (15 cm) having high grain number per spike (97), more spikelets per spike (22), and extended grain filling period (51 days). It was developed at the Directorate of Wheat Research, Karnal under pre-breeding programme, using Buitre (long spike) and the best released variety PBW 343 (Rao *et al.*, 2002). PBW 343 pedigree is K134 (60) /VEE/BOW/PVN/PBW343 (PHR98K42-0L-10K0L10K-0L-2K-0L-35K-0L-0K).The desirable characters present in long spike Buitre material were high biomass, more spikelets and grains per spike. The associated negative traits, such as shriveled grains and susceptibility to rusts have restricted their direct use in breeding programmes/cultivation. Production of Giant 3 is an effort towards introgression of desirable traits from long spiked Buitre germplasm into high yielding adapted genetic background. As a breeding methodology, a low selection pressure was applied in early generations to allow progress of more recombinants to subsequent generations and high selection pressure in later generations following pedigree method for selecting desirable recombinants.

Giant 3 possesses dark green broad leaves producing high biomass and is resistant to brown and yellow rust at adult plant stage. Seedling reaction studies also showed resistance to black, brown and yellow rusts (Rao *et al.*, 2003). This genetic stock has acceptable plant height (90 cm.), days to 50 percent heading and days to physiological maturity. Therefore, it is very much suited to breeding programmes for production of genotypes with superior yield components. The high grain number coupled with medium bold grains (1000-grain weight, 44 g as against 41g in the check PBW 343) indicates an increase in grain number without reducing the grain weight (Table 1). The grain colour of the Giant 3 is amber like check PBW 343.

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Table 1. Salient Characteristics on Genetic Stock

Genotype	Key Characters				Other Characters		
	Grains/ Spike	Spikelets/ Spike	Spike length (cm)	Grain filling period (days)	1000- Grain weight (g)	Protein (%)	Sedimentation value (ml.)
GIANT 3	97	22	15	51	44	11.7	38
PBW 343 (Check)	61	19	10	40	41	11.7	36
Improvement (%) over the best check	59.0	15.8	50.0	27.5	–	–	–

References

Rao NVPR, Mahajan V, Shoran J and Gupta RK (2002) Genetic stocks developed through pre-breeding approach in hybrid wheat programme. *Indian Wheat Newsletter* **8**: 4-5.

New CMS Lines of Paddy (*Oryza sativa* L.)

BC Viraktamath, M Ilyas Ahmed, Sukhpal Singh, MS Ramesha and CHM Vijayakumar
Directorate of Rice Research (DR), Rajendranagar, Hyderabad-500030 (Andhra Pradesh)

Hitherto, the CMS lines introduced from IRRI were being used in the national hybrid rice-breeding programme. Since the most commonly used CMS line viz., IR 58025A has some defects, there is a need for developing indigenous CMS lines. The efforts in this direction have lead to development of following CMS lines.

DRR-2A *(INGR No. 03029; IC 296532)*

DRR-2A is a new cytoplasmic male sterile line involving widely used WA source of male sterility. It was developed at the Directorate of Rice Research, Hyderabad by backcross involving V20A, a Chinese CMS line with WA source of male sterility as female parent and a breeding line, RNR 18953 as male parent. Being non-aromatic, it can be used to develop hybrids without aroma, which otherwise is a major problem in many of the presently available hybrids, where CMS line with aroma has been used. This CMS line is early, flowers between 85-90 days and matures between 110-115 days. It has medium slender grains without any stickiness.

It has good combining ability and requires lower doses (30-35 g./ha.) of GA_3 in hybrid seed production. This characteristic can help to develop hybrids with better grain quality (high milling recovery without aroma) and at lower seed production cost.

DRR-3A *(INGR No. 03030; IC 296533)*

DRR-3A is another cytoplasmic male sterile line involving widely used WA source of male sterility. It was developed at the Directorate of Rice Research, Hyderabad through backcross, involving V20A, a Chinese CMS with WA source of male sterility as female parent and a breeding line, IET 9792 as male parent. This is a new plant type with long bold grains and strong culm with few tillers. Therefore, it would be a suitable plant type to breed indica-tropical-japonica hybrids with super high yield. Besides, it is also non-aromatic, early duration type flowering between 90-95 days and maturing between 115-120 days.

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Viraktamath BC, M Ilyas Ahmed, MS Ramesha and S Singh (2002) Developing and evaluating CMS lines in India for their usability. Abstracts presented to 4th International Symposium on Hybrid Rice held at Hanoi, Vietnam during May 14-17, 2002.

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Early Type Chickpea (*Cicer arietinum* L.) Mutant, H-82-2(M) (*INGR No. 03031; IC 296430*)

VS Lather and RS Waldia
Pulse Section, Department of Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar-125004 (Haryana)

H-82-2 (M) is a fast early vigour, early flowering and early maturing mutant with long internodal length. It is a spontaneous mutant of chickpea isolated from population of cultivar H-82-2 at the Chaudhary Charan Singh Haryana Agricultural University, Hisar during 1993-94 post-rainy season. The progenies of this mutant were studied for true breeding and morpho-physiological characters. The mutant showed consistent fast early growth (shoot length 13.41 cm. compared to 6.52 cm. for H-82-2), long internodal distance 3.38 cm (15 days seedling) and earliness in flowering, pod initiation and maturity. The details of morpho-agronomic features of this mutant are summarized in Table 1. In chickpea early growth and vigour is important for providing increased biomass. This line can be used to generate desirable variability for early fast growth, which will allow chickpea cultivars to compete with weeds at early stage and escape *Fusarium* wilt attack, particularly in irrigated and late sown areas of northern India.

Table 1.Characteristic of chickpea mutant H-82-2(M) and parent line H-82-2

Character	H-82-2(M)	H-82-2
15 days seedling		
Shoot length (cm.)	13.41±0.34	6.52±0.23
Root length (cm.)	6.52±0.31	4.29±0.19
Internodal distance (cm.)	3.38±0.23	1.20±0.11
At maturity		
Plant height (cm.)	63.36±0.82	56.78±0.72
Primary branches	2.80±0.41	2.40±0.43
Secondary branches	7.60±0.62	8.80±0.63
Internodal distance (cm.)	5.88±0.59	3.06±0.44
Days to flowering	62.0±0.51	71.00±0.46
Days to pod initiation	75.00±0.50	101.00±0.57
Days to maturity	129.00±0.55	146.00±0.58
Total pods/ plant	41.50±0.84	52.80±0.99
Seeds/ pod	1.36	1.46
100-seed weight (g.)	15.56	15.30
Seed colour	Creamish brown	Creamish brown
Seed yield/ plant (g.)	10.82	12.50

Reference

Lather VS, RS Waldia and IS Mehta (1997) *International Chickpea Newsletter* **Vol 4**: pp 11

Serpentine Leafminer Resistant Castor (*Ricinus communis* L.) RG 1930 (*INGR No. 03032; IC 296922*)

K Anjani
Directorate of Oilseeds Research, Rajendranagar, Hyderabad-500030 (Andhra Pradesh)

RG 1930 is a unique genetic stock possessing durable resistance to serpentine leafminer (*Liriomyza trifolii*). This pathogen is reportedly resistant to most insecticides, therefore host-plant resistance is the only solution for its effective control. This genetic stock was collected from Assam (Anjani *et al.*, 1994) and was identified as a source of resistance to leafminer at the Directorate of Oilseeds Research, Hyderabad based on visual observations of infested leaves per plant and larval mines per plant from cotyledonary leaf stage to maturity in the field from 1994 to 2000. The number of leaves infested per plant was zero and the larval mines per plant ranged from 0-5. The biochemical studies revealed presence of high total phenols (mg./g. leaf) (36.9) in RG 1930 compared to the susceptible checks Aruna (12.6) and Sowbhagya (11.1), 48-1 (13.8) and DCS-9 (12.8) (Prasad and Anjani, 2001).

RG 1930 is a purple colour morphotype, where entire plant including stem, branches, leaves and spikes are purple in colour. This rare morphotype is localized to northeastern states.

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VS Lather and RS Waldia
Pulse Section, Department of Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University, Hisar-125004 (Haryana)

H-82-2 (M) is a fast early vigour, early flowering and early maturing mutant with long internodal length. It is a spontaneous mutant of chickpea isolated from population of cultivar H-82-2 at the Chaudhary Charan Singh Haryana Agricultural University, Hisar during 1993-94 post-rainy season. The progenies of this mutant were studied for true breeding and morpho-physiological characters. The mutant showed consistent fast early growth (shoot length 13.41 cm. compared to 6.52 cm. for H-82-2), long internodal distance 3.38 cm (15 days seedling) and earliness in flowering, pod initiation and maturity. The details of morpho-agronomic features of this mutant are summarized in Table 1. In chickpea early growth and vigour is important for providing increased biomass. This line can be used to generate desirable variability for early fast growth, which will allow chickpea cultivars to compete with weeds at early stage and escape *Fusarium* wilt attack, particularly in irrigated and late sown areas of northern India.

Table 1.Characteristic of chickpea mutant H-82-2(M) and parent line H-82-2

Character	H-82-2(M)	H-82-2
15 days seedling		
Shoot length (cm.)	13.41±0.34	6.52±0.23
Root length (cm.)	6.52±0.31	4.29±0.19
Internodal distance (cm.)	3.38±0.23	1.20±0.11
At maturity		
Plant height (cm.)	63.36±0.82	56.78±0.72
Primary branches	2.80±0.41	2.40±0.43
Secondary branches	7.60±0.62	8.80±0.63
Internodal distance (cm.)	5.88±0.59	3.06±0.44
Days to flowering	62.0±0.51	71.00±0.46
Days to pod initiation	75.00±0.50	101.00±0.57
Days to maturity	129.00±0.55	146.00±0.58
Total pods/ plant	41.50±0.84	52.80±0.99
Seeds/ pod	1.36	1.46
100-seed weight (g.)	15.56	15.30
Seed colour	Creamish brown	Creamish brown
Seed yield/ plant (g.)	10.82	12.50

Reference

Lather VS, RS Waldia and IS Mehta (1997) *International Chickpea Newsletter* **Vol 4**: pp 11

Serpentine Leafminer Resistant Castor (*Ricinus communis* L.) RG 1930 (*INGR No. 03032; IC 296922*)

K Anjani
Directorate of Oilseeds Research, Rajendranagar, Hyderabad-500030 (Andhra Pradesh)

RG 1930 is a unique genetic stock possessing durable resistance to serpentine leafminer (*Liriomyza trifolii*). This pathogen is reportedly resistant to most insecticides, therefore host-plant resistance is the only solution for its effective control. This genetic stock was collected from Assam (Anjani *et al.*, 1994) and was identified as a source of resistance to leafminer at the Directorate of Oilseeds Research, Hyderabad based on visual observations of infested leaves per plant and larval mines per plant from cotyledonary leaf stage to maturity in the field from 1994 to 2000. The number of leaves infested per plant was zero and the larval mines per plant ranged from 0-5. The biochemical studies revealed presence of high total phenols (mg./g. leaf) (36.9) in RG 1930 compared to the susceptible checks Aruna (12.6) and Sowbhagya (11.1), 48-1 (13.8) and DCS-9 (12.8) (Prasad and Anjani, 2001).

RG 1930 is a purple colour morphotype, where entire plant including stem, branches, leaves and spikes are purple in colour. This rare morphotype is localized to northeastern states.

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Low Glucosinolate and Low Erucic Acid Mustard (*Brassica juncea* L.) HEERA *(INGR No. 03033; IC 296501)*

AS Khalatkar
Botany Department, Nagpur University, Nagpur and Dhara Vegetable Oil & Food Co. Ltd., Vadodara-390023 (Gujarat)

Heera is a genetic stock with low glucosinolate content (16.96 m moles/ g. of seed) and low erucic acid in oil (0.12 %). It was developed through pedigree breeding method from a cross between exotic material ZYR-4 and BJ 1058 by late Dr. AS Kalatkar at the Department of Botany, Nagpur University, Nagpur during 1995. The project on development of '00' lines was supported by the Dhara Vegetable Oil & Foods Company Ltd. (DOFCO), Vadodara, a wholly owned subsidiary of the National Dairy Development Board (NDDB), Anand.

This genetic stock possesses plants, which are tall and late in maturity compared to the Indian mustard varieties viz. Pusa Bold and Varuna. It is yellow seeded and has a small seed size (about 2.67 g. per 1000-seed) with low oil content (33±2%). Also, it is resistant to the white rust disease.

NUDH-YJ-5 *(INGR No. 03034; IC 296507)*

YY Barve, SS Bhadauria and RK Gupta
Botany Department, Nagpur University, Nagpur and Dhara Vegetable Oil & Foods Co. Ltd., Vadodara-390023 (Gujarat)

NUDH-YJ-5 is a genetic stock of Indian mustard with low glucosinolate content (9.3 m moles/g. of seed) and low erucic acid (0.14%) content, classified into '00' types. It was developed from a cross between NU6 (a selection from Pusa Bold x Heera, with about 40 m moles /g of defatted meal and over 45% erucic acid in oil) and EH-1 (EMS induced dwarf, early mutant of Heera) at the Department of Botany, Nagpur University, Nagpur under the project funded by Dhara Vegetable Oil & Foods Company Ltd. (DOFCO), Vadodara during the year 2000.

NUDH–YJ-5 has medium height, early maturity (100 days) and yellow seed with oil content of 37±2.5 percent. It is comparable in yield (1809 kg./ha.) to local check GM-1 (1855 kg./ha.) and Varuna (2103 kg./ha.) over locations and years. Also, it is resistant to white rust disease.

Seedless and Long Duration Fruiting Pointed Gourd, (*Trichosanthes dioica* Roxb.) IIVRPG-105 *(INGR No. 03035; IC 296492)*

D Ram, G Kalloo, MK Banerjee and Billu Singh
Indian Institute of Vegetable Research, 1, Gandhi Nagar (Naria) P. Box No. 5002, P.O. B.H.U. Varanasi-221005 (Uttar Pradesh)

Pointed gourd is a vegetatively propagated dioecious perennial vine belonging to family Cucurbitaceae. Due to its nutritional and medicinal qualities such as diuretic, laxative and cardio-tonic effects it is a preferred vegetable. Also, it invigorates the heart and brain to improve the disorders of the circulatory system. Its seeds are hard and therefore, seedless fruit are in demand. Parthenocarpy in development of seedless fruit is an established mechanism observed in many species including Cucurbitaceous species, e.g. *Cucumis sativus* L. (Sturtevant, 1890; Tatlioglu, 1992). Also, in other vegetables (Gustfson, 1941; Mori, 1947; Takashima and Hatta, 1995) plant growth regulators based induced parthenocarpy has been reported. Seedless fruits

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also provide possibility to fruiting round the year by which growers can get more price of their produce in the market in off-season.

IIVRPG-105 is an obligate parthenocarpic long duration fruiting genetic stock with seedless fruits. It was selected through screening of a total of 220 diverse genotypes/local landraces for parthenocarpy at Indian Institute of Vegetable Research, Varanasi. In each line fully mature female buds (mature but not open) were covered by butter paper envelops and tightened with thin wire to prevent cross pollination through insects, for identification of lines setting parthenocarpic fruits (Durham, 1985). Fruit setting was critically observed and the lines setting fruits despite begging were isolated. Fully immature fruits of edible stage were bisected and observed for seed development. Fruit of the selected line were found free from seeds not only at edible stage but also at mature stage. In second test, the isolated line was closely planted with male and female plant at regular intervals. Despite this it was observed that the identified line produced fruits devoid of seeds. In the third test collected pollens were applied on the stigma of open female flowers and covered with butter paper envelopes to avoid out-crossing. Even after this treatment the line produced seedless fruits confirming the parthenocarpic nature. The fruit characteristics of this line in comparison to the local checks are summarized in Table 1.

Morphologically, this line has medium sized (10-15 cm.) orbicular and un-lobed leaves with rough surface and light green colour. Plants attain a height of more than three meters. Fruiting starts at 7th node and continues up to full plant growth stage. Fruits are medium in size, light green, striped, elliptical in shape and pointed. The flesh of the fruit is light whitish. Length of fruit ranges between 4.81-5.21 cm. Shelf life of fruits is up to 10 days, six day more than the other seeded varieties. Close planting is recommended on bower system for growth and better management.

Table 1. Performance of parthenocarpic lines of pointed gourd

Lines	Fruits/ plant	Fruit length (cm)	Fruit diameter (cm)	Individual fruit (g)	Yield/ plant (kg)
IIVRPG-105	**135**	**4.39**	**2.85**	**20.7**	**2.28**
IIVRPG-01	42	4.20	2.43	17.8	0.748
IIVRPG-06	19	4.98	3.19	22.3	0.424
IIVRPG-10	200	6.14	2.68	25.2	5.040
IIVRPG-137	78	7.41	2.16	28.7	2.239

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Root-knot Nematodes Resistant Tomato, (*Lycopersicon esculentum* Mill.), Hisar Lalit (NT-8) *(INGR No. 03036; IC 296468)*

RK Jain[1], RD Bhutani[3], G Kalloo[2], DS Bhatti[1] and Kirti Singh[3]

1. Department of Nematology, CCS Haryana Agricultural University, Hisar-125 004 (Haryana)

2. Deputy Director General (Horticulture) ICAR, KAB-II, Pusa Gate, IARI, New Delhi-110 012

3. Department of Vegetable Science, CCS Haryana Agricultural University, Hisar-125 004 (Haryana)

Hisar Lalit is a genetic stock with high resistance to root knot nematodes (*Meloidogyne javanica* and *Meloidogyne incognita*). This genotype was developed through hybridization between a released tomato variety HS-101 (susceptible, but high yielding) as recurrent parent and Resistant Bangalore (R 2) as donor parent at the Department of Vegetable Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar. Backcross pedigree method followed by simple selection was used for its development with cultivation of segregating populations in nematode infested soils for selection of resistant genotypes.

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Table 1. Description of parents and Hisar Lalit (NT-8) tomatoes

Character	Resistant Bangalore(Resistant)	HS-101(Susceptible)	Hisar Lalit(NT-8)
Plant habit	56.8 cm, semi-determinate, late	43.7 cm, determinate dwarf, early	48.7 cm, semi-determinate, early
Fruits per plant	8.5	20.6	22.5
Fruit weight (g.)	60.5	34.4	53.3
Yield potential	Poor yielder	High yielder	High yielder
Fruit colour	Red	Red	Deep red
Fruit shape	Round	Round	Round
Days to first picking	80 days	65-70 days	65-70 days
Root-knot index	–	4.5	1.0
Resistance reaction	Resistant	Susceptible	Resistant

The plants of this genetic stock are semi-determinate with stem being hairy and brittle at early stage and woody at maturity (Table 1). There is synchronization in flowering and fruiting. There was 51 to 79 percent reduction in the population of *Meloidogyne javanica* where this genetic stock was grown compared to increase in pest population from 29 to 105 percent in plots with HS-101 a susceptible genotype. Its root-knot index (resistance index) was 1.0 compared to 4.5-5.0 of HS-101. It is a high yielding genotype producing medium size, round red attractive fruits with average production of 200-250 q./ ha., 116 percent higher than check under multi-location trials.

The resistance to *Meloidogyne javanica and M. incognita* was confirmed under the All India Coordinated Research Trials on Plant Parasitic Nematodes at Anand (Gujarat). For cultivation, planting on raised beds is recommended at a seed rate of 500-600 g. of seed per hectare. This genotype is best suited for nematode infested soils of Haryana, Gujarat and adjoining areas under irrigated condition.

Gynoecious Line of Bitter Gourd, (*Momordica charantia* L.) Gy-63 *(INGR No. 03037; IC 296539)*

D Ram, G Kalloo and Billu Singh
Indian Institute of Vegetable Research, 1, Gandhi Nagar (Naria) Post Box No. 5002, P.O. B.H.U. Varanasi-221 005 (Uttar Pradesh)

Bitter gourd (*Momordica charantia*) is a monoecious cucurbit, known for its nutritional, medicinal and curative properties. Commercial hybrid seed production in this crop is being carried out by pinching the staminate flower buds in the monoecious line followed by hand pollination or insect pollination. Gynoecious flowering habit (sex form) has been commercially exploited in cucurbits like cucumber (*Cucumis sativus* L.) for hybrid seed production (Kalloo, 1988). Occurrence of gynoecious lines (pistillate line) in bitter gourd is very rare, though Zhou *et al.*, (1998) reported its utilization in hybrid seed production.

Gy-63 is a gynoecious genetic stock with high yield and attractive fruits. It was identified at Indian Institute of Vegetable Research, Varanasi through screening of germplasm (259 lines) during summer. Three gynoecious plants designated as Gy-35, Gy-63 and Gy-263B, were identified in three populations, viz. VRBT-35, VRBT-63 and IC-68263B respectively. Attempts were made to cross each gynoecious plant with (i) monoecious plant of the same population (sister plant) or (ii) monoecious plant of other population and (iii) gynoecious plant producing staminate flower. F_1 plants were examined for the presence or absence of pistillate and staminate flowers. Simultaneously, three independent gynoecious plants and progenies of five crosses were also examined for the possible involvement of genetic and environmental factors in the expression of gynoecious flowering habit. Two gynoecious plants (Gy-35 and Gy-63) did not produce staminate flower till their physiological maturity, but Gy-263B produced few staminate flowers at later stages. Thus gynoecious expression in Gy-263B was unstable. Expression of few staminate flowers is advantageous for the maintenance of truly gynoecious plants through selfing. Gynoecious sex expression in Gy-63 was stable over several developmental stages. For the determination of genetic behaviour, crossed fruits involving three gynoecious plants and their five crosses were raised and F_1 plants were observed for the expression

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Character	Resistant Bangalore(Resistant)	HS-101(Susceptible)	Hisar Lalit(NT-8)
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Indian Institute of Vegetable Research, 1, Gandhi Nagar (Naria) Post Box No. 5002, P.O. B.H.U. Varanasi-221 005 (Uttar Pradesh)

Bitter gourd (*Momordica charantia*) is a monoecious cucurbit, known for its nutritional, medicinal and curative properties. Commercial hybrid seed production in this crop is being carried out by pinching the staminate flower buds in the monoecious line followed by hand pollination or insect pollination. Gynoecious flowering habit (sex form) has been commercially exploited in cucurbits like cucumber (*Cucumis sativus* L.) for hybrid seed production (Kalloo, 1988). Occurrence of gynoecious lines (pistillate line) in bitter gourd is very rare, though Zhou *et al.*, (1998) reported its utilization in hybrid seed production.

Gy-63 is a gynoecious genetic stock with high yield and attractive fruits. It was identified at Indian Institute of Vegetable Research, Varanasi through screening of germplasm (259 lines) during summer. Three gynoecious plants designated as Gy-35, Gy-63 and Gy-263B, were identified in three populations, viz. VRBT-35, VRBT-63 and IC-68263B respectively. Attempts were made to cross each gynoecious plant with (i) monoecious plant of the same population (sister plant) or (ii) monoecious plant of other population and (iii) gynoecious plant producing staminate flower. F_1 plants were examined for the presence or absence of pistillate and staminate flowers. Simultaneously, three independent gynoecious plants and progenies of five crosses were also examined for the possible involvement of genetic and environmental factors in the expression of gynoecious flowering habit. Two gynoecious plants (Gy-35 and Gy-63) did not produce staminate flower till their physiological maturity, but Gy-263B produced few staminate flowers at later stages. Thus gynoecious expression in Gy-263B was unstable. Expression of few staminate flowers is advantageous for the maintenance of truly gynoecious plants through selfing. Gynoecious sex expression in Gy-63 was stable over several developmental stages. For the determination of genetic behaviour, crossed fruits involving three gynoecious plants and their five crosses were raised and F_1 plants were observed for the expression

of flowering habit. Interestingly, in the same cross, variable number of F_1 gynoecious and monoecious plants were observed. Maximum numbers of three gynoecious plants were recovered from the progeny of 8 plants in the cross between Gy 263B and one of their sister-plant. Similarly, in 2 crosses, viz. Gy35 x Gy263B and Gy263B x VRBT63 also one gynoecious plant was recovered (Table 1). The results pertaining to recovery of gynoecious plants in very small F_1 population indicates that this trait is heritable and under the control of certain major gene(s) recessive in nature (Ram *et al.*, 2002).

Absolute gynoecious line GY-63 is the first truly tropical gynoecious line in bitter gourd. Its plants are very vigorous and bear light green leaves of medium to big size. The flowering starts from 7th node within 45 to 48 days and fruits attain edible maturity in 64 days after seeding (8-10 days after fruit set). Fruits are green in colour. Fruits attain a length up to 15 cm and a diameter of 3.55 cm. Average individual fruit weight is 75–100 g. An average of 30 fruits per plant can be harvested. It possesses good keeping quality, less seed and more flesh. This gynoecious line yields better under bower system.

Table 1. Flowering percentage of pistillate flowers in F_1s derived from gynoecious plants

Female plant	Male plant	F_1 plant			Pistillate *flower (%) mean (range)
		Gyn.	Mon.	Total	
Gy35	IC-68263	0	8	8	50.6 (34.9-58.5)
Gy35	Gy263	1	6	7	48.3 (28.2-58.1)
Gy35	VRBT63	0	3	3	52.5 (29.5-57.9)
Gy63	Gy263	3	5	8	46.3 (46.3-87.5)
Gy263B	Gy263	1	1	2	20.0

Gyn.= Gynoecious; Mon.= monoecious; * = Observation on monoecious plants: "Plants of Pusa Hybrid 2 (13.4%) and PBIG1 (11.3%)

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High Yielding Neem (*Azadirachta indica* A. Juss.) CRIDA-8 *(INGR No. 03038; IC 296921)*

B Venkateshwarlu, J Mukhopadhyaya and Abdul Rasul

Division of Crop Sciences , Central Research Institute for Dryland Agriculture (CRIDA), Santosh Nagar, Saidabad-500059 (Andhra Pradesh)

CRIDA-8 is a neem genetic stock with high azadirachtin content in seed and a high kernel to seed ratio identified by Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad following a comprehensive nation wide survey. CRIDA-8 is a high yielding tree of twenty-five years of age with a yield potential of 75 kg. air-dried fruit per annum based on data collected for five years, from 1997-2001. It has 2.1 m. clean bole with compact crown. The tree has been identified in village Hayathanagar of Ranga Reddy district of Andhra Pradesh by a simple method of selection.

The tree has a compact crown with a girth of 150 cm. at breast height, flowers in May/June and fruit fall completes by the end of July. It flowers only once in the season. The fruits are relatively small and oblong. The fruit has 56 percent kernel, which has 21 percent oil content. The 100 seed weight is 15 g. The azadirachtin content in the kernel was determined to be 0.75 percent in kernels on the basis of five years data.

Both seed raised and micro-propagated progeny from this tree have been produced and evaluated at three locations viz. Hyderabad, Pune and Kovilpatti with an average height of 5.2 m and girth of 27 cm. The performance of seed raised progeny was similar. However, micro-propagated plants flowered at the end of 28 months, whereas seedlings flowered after 36 months. The progeny

of flowering habit. Interestingly, in the same cross, variable number of F_1 gynoecious and monoecious plants were observed. Maximum numbers of three gynoecious plants were recovered from the progeny of 8 plants in the cross between Gy 263B and one of their sister-plant. Similarly, in 2 crosses, viz. Gy35 x Gy263B and Gy263B x VRBT63 also one gynoecious plant was recovered (Table 1). The results pertaining to recovery of gynoecious plants in very small F_1 population indicates that this trait is heritable and under the control of certain major gene(s) recessive in nature (Ram *et al.*, 2002).

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of the plus tree has been analysed for azadirachtin and other seed related traits. In case of micro propagated plants the plants have behaved true to the mother plant. (Venkateshwarlu and Mukhopadhyaya, 1999). The AFLP studies also confirmed the true to type character of the progeny produced through micro-propagation (Singh *et al.*, 2002).

The germplasm selected exhibits intermediate growth rate with high adaptation to both red and black soil area under 500-1200 mm. rainfall zones. It can be planted on the boundaries and also in blocks with 8 m. x 6 m. spacing. Six months old seedlings or micro-propagated planting material can be transplanted in 45 x 45 cm pits in the beginning of the monsoon. The tree establishes well under rainfed conditions. However, in dry areas with short monsoon terminating in September, watering during first summer helps in better establishment and growth. Intercrops like green gram, black gram, groundnut and cowpea can be grown in the interspaces for 3-4 years.

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Scented Rose-geranium, *Pelargonium graveolens* L' Herit. NIC 23414 *(INGR No. 03039; IC 296494)* of Quality Aroma

KS Negi, DC Bhandari and KC Pant[1]; ML Maheshwari[2]; P Suneja[3]

1. National Bureau of Plant Genetic Resources, Regional Station, Bhowali, Dist. Nainital, (Uttranchal)

2. E8, Street E, Mayapuri, New Delhi-110 064

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

Scented Rose-Geranium, NIC 23414 is a genetic stock with high quality aroma identified at National Bureau of Plant Genetic Resources, Regional Station Bhowali. The essential oils obtained from NIC 23414, Scented Rose-Geranium under Uttranchal conditions is acceptable in the industry. It has good major chemical constituents, such as Cis-rose oxide 0.4777%, Trans-rose-oxide 0.1110%, Isomenthone 7.80%, Linalool 21.25%, Citronellol 32.28% and Geraniol 28.56%. Scented Rose-Geranium (*Pelargonium graveolens* L' Herit.) was introduced from Indonesia to the herbal garden of National Bureau of Plant Genetic Resources, Regional Station, Bhowali in 1991 by Mr GD Kelkar. Stem cuttings of rose-geranium were also obtained from M/s SH Kelkar & Co., from their research farm at Hyderabad, Andhra Pradesh during 1990.

Scented Rose-Geranium, NIC 23414 is perennial (up to seven years), pubescent or sparsely hairy herb with creeping rhizomatous root-stocks, 120-160 cm. tall; leaves sub-orbicular, deeply 5-12 lobed, 20 cm. across, segments irregularly lobed, pubescent on both surfaces, lower leaves petiolate, upper ones sessile, dark green; flowers pale pink-purple with dark purple centre/veins, one cm. across, solitary or 8-10 together; sepals 5, free, 4-5 mm. long, lanceolate, acute; petals 5 free 10 mm. long, obovate; capsule 1-2 cm. long, forming beak, enclosed by persistent erect calyx lobes, single seeded.

This genotype is evergreen and resistant to frost, diseases and pests. Terminal shoot-apex with 4-6 nodes of the stem from healthy plants with profuse branching are good to multiply and for regeneration round the year except rainy season. After six months, 50-200 stem cuttings may be obtained from a single plant for oil extraction. Plantation of geranium is done with 30 cm. plant-to-plant and row-to-row distance, yielding about 554 quintals herbage (leave and tender stem) after four cuttings (at three months interval) with and a yield of 42 kg. of essential oil per ha/year. Large-scale extraction of geranium herbage through steam and hydro-distillation units yielded 0.07 and 0.15 percent essential oil respectively. The cultivation of Scented Rose-Geranium, NIC 23414 has been popularized among 60 farmers of nine districts in Uttranchal.

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Variegated Leaved Balsam, *Impatiens wallerana* Hook. F. 'Queen of Balsams' A Leafy Ornamental, TBGT 30225 *(INGR No. 03040; IC 296493)*

PA Jose and Jacob Thomas
Division of Horticulture and Garden Development, Tropical Botanic Garden and Research Institute (TBGRI), Pacha-Palode, Thiruvananthapuram-695 562 (Kerala)

Impatiens wallerana belonging to the family Balsaminaceae is commercially known as Busy lizy or the Patient Lucy. It is a native of East Africa. It is a perennial tender succulent herb, which grows below one meter in height with green foliage and varied flower colour depending on the variety. The capsule is oblique-fusiform with seldom seed setting in cultivated plants.

TBGT 30225 is a variegated leaved genetic stock of *Impatiens wallerana.* A young branch with variegated leaves developed spontaneously as 'sport' in a normal potted plant of *Impatiens* growing at Tropical Botanic Garden and Research Institute (TBGRI), Thiruvananthapuram. The variegated branch of 8-10 cm. was then excised from the mother plant for isolation and propagation of the new variegated plant type (Jose and Thomas, 1994; Jose and Thomas 1999a). The clone has retained the variegation and subsequently multiplied vegetatively for five generations. The new variegated plant has been characterized by variegated leaves, which are having irregular creamy-white marginal patches merging with the faded central green portion.

This succulent herb is 50-70 cm. tall, profusely branched. Leaves variegated, irregular with creamy-white marginal patches merging with the faded central green portions, simple, alternate and dense towards tip, ovate-elliptic, 4-7 x 1.8-4.5 cm. in size, glabrous with petiole length of 0.7–4.5 cm. Flowers are asymmetrical, solitary or binate from the leaf axis. Bracts and bracteoles are subulate to 3 mm. long. Sepals are three upper two are smaller rosy green, lower petaloid with a long spur. Petals are showy with five lobes crimson red in colour. Stamens are five, united in a short tube towards apex. Ovary is superior, glabrous and capsule oblique fusiform.

There was no clear-cut difference between the parent and mutant except in the leaf variegation (Jose and Jacob Thomas, 1999 b). However, slight differences were observed in stem and flower size in relation to the vegetative/flowering habit of the variegated plant. The new germplasm is an excellent specimen for displaying in gardens or green houses. It is also suited for flowerbeds, borders, window boxes, porch boxes and pot cultivation. It performs well under semi-shade conditions.

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Green Flowered Stripped Lip Orchid, (*Eulophia andamanensis* Reich b.f.), Pretty Green Bay *(INGR No. 03041; IC 296534)*

DR Singh, Sujatha Nair and TVRS Sharma
Central Agricultural Research Institute (CARI), P.B. No. 181, Port Blair–744101 (Andaman and Nicobar Islands)

Pretty Green Bay is an orchid having green flowers with stripped lips belonging to the subfamily Vandoideae, tribe Cymbidieae and subtribe Cyrtopodiinae. This terrestrial orchid is spread all over the tropics and sub-tropics of the world. In Asiatic tropics they are found in India, Sri Lanka, Indonesia and the Pacific Islands. Numerous species of this genus occur throughout India. *Eulophia andamanensis* is endemic to Andaman and Nicobar Islands. They are being collected and maintained at Central Agricultural Research Institute (CARI), Port Blair and are propagated either through the division or separation of pseudo-bulbs or by tissue culture. This orchid has been identified for its potential as an export commodity owing to its good keeping quality and other features like long spikes with many green florets opening over a period of nearly one month. (Singh, 2003).

Pretty Green Bay is a ground orchid with underground or sub-terrestrial tubers with or without distinct pseudo-

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Pretty Green Bay is a ground orchid with underground or sub-terrestrial tubers with or without distinct pseudo-

bulbs. The scape or the stalk of the flower-bunch comes out at the base from one side of the tuber. Leaves are short during flowering and linear lanceolate. Flowers are medium size, fully open and spread out, displaying the pretty lip. Bracts are shorter than the pedicel, sepals 2-3" long and the lip are shorter than the sepal (Singh, 2003). Sepals and petals are similar and sub-equal, the dorsal sepal and petals are broader, while the lateral sepals are often fused at base with the column, with which the base of the lip may also be fused. Sepals are linear, lanceolate, 3-5 nerved and acuminate. Sepals and petals are green in color, lip creamish green with maroon horizontal stripes (Singh, 2003). Lip is distinctive, usually three lobed, with the two side-lobes erect and clasping the column, the broad mid-lobe is out-thrust, spreading, entire or again bi-lobed erect and clasping the column, the broad mid-lobe is out-thrust, spreading, entire or again bi-lobed. The upper surface of the disc is variously crested, ridged or lamellated, rarely smooth. Base of the lip has a small sac or a short spur. Column is stout often with two lateral flaps. Pollinia are two, each deeply cleft and with a short broad stalk. Blooming period is November to March. Florets are borne on long spike of 0.6 - 1.3 m. (Singh, 2002). The pods are formed by self-pollination and the pod length varies from 5.6 - 6.2 cm., while the girth from 0.5 - 1.0 cm. Numerous seeds are produced per pod (Table 1).

In addition to ornamental cultivation, the spikes can be used in ikebana and in different flower arrangements. As the colour of the florets is rare it can be used in breeding programmes to incorporate this colour. It can also be grown in pots. The potting media comprising charcoal, coconut husk and leaf mould in equal parts is found to be ideal for its growth and flowering (Singh, 2003).

Table 1. Salient features of *Eulophia andamanensis*

Length of spike (cm.)	61.2 – 130
Life of spike (days)	49.67
Flower size (cm.)	6.65
Number of spike/ plant	2 – 4
Number of florets/ spike	29 – 45
Number of suckers/ plant	2 – 4
Number of florets fresh at a time	15 – 20
Leaf venation	Parallel, midrib and 6 veins prominent on under surface of leaf
Leaf arrangement	Alternate
Size of pseudo-bulb	Length 20 cm., Breadth (at base) 5.5 cm.
Average weight of pseudo-bulbs (g.)	325
Shape of pseudo-bulb	Elongated

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Singh DR, Sujatha A Nair and TVRS Sharma (2003) *Eulophia andamanensis* 'Pretty Green Bay' *The Orchid Journal of the Royal Horticultural Society, London.* **Vol III** (1251): 48.

Regular Bearing, High Temperature Tolerant Dashehari Clone Mango (*Mangifera indica* L.), Akshay *(INGR No. 03042; IC 296830)*

Hari Govind Singh

Ex. Vice Chancellor, GBPUA&T, Pantnagar, Village Poore Beni Bhadwari, P.O. Konhara via Amethi, Distt, Sultanpur (Uttar Pradesh)

Akshay is a Dashehari clone of mango identified for regular bearing at a mango orchard of 234 plants grown at Village Poore-Beni Bhadwaria, Kondara, Amethi, district Sultanpur. Akshay Dashehari clone was planted in 1976. It has been observed that average weight of mango fruits of this variety even under high temperature is 210 percent higher as compared to other deshehari plants of similar age, showing that temperature did not affect weight and size of fruits. Generally, physiological and environmental factors attribute to irregular or alternate bearing, which are the major disorders in mango production in northern India.

Akshay has been identified as a regular bearing clone because of its consistent performance for the last seven

bulbs. The scape or the stalk of the flower-bunch comes out at the base from one side of the tuber. Leaves are short during flowering and linear lanceolate. Flowers are medium size, fully open and spread out, displaying the pretty lip. Bracts are shorter than the pedicel, sepals 2-3" long and the lip are shorter than the sepal (Singh, 2003). Sepals and petals are similar and sub-equal, the dorsal sepal and petals are broader, while the lateral sepals are often fused at base with the column, with which the base of the lip may also be fused. Sepals are linear, lanceolate, 3-5 nerved and acuminate. Sepals and petals are green in color, lip creamish green with maroon horizontal stripes (Singh, 2003). Lip is distinctive, usually three lobed, with the two side-lobes erect and clasping the column, the broad mid-lobe is out-thrust, spreading, entire or again bi-lobed erect and clasping the column, the broad mid-lobe is out-thrust, spreading, entire or again bi-lobed. The upper surface of the disc is variously crested, ridged or lamellated, rarely smooth. Base of the lip has a small sac or a short spur. Column is stout often with two lateral flaps. Pollinia are two, each deeply cleft and with a short broad stalk. Blooming period is November to March. Florets are borne on long spike of 0.6 - 1.3 m. (Singh, 2002). The pods are formed by self-pollination and the pod length varies from 5.6 - 6.2 cm., while the girth from 0.5 - 1.0 cm. Numerous seeds are produced per pod (Table 1).

In addition to ornamental cultivation, the spikes can be used in ikebana and in different flower arrangements. As the colour of the florets is rare it can be used in breeding programmes to incorporate this colour. It can also be grown in pots. The potting media comprising charcoal, coconut husk and leaf mould in equal parts is found to be ideal for its growth and flowering (Singh, 2003).

Table 1. Salient features of *Eulophia andamanensis*

Length of spike (cm.)	61.2 – 130
Life of spike (days)	49.67
Flower size (cm.)	6.65
Number of spike/ plant	2 – 4
Number of florets/ spike	29 – 45
Number of suckers/ plant	2 – 4
Number of florets fresh at a time	15 – 20
Leaf venation	Parallel, midrib and 6 veins prominent on under surface of leaf
Leaf arrangement	Alternate
Size of pseudo-bulb	Length 20 cm., Breadth (at base) 5.5 cm.
Average weight of pseudo-bulbs (g.)	325
Shape of pseudo-bulb	Elongated

References

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Akshay has been identified as a regular bearing clone because of its consistent performance for the last seven

years (1993-1999). Sixty to 65 percent new shoots on this clone are produced in May, which subsequently bear fruits. The fruit size is medium with excellent fruit quality. The fruits of Akshay clone compared well with other Dashehari plants of similar age. During 1999 the fruit weight and size of Dashehari has been reduced drastically. This may have happened due to extremely high temperature in April. The average maximum temperature for April (1989-1998) was 36-37°C, whereas for April 1999, it was 39-40°C. The fertilizer and irrigation were applied uniformly. The average weight of mango fruits of Akshay, which were plucked randomly, was 210 percent higher as compared to other Dashehari plants of similar age, canopy and fruit number. Thus the weight and size of fruits of Akshay were relatively less affected due to high temperature during month of April, providing stability under the changing environment.

Genotype bears leaves of medium size, oval to lanceolate in shape with entire to slightly wavy margin and sub-acuminate apex. Fruit bearing is regular and heavy, with excellent fruit quality identical to Dashehari mango with tolerance to high temperature.

Reference

Singh HG (1999) Some observations on Akshay – A regular bearing Dashehari Clone of Mango. Short communication *Indian Journal of Pl. Genet. Resources* **12**(2): pp 268.

Sugarcane Clones (*Saccharum officinarum* L.)

M Jayaprakash[5], J. Papa Rao[1], K Prasada Rao[1], B Ramachandra Rao[1], Smt. K. Krishanamma[2], JVR Bhupal Rao[2], P. Ravindra Babu[2] and K Jhansi[4]

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2. Sugarcane Research Station, Vuyyuru, Andhra Pradesh
3. Regional Agricultural Research Station, Anakapalle, Andhra Pradesh
4. Division of Forage Crops, Veterinary Research Wing, ANGRAU, Hyderabad, Andhra Pradesh
5. Regional Rice and Sugarcane Research Station, Rudrur, Andhra Pradesh

91 V 83 (Co V 95101) ***(INGR No. 03043; IC 296849)***

91 V 83 (Co V 95101) is an early maturing, non-lodging high yielding sucrose rich clone with good ratooning performance, resistant to red rot and smut diseases. The genetic stock was developed at the Sugarcane Research Station, Vuyyuru, Andhra Pradesh from a bi-parental cross between Co 798 and Co 62198 followed by selection. The clone is early maturing and sucrose rich (19-20 %) suited to serve as an opening mill cane. It is suitable for cultivation under adverse and low-input conditions. The plant possesses erect growth habit with dirty gray exposed and yellowish green unexposed stem. Cane diameter is 2.52 cm. and cane yield is between 120-130 t/ha.

83 V 15 ***(Co V 92102) (INGR No. 03044; IC 296848)***

83 V 15 (Co V 92102) is a genotype with mid to late maturity period. Though it lodges early, but does not snap and continues to grow. It is resistant to red rot and smut diseases and also capable to withstand salinity up to 4 E.C. It was developed at the Sugarcane Research Station, Vuyyuru, Andhra Pradesh from a bi parental cross between CoC 671 and Co 6806 followed by selection. The clone exhibits mid to late (8^{th} week) flowering with 88.8 percent pollen fertility. It is rich in sucrose (18-19%) and resistant to red-rot and smut. The plant possesses semi-erect growth habit with purple exposed and yellowish green unexposed stem. Cane diameter is 2.52 cm. with cane yield of 120-130 t/ha.

High L-dopa Content Mucuna, (*Mucuna* spp.) Lines

TN Shivananda and T Vasantha Kumar

Indian Institute for Horticulture Research (IIHR), Hessaraghatta Lake, Bangalore-560 089 (Karnataka)

Mucuna pruriens Baker and *Mucuna utilis* Wall. ex Wight are high value medicinal crops grown extensively in South India for their amino-acid derivative L 3, 4-Dihydroxyphenylalanine (L-DOPA) present in seeds. Cultural practices have been developed for optimum production of plant biomass, as in the drug preparation

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all plant parts are used, though seed is the most economically important part. Hence seed yield is mainly recorded for economic yield potential. *M. pruriens* has highly vigorous plants growing to a height of 10 to 12 feet compared to *M. utilis,* growing to a height of 6 to 7 feet with less branching habit. Staking is required for *M. pruriens* with 8 to 10 feet bamboo poles. Seeds of both the species are used as aphrodisiac. It is grown as a wasteland crop on borders, as cattle avoid it.

COWHAGE /ATMAGUPTA, IIHR-19855 ***(INGR No. 03045; IC 296847) Mucuna pruriens Baker***

COWHAGE /ATMAGUPTA IIHR-19855 is a *Mucuna pruriens* accession with high L-DOPA content (9.5%) in seeds. This high yielding accession with high L- DOPA content was identified at Indian Institute for Horticulture Research (IIHR), Bangalore. L-DOPA content as analyzed using HPLC method at the Section of Medicinal Crops of the IIHR. The results were at par with the results obtained at Al Ameen College of Pharmacy. The L-DOPA content recorded in the present accession is much higher than the values reported earlier (4.5%).

The genotype possesses intermediate growth habit with extended duration of flowering (200 days) and pod maturity period of 150 to 180 days. The pods are more or less 'S' shaped and possess 3-4 seeds. However, this species is not grower friendly as the pods have hirsute surface with long highly itchy hairs, which is a unique feature of this species. Plant growth is highly vigorous and needs strong support. Seeds have dormancy.

COWHAGE /ATMAGUPTA IIHR-19854 ***(INGR No. 03046; IC 296846)***

Mucuna utilis **Wall. Ex Wright** COWHAGE/ATMA-GUPTA IIHR-19854 is a *Mucuna utilis* accession with high L-DOPA content (5.5%) in seeds. This is a cultivated species of *Mucuna* and this accession has been identified with next highest L-DOPA content, which was analyzed using HPLC method at the Section of Medicinal Crops of the Indian Institute for Horticulture Research. The results were at par with the results obtained at Al Ameen College of Pharmacy. Plants are determinate type, taking 120-150 days to reach maturity and last for 120 days in field cultivation. The pod surface is smooth and non-itchy. The pod colour is moth greenish when immature, but becomes black on maturity. Seeds can be harvested from the fruits easily. Seeds are cream coloured, bold and non-dormant.

Reference

Annual Report (2000-01). IIHR, Bangalore pp 97-99.

BOOK REVIEW

Agricultural Heritage of India

Editors: Y.L. Nene and S.L. Chaudhary
Asian Agri-History Foundation (AAHF), Secunderabad and Rajasthan Chapter of AAHF, Udaipur

The book titled 'Agricultural Heritage of India' is the outcome of the National Conference on Agricultural Heritage of India, organized by the Rajasthan chapter of the Asian Agri-History Foundation (AAHF) Udaipur, Rajasthan held from 10-15th February 2002 at Rajasthan College of Agriculture, Udaipur. It comprises 21 invited full papers along with 65 extended abstracts encompassing a range of information shared at the conference.

The first two papers deal with agro-biodiversity. The first enumerates the Mesolithic and pre-Neolithic hunter-gatherers period, especially related to diffusion and diversification of agriculture in Saraswathi Valley Civilisation. It is interesting to note that the process of recognition of plant species useful to humans commenced in India in the pre-historic period. According to archaeological evidences there existed three distinct phases, early, mature and late. From the cited literature it appears that agricultural production and prosperity were of very high order and the produce was even exported during early phase. The late phase of Indus-Saraswathy Valley Civilization saw a paradigm shift in the agricultural patterns with opportunities for rainfed agriculture and mixed farming systems. Also evident is the fact that ultimately the main river dried up and its tributaries took different courses, which coincided with the breakdown of the inter-regional trade and emergence of local economies.

The second paper enumerates the role of ancient Indian Agriculture in conservation and enhancement of plant genetic resources, highlighting the importance and value of biodiversity based Indian farming systems and eco-friendly practices of Indian agriculture based on embodiment of biodiversity in cultural traditions, religious beliefs and social ethos.

Two papers, one on the role of soil as a natural resource with specific thrust towards biodynamic farming practices and the second tracing the history of irrigation practices from the ancient to modern era along with suggestions for land management are very informative. While another interesting paper describes the traditional rain water harvesting methods practiced in Indian Thar desert, where information on specific use of water body, size and shape, capacity and modus operandi etc. have been elegantly covered. Another paper elaborates the age-old practice of Beushening, which combines direct dry seedling of rice in well-prepared field, wet ploughing of the young seedlings 20-35 days after emergence, laddering of the field and seedling redistribution is a time-tested traditional agronomic technique, still practiced by Indian farmers in uncertain rain-fed environments. An interesting paper on Indigenous knowledge of Arunachal Pradesh farmers documents relevance of tribal wisdom. Mention may be made of the biological methods practiced for control of insects and pests using a variety of plant extracts, use of wood ash for grain storage, bamboo stack in open for maize cob storage. animal husbandry by Aditribes and eco-forestry ways of farming practiced by the farmers. Two additional papers represent case studies of indigenous methods followed by tribals of Rajasthan in post harvest management and crop and animal husbandry. In the first case study, 40 villages in four districts of Rajasthan have been surveyed and information on threshing, drying, winnowing and storage has been compiled. In the second case study, the survey on crop products and animal management in three tribal dominated districts of Rajasthan is reported. Some of the interesting findings are; soaking of maize seeds in cow's urine to increase resistance against insect pests, spraying of paddy with a solution of cow's urine and asafoetida to repel sucking pests, treating bunch top of chillies with gugul smoke, sour butter milk sprays, or liquid waste of tanned leather, and indigenous methods for treating common animal-ailments with plant products. The paper on disease and insect pest management practices in ancient and medieval India brings out several more practices, like treating sugarcane cut ends with a mixture of hog's fat, cow's urine and honey; seed dressing with milk, ghee and cow dung, smoking by burning animal flesh, use of ash for ensuring good germination and use of salts for disinfecting cuttings.

It is interesting that the concept of fumigation existed even in those days.

The paper on 'Dairying in Ancient India' presents a vivid picture of the dairy production system used during ancient times, enumerating the curative properties of milk and milk products. Various other papers on diversity of fruits, heritage of ornamental plants in India and the traditional applications of lac and its products present a detailed account of the respective aspects in simple and lucid language. Research to validate and re-establish the old management practices are the need of the hour.

The book provides comprehensive and integrated information on all aspects of ancient agricultural history. It describes the state of our natural and cultural heritage with a view to increase awareness about agricultural heritage and stimulate scientific research based on traditional knowledge. In nutshell, the book is a compendium of valuable information on ancient Indian agriculture with a large number of quotes from old literature and will be a very useful addition to libraries as a fact-finding guide on ancient agriculture.

Kalyani Srinivasan and Anurudh K. Singh
Germplasm Conservation Division, Pusa Campus, New Delhi-110012