

# Indian Journal of Plant Genetic Resources

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Vol. 6

1993

No. 1

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Published by

INDIAN SOCIETY OF PLANT GENETIC RESOURCES

NBPGR CAMPUS, NEW DELHI - 110 012, INDIA

## COLLECTION OF RABI SORGHUM GERMPLASM I. NORTHERN KARNATAKA AND ADJOINING AREAS OF ANDHRA PRADESH

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Systematic *rabi* sorghum germplasm collection in India were initiated jointly by the National Bureau of Plant Genetic Resources and International Crops Research Institute for the Semi-Arid Tropics. The collections from Karnataka could be a good addition to the *rabi* sorghum collections. As most of them are grown under residual soil moisture conditions, these are likely to be good source for drought tolerance. Most of them have attractive grain characters which can be used to improve *rabi* sorghums. The pop sorghum and sugary grain (wrinkled) forms are good addition to the limited accessions in world collection of sorghum germplasm. They can be used to breed cultivars for alternative uses of sorghum. Majority of the samples collected in this mission belong to the race *Durra* with a wide range of diversity. Landraces collected seem to be useful in sorghum improvement programmes. Sorghums with large glumes (membranaceum group) were observed to be bird resistant.

**Key words :** Sorghum, germplasm, variability, landraces, *durra* race, bird resistance

To collect *rabi* (post-rainy season) sorghum from Karnataka, India, a germplasm collection mission was jointly launched by the National Bureau of Plant Genetic Resources (NBPGR), New Delhi and the Genetic Resources Division, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru. Karnataka, one of the most important sorghum growing states in India, lies between 11°31' and 18°41' N latitudes and 74°12' and 78°40'E longitude in the west central parts of peninsular India. The total geographical area of Karnataka state is 1,98,000 sq km, which runs from 700 km north to south and 400 km from east to west. The areas covered were Bidar, Gulbarga, Bijapur, Bellary and Raichur districts of northern Karnataka; Ananthpur and Kurnool districts of Andhra Pradesh. The route followed is given in Fig. 1. The expedition was planned to coincide with the harvesting

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of sorghum in several areas except in parts of Bijapur district where the crop was harvested and head samples were collected from threshing floors. Course grid sampling was followed, with emphasis on collecting random samples. A farmer's field was considered as a unit and random plants were collected as populations. While collecting samples, information on traditional farming practices and other relevant passport data were also gathered. A total of 176 samples of sorghum, were collected. No wild and weedy forms of sorghums were noticed during this collection mission. All the samples collected were authentic indigenous landraces except *muguthi*, *gangavati*, M35-1 and SPV 894.

The soils are mainly red sandy to black clay in the area explored. The average annual rainfall ranges between 518 mm (Bellary) to 977 mm (Bidar). Sorghum is planted either as sole crop or mixed mainly with safflower. However, farmers of this region also grow pigeonpea, chickpea or groundnut in mixed cropping with sorghum. Most of the *rabi* sorghum landraces were planted in September and harvested in the first or second week of February.

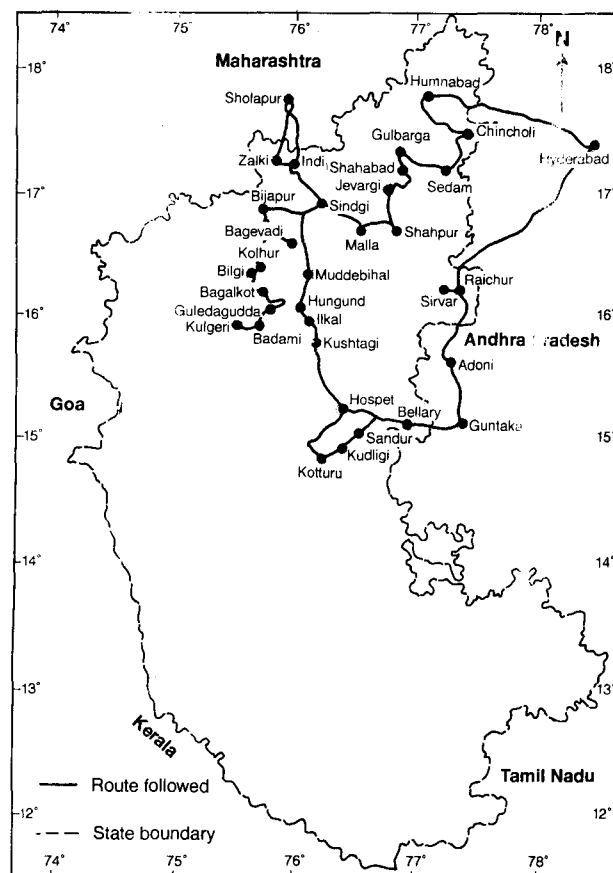


Fig. 1. Route followed and areas explored for germplasm collection in northern Karnataka and adjoining areas of Andhra Pradesh

In some parts of northern Karnataka, sorghum was planted in October and harvested in the last week of February. Sorghum grain is generally used for the preparation of *roti* (unleavened bread) in this area.

### VARIABILITY IN THE GERMPLASM

Panicle shape and spiklet morphology of the samples were observed and recorded at the time of collection. Though some of the types were similar to those collected during the *kharif* season (Prasada Rao and Gopal Reddy, 1980), most of them were different. The collected samples were classified into the following basic and intermediate races (Harlan and de Wet, 1972) which are presented in Table 1.

**Table 1 : Classification of the *rabi* sorghum germplasm collections**

| Species/race                                                           |                         | Number of samples collected |
|------------------------------------------------------------------------|-------------------------|-----------------------------|
| <b>Species :</b> <i>Sorghum bicolor</i> (L.)Moench ssp. <i>bicolor</i> |                         |                             |
| <b>Race</b>                                                            | <i>Durra</i>            | 129                         |
|                                                                        | <i>Durra-bicolor</i>    | 31                          |
|                                                                        | <i>Guinea-durra</i>     | 4                           |
|                                                                        | <i>Durra-caudatum</i>   | 4                           |
|                                                                        | <i>Caudatum-bicolor</i> | 5                           |
|                                                                        | <i>Guinea</i>           | 1                           |
|                                                                        | <i>Guinea-bicolor</i>   | 2                           |
| Total                                                                  |                         | 176                         |

Most of the landraces collected in the present mission belong to the basic race *Durra*. The large glume sorghums (membranaceum group) collected were observed to be bird resistant and excellent source for developing pop sorghums. The predominant races collected during this expedition were *Durra*, *Durra-bicolor* or *Guinea* (Fig 2). Considerable variation was observed in panicle length, width and shape within "*Tella Jona*" (Fig. 3). They belong to race *Durra* with white grain. The 176 sorghum samples collected in this mission with their local names are listed in Table 2. Wide range of variation was found within the landrace "*Gundu Tenai*" (Fig. 4).

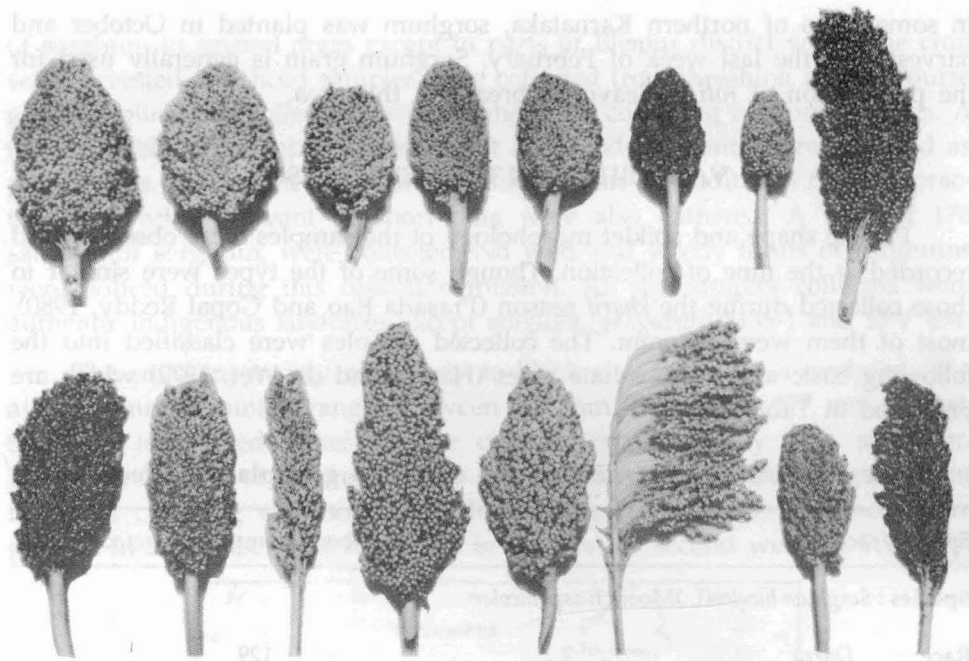


Fig. 2. Different races of sorghum collected from Karnataka

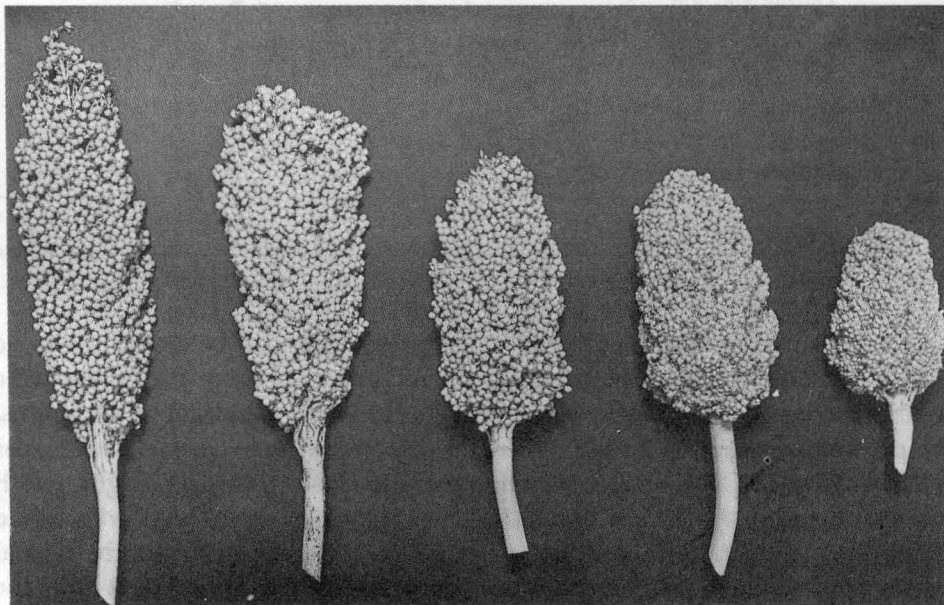


Fig. 3. Variation in landrace - Tella Jonna

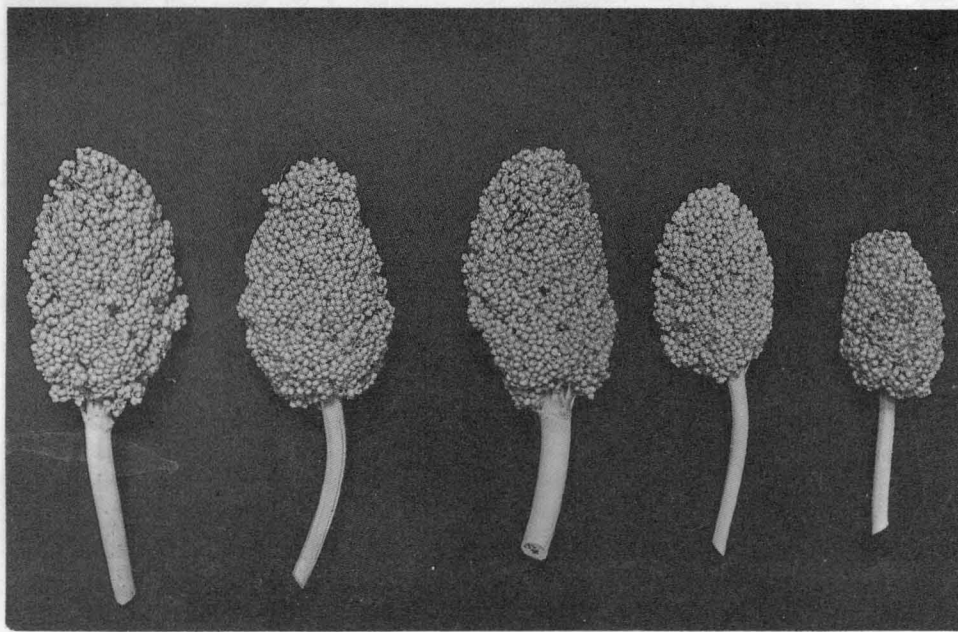


Fig. 4. Variation in landrace - Gundu Tenai

In northern Karnataka, though sorghum is mainly used for making unleavened bread, it is also used for popping. Most of the pop sorghums have large glumes with compact to semi compact panicles, which belong to the intermediate race *Durra-bicolor*. In Karnataka, another distinct form of sorghum landrace was collected. It has surgary grain with soft endosperm and wrinkled grain surface (Fig. 5), locally called "Sakkara Mukri Jola" and is used to prepare a favourite sweet dish. Variability collected for this landrace will be very useful for contributing genes for sweetness. However, there is a need to estimate gluten content in these collections, which can be compared with some check variety like M-35. Enormous variation was found within Maldandi, an improved landrace, which is extensively grown around Bijapur, Gulbarga and Raichur districts of Karnataka. The local landraces "Kadabuni Jola" which has red grains belongs to race *Durra*, and intermediate races *Durra-bicolor* and *Durra-caudatum* (Fig 6). Some collections were also made for sweet-stalk sorghums and can be used in developing varieties for dual purpose. 'Bili Jola' collection were having compact elliptic to oval shape panicles (Fig 7). The sorghum crop in these areas was generally free from foliar diseases, however, stem borer was the important pest observed during this collection mission. Covered grain smut and ergot were also present.

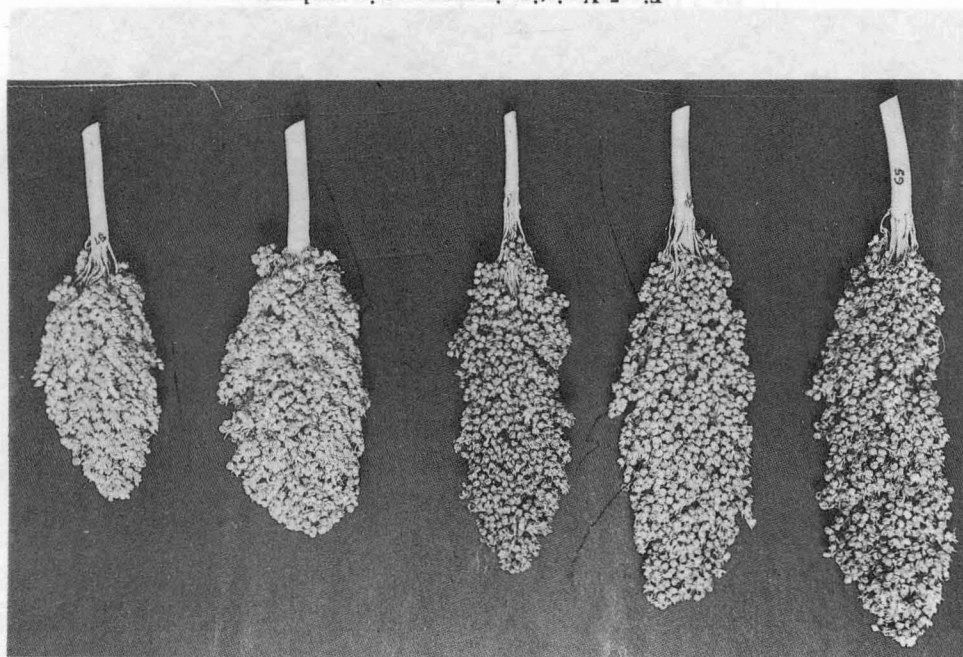


Fig. 5. Variation in sugary grain sorghums

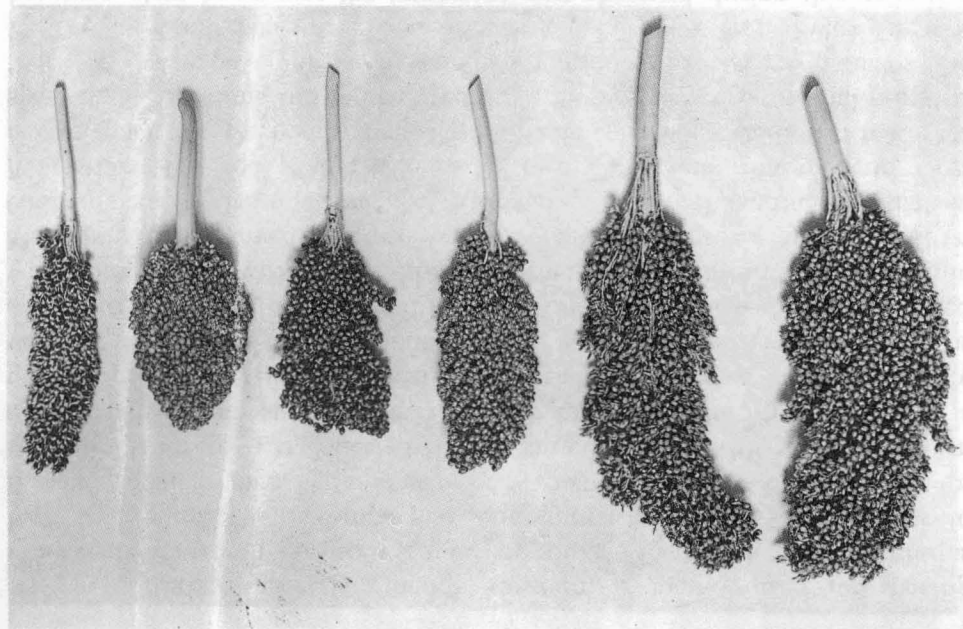


Fig. 6. Variation in landrace - Kadabuni Jola

**Table 2 : Local names of sorghum landraces collections**

| S.No. | Local Name        | No. of samples | S.No. | Local Name           | No. of samples |
|-------|-------------------|----------------|-------|----------------------|----------------|
| 1     | Tella Jonna       | 10             | 30    | Biligundu            | 1              |
| 2     | Badi Jowar        | 3              | 31    | Afzalpur Local       | 1              |
| 3     | M35-1             | 3              | 32    | Bidar Local          | 1              |
| 4     | Maldandi          | 13             | 33    | Aurada Local         | 1              |
| 5     | Bili Jola         | 22             | 34    | Jewarge Local        | 3              |
| 6     | Kempu Jola        | 4              | 35    | Chittapur Local      | 1              |
| 7     | Allina Jola       | 20             | 36    | Lakkadi              | 1              |
| 8     | Kadabuni Jola     | 12             | 37    | Mattalli             | 1              |
| 9     | Safed Jowar       | 3              | 38    | SPV 894              | 1              |
| 10    | Kempu Kate        | 1              | 39    | Kakimuti Jola        | 3              |
| 11    | Ujala Jola        | 1              | 40    | Phulamalligi         | 1              |
| 12    | Basavanna Butta   | 2              | 41    | Benni Jola           | 1              |
| 13    | Gulabi Jowar      | 1              | 42    | Suryahaula           | 1              |
| 14    | Holi Jola         | 5              | 43    | Bijapur Jola         | 2              |
| 15    | Gundu Jola        | 2              | 44    | Gulbarga Jola        | 5              |
| 16    | Holgi Jola        | 2              | 45    | Dundanna Bilijola    | 1              |
| 17    | Gundu Tenai       | 5              | 46    | Raichur Jola         | 3              |
| 18    | Sakkaramukri Jola | 6              | 47    | Muddakanki Jonna     | 1              |
| 19    | Shakti            | 1              | 48    | Desavali Jonna       | 1              |
| 20    | Kachkach Jola     | 1              | 49    | Basavannamuthi Jonna | 1              |
| 21    | Banuth Jola       | 1              | 50    | Cheruku Jonna        | 1              |
| 22    | Muddihali Jola    | 1              | 51    | Bendu Jonna          | 1              |
| 23    | Aliali Jola       | 1              | 52    | Chapati Jonna        | 3              |
| 24    | Kempuguni Jola    | 2              | 53    | Pelala Jonna         | 1              |
| 25    | Muguthi           | 3              | 54    | Yerra Jonna          | 2              |
| 26    | Machendri         | 1              | 55    | Mudda Jonna          | 1              |
| 27    | Kagi Moti Jola    | 1              | 56    | Nandyala Jonna       | 1              |
| 28    | Gangavati         | 1              | 57    | Kanakam Jonna        | 1              |
| 29    | Hagari Local      | 1              | 58    | Kareguni Jola        | 3              |
|       |                   |                |       | Unknown              | 2              |

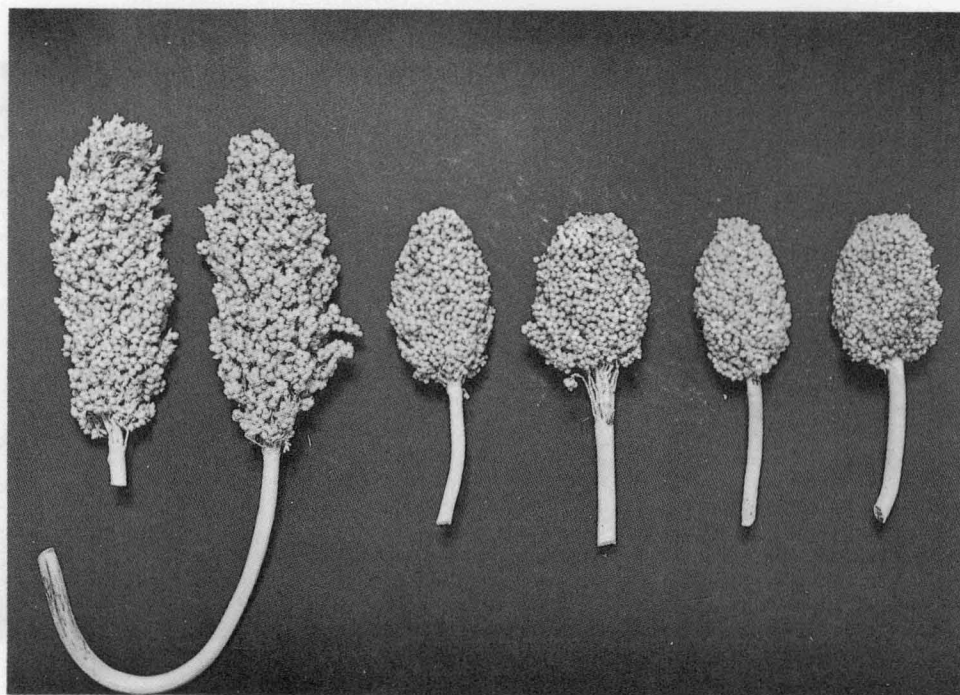


Fig. 7. Variation in landrace - Bili Jola

#### ACKNOWLEDGEMENTS

Funds for undertaking this collection programme were provided by Asian Development Bank for which we are very grateful. We also thank Dr. R.S. Rana, Director, National Bureau of Plant Genetic Resources, New Delhi; Dr. Y.L. Nene, Deputy Director General, International Crops Research Institute for the Semi-Arid Tropics, Patancheru for their support and encouragement. Our thanks are also due to the farmers for generously providing seeds and valuable information.

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## GENETIC DIVERSITY IN GLADIOLUS

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Multivariate analysis of divergence among 25 varieties of gladiolus for 16 developmental characters led to their grouping into five clusters. The first cluster had four varieties while the second had only one. Cluster III was the biggest with 11 varieties whereas cluster V and IV had two and seven varieties (6 varieties and 1 hybrid), respectively. Based on cluster means, characters like days for initial flowering, leaf area, days for last floret opening, number of corms and cormels produced per plant and propagation coefficient were the major factors for differentiation among the 25 genotypes. The intercluster  $D^2$  values ranged from 11.417 to 84.953 suggesting very little domestication in this crop.

**Key words :** Gladiolus cultivars, genetic diversity, multivariate analysis

Gladiolus, an important cut flower crop with high potential for export, is grown throughout India. Very limited studies have been carried out for its improvement. The present study is aimed to gather information on, (i) genetic divergence among the existing varieties, (ii) the relationship of genetic diversity with their geographic and ecological background, (iii) the factors influencing divergence and (iv) the parental group which are likely to yield superior segregants on hybridization.

### MATERIALS AND METHODS

The material for the present investigation consisted of 25 genotypes of gladiolus (11 indigenous hybrids alongwith their 13 exotic and one indigenous parents) which were grown at the Indian Agricultural Research Institute, New Delhi during 1991-92 in RBD replicated thrice, allowing feeding area of  $40 \times 15$  cm per plant and keeping 10 plants per replication. The main objective was to select divergent forms for the purpose of further improvement through hybridization. Data were recorded on six plants (leaving two bordering plants on each side in each row) per replication, on 16 quantitative characters, viz., days to sprouting and flowering, number of leaves and leaf area per plant, plant height and rachis length, diameter of foremost floret after two days of opening, days for last floret opening, number of florets per spike, number of

capsules per spike and number of seeds per capsule, number and weight of corms and cormels per plant and propagation coefficient.

The data were subjected to multivariate analysis using Mahalanobis'  $D^2$ . The  $16 \times 16$  dispersion matrix was used for simultaneous testing of significance of differences in the character means using Wilk's criterion and the varieties were grouped into clusters according to Tocher's method (Rao, 1952).

### RESULTS AND DISCUSSION

The analysis of variance for 16 characters (Table 1) showed highly significant mean square for all the characters except for days to last floret opening. A wide range of diversity existed among the 25 genotypes for most of characters. In fact, the past performance of these strains at IARI revealed that distinct genetic forms exist in this crop as they belong to different ecological regions. However, the phenotypic performance of 11 hybrids showed heterotic effects for majority of characters in comparison to respective parents probably due to wide range of genetic diversity among parents.

Table 1 : Analysis of variance for various characters of gladiolus

| Characters                                                 | Mean sum of squares             |                                |                      |
|------------------------------------------------------------|---------------------------------|--------------------------------|----------------------|
|                                                            | Replica-<br>tions<br>(d.f. = 2) | Treat-<br>ments<br>(d.f. = 24) | Error<br>(d.f. = 48) |
| Days to 50% sprouting                                      | 1.25                            | 6.88**                         | 1.17                 |
| Days to flowering                                          | 14.43                           | 233.76**                       | 2.19                 |
| Number of leaves per shoot (excluding flag leaves)         | 1.88                            | 1.03**                         | 0.14                 |
| Leaf area (cm <sup>2</sup> )                               | 5.43                            | 1032.61**                      | 15.43                |
| Diameter of foremost floret after two days of opening (cm) | 0.67                            | 4.32**                         | 0.19                 |
| Number of seeds per capsule                                | 20.23                           | 301.01**                       | 6.33                 |
| Plant height (cm)                                          | 9.50                            | 462.60**                       | 3.91                 |
| Rachis length (cm)                                         | 10.89                           | 145.31**                       | 1.69                 |
| Days for last floret opening                               | 91.00                           | 274.26*                        | 111.59               |
| Number of corms produced per plant                         | 0.07                            | 0.35**                         | 0.09                 |
| Average weight of a daughter corm (g)                      | 25.26                           | 200.96**                       | 5.74                 |
| Number of cormels produced per plant                       | 6.55                            | 2901.30**                      | 9.45                 |
| Weight of cormels produced per plant (g)                   | 1.81                            | 42.55**                        | 0.87                 |
| Propagation coefficient (%)                                | 2939.12                         | 12521.92**                     | 1252.57              |
| Number of florets per spike                                | 1.50                            | 13.65**                        | 0.43                 |

\*\* =  $P_{0.01}$ , \* =  $P_{0.05}$

On the basis of D<sup>2</sup> analysis, all the 25 genotypes were grouped in 5 clusters (Table 2). Maximum number of varieties i.e., 11 were included in cluster III. Cluster II had only one variety i.e., High Style and cluster V two (one Gambier Pearl and the other a cross i.e. Green Lilac × Heady Wine). Cluster IV was the second largest group of seven genotypes whereas cluster I had only four genotypes. Cluster I included three exotic varieties (Green Lilac, Heady Wine and Regency), was the earliest in flowering (113.86 days) with less number of leaves (6.12) but highest rachis length (33.77 cm) while propagation coefficient recorded was minimum (169.67%). Cluster II which had only one variety was found to be outstanding with regard to

**Table 2 : Cluster formation of 25 genotypes of gladiolus on the basis of genetic divergence**

| Cluster | Number of genotypes | Varieties                                                                                                                                                                                                                                                                           |
|---------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I       | 4                   | Gambier Pearl × Regency, Greenlilac, Heady wine, Regency                                                                                                                                                                                                                            |
| II      | 1                   | High Style                                                                                                                                                                                                                                                                          |
| III     | 11                  | Christian Jane × Rose Time Steamboat, Eve × Mayur, Mayur × Heady Wine, Miss America × American Beauty, Pfitzer's Sensation × Christian Jane, White Oak × Christian Jane, White Oak × High Style, White Oak × Pfitzer's Sensation, Christian Jane, Miss America, Pfitzer's Sensation |
| IV      | 7                   | American Beauty × Christian Jane, American Beauty, Eve, Mayur, Rose Time Steamboat, Smoky Lady, White Oak                                                                                                                                                                           |
| V       | 2                   | Green Lilac × Heady Wine, Gambier Pearl                                                                                                                                                                                                                                             |

leaf area (115.80 cm<sup>2</sup>) and propagation coefficient (338.33%) as number and weight of corms and cormels produced per plant were maximum. However, it was minimum for number of seeds per capsule. Cluster III consisted of eight indigenous and three exotic varieties which gave average performance for many of the characters. However, floral diameter (12.50 cm), rachis length (48.34 cm in Mayur × Heady Wine) and propagation coefficient (209.33% in White Oak × Smoky Lady) were maximum in the indigenous group while among the three exotics, only Miss America produced maximum number of seeds (52.14) per capsule. Cluster IV consisted of seven varieties (5 exotic and 2 indigenous) where one of the indigenous varieties (Mayur) produced minimum number of leaves (6.44) and minimum length of spike (40.79 cm) but maximum number of flowers per spike (15.05), corms per plant (2.15) and maximum propagation coefficient (330.00%). Cluster V consisted of only two varieties (one indigenous and one exotic) which showed that indigenous material was better for flower size (10.58 cm), corm and cormel production and propagation coefficient (22.33%) while its performance was poor for rachis length (30.61 cm) and for number of florets (7.94) per spike.

Cluster means (Table 3) showed that the varieties in cluster I are average varieties for many characters. Cluster II remained good for leaf area, diameter of foremost floret, number of seeds per capsule and for corm and cormel production because the propagation coefficient (338.33%) was maximum in this cluster. Cluster III was average for most of the characters but for propagation coefficient (145.82%), it was the poorest. The varieties of cluster V showed delayed flowering with maximum plant height and spike length as well as maximum number of flowers per spike (13.35) and seeds per capsule (39.93). Cluster V accessions were earliest in flowering (101.87 days) with minimum leaf area (61.08 cm<sup>2</sup>).

**Table 3 : Means of clusters for different quantitative characters in gladiolus**

| Characters                                                 | Clusters |        |        |        |        |
|------------------------------------------------------------|----------|--------|--------|--------|--------|
|                                                            | I        | II     | III    | IV     | V      |
| Days to 50% sprouting                                      | 10.63    | 11.60  | 10.10  | 10.30  | 7.30   |
| Days to flowering                                          | 120.46   | 123.29 | 120.96 | 128.44 | 101.87 |
| Number of leaves (excluding flag leaves) per sheet         | 6.47     | 8.04   | 6.54   | 7.26   | 6.18   |
| Leaf area (cm <sup>2</sup> )                               | 73.61    | 115.80 | 66.80  | 86.83  | 61.08  |
| Diameter of foremost floret after two days of opening (cm) | 9.41     | 11.17  | 10.11  | 10.60  | 9.93   |
| Number of seeds per capsule                                | 25.78    | 18.18  | 37.27  | 39.93  | 19.58  |
| Plant height (cm)                                          | 69.24    | 91.84  | 77.34  | 97.36  | 80.57  |
| Rachis length (cm)                                         | 30.35    | 36.23  | 38.63  | 45.72  | 35.69  |
| Days to last floret opening                                | 128.99   | 132.40 | 135.74 | 138.80 | 115.36 |
| Number of corms produced per plant                         | 1.70     | 2.51   | 1.42   | 1.65   | 1.69   |
| Average weight of a daughter corm (g)                      | 41.24    | 54.97  | 30.70  | 36.25  | 38.64  |
| Number of cormels produced per plant                       | 35.80    | 161.67 | 16.27  | 41.09  | 29.17  |
| Weight of cormels per plant (g)                            | 8.09     | 17.86  | 3.43   | 7.51   | 4.55   |
| Propagation coefficient (%)                                | 201.25   | 338.33 | 145.82 | 179.90 | 188.17 |
| Number of capsules per sheet                               | 5.93     | 8.50   | 8.17   | 10.06  | 6.87   |
| Number of florets per spike                                | 9.61     | 10.42  | 12.27  | 13.35  | 9.79   |

Intra and intercluster D<sup>2</sup> values are given in Table 4. Intracluster D<sup>2</sup> values ranged from 0 to 8.596. It was maximum in cluster IV followed by cluster III and cluster I. Cluster II and cluster IV had one and two genotypes, respectively. The intercluster D<sup>2</sup> values ranged from 84.953 to 11.854. It was maximum between cluster II and cluster III (84.953) followed by cluster II and cluster V (77.334). The minimum intercluster D<sup>2</sup> values was found between cluster III and cluster IV (11.417), followed by a similar intercluster D<sup>2</sup> values

between cluster I and cluster II (11.854). This reveals that genotypes of these clusters (I, III and IV) are close to each other. It is quite apparent that cluster I and III, and III and IV are close to each other. Cluster I with four genotypes seem to be very close to cluster V which comprised two genotypes. Cluster II which had one genotype appears to be very far from Cluster I, III and V. Cluster II was very far from cluster IV also which consisted of seven genotypes.

**Table 4 : Average intra and intercluster  $D^2$  values among 25 genotypes of gladiolus**

| Cluster | I      | II     | III    | IV     | V    |
|---------|--------|--------|--------|--------|------|
| I       | 4.032  |        |        |        |      |
| II      | 56.115 | 0.000  |        |        |      |
| III     | 11.854 | 84.953 | 8.082  |        |      |
| IV      | 25.130 | 54.125 | 11.417 | 8.596  |      |
| V       | 14.737 | 77.334 | 19.927 | 35.772 | 3.61 |

Perusal of Table 5 reveals the contribution of different characters. Plant height and number of cormels contributed maximum value (19.33%) followed

**Table 5 : Contribution of each character to divergence in gladiolus**

| Characters                               | Number of times<br>appearing first to ranking | Per cent<br>contribution |
|------------------------------------------|-----------------------------------------------|--------------------------|
| Days to sprouting                        | 0.00                                          | 0.00                     |
| Days to flowering                        | 50.00                                         | 16.66                    |
| Number of leaves per sheet               | 0.00                                          | 0.00                     |
| Leaf area (cm <sup>2</sup> )             | 19.00                                         | 6.33                     |
| Diameter of foremost floret after 2 days | 3.00                                          | 1.00                     |
| Number of seeds per capsule              | 2.00                                          | 0.66                     |
| Plant height (cm)                        | 58.00                                         | 19.33                    |
| Rachis length (cm)                       | 38.00                                         | 12.66                    |
| Days for last floret opening             | 1.00                                          | 0.33                     |
| Number of corms produced per plant       | 0.00                                          | 0.00                     |
| Average weight of a daughter corm (g)    | 7.00                                          | 2.33                     |
| Number of cormels produced per plant     | 58.00                                         | 19.33                    |
| Weight of cormels produced per plant (g) | 10.00                                         | 3.33                     |
| Propagation coefficient (%)              | 32.00                                         | 10.66                    |
| Number of capsules per sheet             | 9.00                                          | 3.00                     |
| Number of florets per spike              | 13.00                                         | 4.33                     |
| Total                                    | 300.00                                        | 100.00                   |

by days for initial flowering (16.66%) and rachis length (12.66%). Lowest contribution was observed for days for 50 per cent sprouting, number of leaves per shoot and number of corms produced per plant whereas contribution of other characters was moderate towards the genetic diversity. Number of seeds per capsule and days for last floret opening contributed less than 1 per cent towards genetic divergence.

The results of present findings are in close agreement with the earlier studies (Suman *et al.*, 1984; Raamsdonk and De Vries, 1989; Misra *et al.*, 1990) which showed that the pattern of distribution of these genotypes in various clusters was having considerable amount of genetic divergence among them for most of the characters studied.

#### ACKNOWLEDGEMENTS

Senior Author is highly grateful to the Director, IARI, New Delhi for providing financial assistance in the form of Jr. Research Fellowship. Authors are also highly grateful to the Head, Division of Floriculture & Landscaping, IARI, New Delhi for providing facilities, and to Drs. H. C. Saini and C. S. Kalia for their kind help in carrying out the present investigations.

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## EVALUATION OF CHERRY GERMPLASM

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Thirty seven cherry cultivars were introduced at Temperate Horticultural Research Station, Kotkhai (National Hortorium) during 1961 to 1965 out of which 20 are still existing in satisfactory condition of growth and productivity. Cultivar Triumph Domini was very good yielder which produced 46.0 kg fruit (cumulative yield of 1990-1992). This was followed by Pictroase Negre (10.700 kg) and Germersdorfer (10.450 kg). Triumph Domini was also earliest to ripe closely followed by Pictroase Negre and were early to the already recommended cultivar Seneca. These are bright to dark red in colour and sweet in taste. Triumph Domini, Bigarreau Noir Hative, Germersdorfer and Emperor Francis were almost free from shot hole leaf disease and all other cultivars had light to moderately high attack of the disease. Moderate to severe infestation of flat headed peach tree borer, *Sphenoptera lafertei* Thomson was noticed in most of the germplasm. However, trees of Triumph Domini, Bigarreau Noir Hative, Bedford Prolific-202, Pictroase Negre, and Early River were free from the ravages of the insect pest.

**Key words :** Cherry germplasm, evaluation, shot hole disease, peach tree borer

Cherry is the earliest fruit to come in the market. It is grown on small scale in Himachal Pradesh, Kashmir and Kumaon hills. The area under the fruit is only about 380 hectares (Srivastava, 1974). Main production is confined to Kashmir only, from where the fruits are sent to distant markets. Very limited plantations are also available in Shimla and Narkanda areas of Shimla district and Kullu area. The major limiting factor in its cultivation is absence of early ripening and self fruitful varieties. Prevalence of gummosis and leaf spot are main reasons in its decline. Presently available varieties are mostly mid season in ripening. To select promising cultivars of cherry, the existing germplasm at the station was evaluated for growth, yield, fruit quality, insect-pest and disease resistance. The observations reported in this paper would help in proper evaluation of this germplasm for selecting promising cultivars.

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## MATERIALS AND METHODS

Thirty seven cherry cultivars were introduced at Temperate Horticultural Research Station, Kotkhai (National Hortorium) during 1961 to 1965 from which 19 cultivars belonging to *Prunus avium* group and one namely Suda Hardy of *Prunus cerasus* type are still existing in satisfactory condition of growth. Each cultivar comprising two trees, planted at eastern aspect of the station at an elevation of 1800m above sea level. The station is located in the Temperate Wet Zone of the state and is moderately suited for cherry cultivation. These trees were trained to modified centre leader system and cultural operations as well as manurial schedule for all the experimental trees were uniform. Observations on yield and fruit quality were recorded during 1990-1992.

Varieties were also studied for the incidence of flat headed peach tree borer (*Sphenoptera lafertei* Thomson) which is a serious pest of stone fruits and mainly responsible for gummosis in these fruit plants. Oozing of gum from the main trunk and limbs with elliptical adult emergence holes (old attack) were also considered. The attack was arbitrarily graded into five categories on the basis of gum-oozing and adult emergence holes which are as : healthy (0), light (1 to 10), moderate (11- 30), heavy (21-30), very heavy (31-50) and severe (more than 50). Observations on shot hole disease attack were categorized according to visual key depending upon the incidence and intensity of attack.

## RESULTS AND DISCUSSION

The data on growth, yield, fruit quality and incidence of flat headed peach tree borer and shot hole disease are given in Table 1.

**Trunk girth and tree height :** Maximum tree growth in respect of girth (109 cm) was recorded in Bigarreau Severne which was followed by Bigarreau Noir Gross. Tree of Suda Hardy had minimum (58 cm) tree girth. Trees of Red Heart were more in vertical growth and Early River ranked second in this respect.

**Yield :** The data on cumulative fruit yield for 3 years (1990-92) revealed maximum yield of 46.0 kg in Triumph Domini. It was followed by Pietroase Negre (10.700 kg) and Germersdorfer (10.450 kg). All other cultivars yielded in very poor cropping in Kotkhai conditions. Yield in cultivars like Emperor Francis, Boambe-De-cotnari, Pinkish Early, Sohmidt, White Heart Big Late was almost negligible. The performance of Triumph Domini was comparatively better in each year.

**Maturity :** Various cultivars are classified into different categories according to ripening order in Table 2

**Table 1 : Observations on tree growth, yield, quality and incidence of insect-pest and diseases of cherry germplasm**

| Cultivar              | TG    | TH   | CFY    | DH   | AFW  | TSS  | LA   | ISH |
|-----------------------|-------|------|--------|------|------|------|------|-----|
| Red Heart             | 97.0  | 5.75 | 3.200  | 29/5 | 1.35 | 5.0  | +    | +   |
| Black Heart           | 69.0  | 4.30 | 5.750  | 28/5 | 2.15 | 8.0  | +    | +   |
| Napolean              | 80.0  | 5.00 | 3.800  | 25/5 | 2.31 | 10.0 | +    | +   |
| Germrsdorfer          | 86.0  | 4.15 | 10.450 | 7/5  | 1.30 | 14.0 | +    | 0   |
| Early River           | 94.0  | 5.55 | 0.480  | 7/5  | 1.85 | 6.3  | 0    | ++  |
| Early Purple          | 76.0  | 5.50 | 1.450  | 29/5 | 1.95 | 14.0 | +    | +   |
| Schmidt               | 100.0 | 5.25 | 0.05   | 28/5 | 4/10 | 9.5  | 0    | +   |
| Pinkish Early         | 66.5  | 4.60 | -      | -    | -    | -    | +++  | +   |
| Frogmore              | 91.0  | 5.45 | -      | -    | -    | -    | +++  | +   |
| Suda Hardy            | 58.0  | 4.31 | 0.05   | 25/5 | 2.80 | 9.0  | +++  | +   |
| Triumph Domini        | 87.0  | 5.40 | 46.00  | 30/4 | 2.35 | 6.0  | 0    | 0   |
| Pietroase Negre       | 92.0  | 4.60 | 10.70  | 4/5  | 1.35 | 7.0  | 0    | 0   |
| Emperor Francis       | 59.0  | 4.20 | -      | -    | -    | -    | +    | 0   |
| Bigarreau Noir Hative | 91.0  | 5.10 | 1.60   | 29/5 | 2.35 | 10.0 | 0    | 0   |
| Bigarreau Noir Gross  | 105.0 | 5.20 | 4.87   | 8/6  | 4.14 | 8.0  | +    | +   |
| Guigne Noir Gross     | 74.0  | 4.80 | 2.65   | 10/6 | 2.50 | 10.0 | +++  | +   |
| Bedford Prolific-202  | 104.0 | 5.90 | 1.26   | 20/5 | 1.70 | 4.0  | 0    | +   |
| Bigarreau Severne     | 109.0 | 5.20 | 2.25   | 7/5  | 1.40 | 7.0  | ++++ | +   |
| Boambe-De-Cotnari     | 60.0  | 4.35 | -      | -    | -    | -    | ++++ | +   |
| White Heart Big Late  | 76.0  | 5.40 | -      | -    | -    | -    | 0    | +   |

0 Attack free, + Light, ++ Moderate incidence, +++ Heavy incidence, ++++ Very heavy/Severe incidence

TG = Trunk girth (cm), TH = Tree height (m), CFY = Cumulative fruit yield (1990-1992), DH = Date of Harvest (Date/Month), AFW = Average fruit weight (g), TSS = T.S.S. (Brix) %, LA = Level of attack of flat headed peach tree borer, ISH = Incidence of shot hole disease

**Table 2 : Order of ripening of cherry germplasm under Kotkhai conditions**

| Early season<br>(Before May,5) | Early mid<br>season<br>(May 6-15) | Mid season (May<br>16-25) | Late mid<br>season (May<br>25-June)                                      | Late season<br>(After June) |
|--------------------------------|-----------------------------------|---------------------------|--------------------------------------------------------------------------|-----------------------------|
| Triumph Domini                 | Germersdorfer                     | Bedford Prolific-202      | Red Heart                                                                | Bigarreau<br>Noir Gross     |
| Pietroase Negre                | Early River                       | Napolean                  | Schmidt                                                                  | Guigne Noir<br>Gross        |
|                                | Bigarreau Severne                 |                           | Black Heart<br>Buda Hardy<br>Early Purple<br>Bigarreau<br>Noir<br>Hative |                             |

Triumph Domini cultivar started maturing in last week of April and was completely harvested in April or early May. Pietroase Negre was slightly late in ripening than the Triumph Domini. Three cultivars namely Germersdorfer, Early River and Bigarreau Severne two other varieties namely Napolean, and Bedford Prolific-202 were early mid season in ripening. Napolean was also reported to be late mid season by MAFF (1961).

**Fruit size :** There were large variations in fruit size of cherry cultivars and the average weight ranged from 1.30g to 4.14g. According to fruit weight, the cultivars can be classified into 3 groups. (Table 3).

**Table 3 : Classification of cherry cultivars according to fruit weight**

| Small size (less than 2g) | Medium (2 to 4g)      | Large (4 to 6g)      |
|---------------------------|-----------------------|----------------------|
| Germersdorfer             | Black Heart           | Schmidt              |
| Pietroase Negre           | Bigarreau Noir Hative | Bigarreau Noir Gross |
| Red Heart                 | Triumph Domini        |                      |
| Early River               | Napolean              |                      |
| Early Purple              | Suda Hardy            |                      |
| Bigarrequ Severne         | Guine Noir Gross      |                      |
| Bedford Prolific-202      |                       |                      |

**Fruit colour :** Cherry cultivars in the present study were found yellow to dark red and black in colour. According to colour the cultivars are classified in to following four groups (Table 4). Five cultivars did not produce any crop in last three years so could not be evaluated for this parameter.

**Table 4 : Classification of cherry cultivars according to colour and appearance**

| Very attractive<br>(dark red to black) | Attractive<br>(Bright red) | Moderately attractive<br>(Red blush on yellow<br>background) | Fair (pale colour with<br>red blush) |
|----------------------------------------|----------------------------|--------------------------------------------------------------|--------------------------------------|
| Black Heart                            | Red Heart                  | Germersdorfer                                                | Early River                          |
|                                        | Schmidt                    | Bigarreau Noir<br>Gross                                      | Suda Hardy                           |
|                                        | Napolean                   | Bigarreau Noir<br>Hative                                     |                                      |
|                                        | Triumph Domini             | Guigne Noir Gross                                            |                                      |
|                                        | Pietroase Negre            | Bigarreau Severne                                            |                                      |
|                                        | Early Purple               |                                                              |                                      |

**Fruit taste :** Taste of fruit as adjudged by panel of experts, were classified as shown in Table 5.

**Table 5 : Classification of cherry cultivars according to taste**

| Sweet of good<br>quality | Subacidic but<br>acceptable | Watery acidic fairly<br>acceptable | Acidic and Bitter<br>with poor quality |
|--------------------------|-----------------------------|------------------------------------|----------------------------------------|
| Bigarreau Noir Cross     | Early River                 | Germersdorfer                      | Napolean                               |
| Bigarreau Noir<br>Hative | Black Heart                 | Bedford Prolific-202               | Suda Hardy                             |
| Red Heart                | Guigne Noir Gross           |                                    | Bigarreau Severne                      |
| Triumph Domini           |                             |                                    |                                        |

**Insect/pests :** Moderate to severe incidence of flat headed peach tree borer was noticed on most of the cultivars. Trees of Early River, Schmidt, Triumph Domini, Pietroase Negre, Bigarreau Noir Hative, Bedford Prolific-202 and White Heart Big Late were free from the ravages of the insect pest. Gumming tendency was mainly associated with insect damage and trees planted at north eastern aspect were least affected. Heavy infestation of cherry by flat headed peach tree borer in Himachal Pradesh is reported by Sharma *et al.* (1990) as compared to other stone fruits and this is stated to be due to its open branches and less spread of its canopy.

**Shot hole disease :** Incidence of shot hole disease was also recorded and the categorization was done on visual observations. Four cultivars namely Triumph Domini, Bigarreau Noir Hative, Germersdorfer and Emperor Francis were observed almost free of shot hole disease and all other cultivars had light to moderately high attack of the disease.

The disease is also known as cherry leaf spot which is caused by *Cocomyces hiemalis* and is world wide in its distribution. This may result in reduced shoot growth, reduction in fruit set and size, death of spurs in winter and even death of trees. Defoliation prior to ripening period is reported to reduce size and quality of fruit with uneven ripening and insipid taste (Anderson, 1956).

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## SACCHARUM GERMPLASM COLLECTION IN ARUNACHAL PRADESH

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Lohit and Tawang Districts of Arunachal Pradesh were surveyed during October 1990 for collection of *Saccharum* germplasm. Areas around Paye, Hawa Camp and Hayuliang were particularly rich in diversity for *Saccharum spontaneum* and *Erianthus* in Lohit district. All morphotypes of *S. spontaneum* were present in these areas. *Erianthus fulvus* and *Miscanthus nepalensis* were extensively distributed in Tawang district. *S. spontaneum* was sparsely distributed in Tawang.

**Key words :** *Saccharum* spp., distribution, diversity

Arunachal Pradesh is a major area of diversity for *Saccharum* germplasm. *S. spontaneum*, *Erianthus* spp., *Miscanthus nepalensis*, *Narenga porphyrocoma* and *Sclerostachya fusca* are extensively distributed in the state. They co-exist and flower together in their natural habitats providing ample opportunity for introgression. Germplasm collection from the state was hence considered a priority and the state was explored during 1984 and 1985 (Sreenivasan *et al.*, 1984; Sreenivasan and Palanichamy, 1985) and nearly 300 clones were collected. The present collection is from areas not covered earlier and from where representation was too low.

### COLLECTION METHODS

Target areas for collection were the districts of Lohit and Tawang. The team which surveyed Lohit during 1985, identified specific areas around Hayuliang for further collection. Tawang district was considered important for collection because of the possibility of collecting cultivated and wild sugarcane growing at high altitudes. The survey was conducted during (11-27 October 1990) which coincides with the peak flowering of *Saccharum* and related grasses in the region. Collection routes were fixed based on the earlier

reports on species distribution in the state. Efforts were made to collect adequate samples to represent the whole range of variability available in a defined geographic area. Cane samples were collected from cultivated species while clumps were collected from *S.spontaneum*, *Erianthus*, *Miscanthus* and *Imperata*. Passport data on the collections were recorded on the spot. This included information on altitude, habit, plant association, soil type, topography, morphological traits and flowering.

### COLLECTION IN LOHIT DISTRICT

Two major areas were identified for collection in Lohit district, (i) in the Tezu-Paya-Sunpura direction in the south and (ii) Tezu- Hayuliang-Walong direction in the North. Tezu-Paya-Sunpare areas consist essentially of flat lands with marshy patches and forest vegetation. Elevation is only 230-250 m above MSL. Both narrow leaved thin forms and medium tall forms of *S.spontaneum* were found to colonise the banks of Digaru river. Beyond Digaru, *S.spontaneum* was abundantly growing in dense thickets in association with other grasses like *Arundo* and *Phragmites*. *S. spontaneum* and *Erianthus* were abundant in Paya-Sunpare area. *S.spontaneum* in particular showed considerable variability observed in height from 2m to 6m. Forest margins were often waterlogged and both *S.spontaneum* and *Erianthus* were found to thrive well under these conditions.

Tezu-Hayuliang sector is mountainous. From Tezu (300m), the altitude gradually increases to 1640m at Sewak pass and then drops to 600m at Hayuliang. Small forms of *S.spontaneum* were frequent for a few kilometers from Tezu. Diversity was more at higher altitudes such as Hawa pass-Hawa Camp areas. Diverse morphotypes of *S.spontaneum* were found in this area, particularly tall, thick forms having broad and thick leaves. They often exceeded 5m in height and 2.5cm in stalk thickness. Some of them were mildly sweet also. Clone IND 90-804, collected from Hawa Camp was 5.4m tall, 2.7cm thick and recorded 14 per cent H.R.Brix. It had distinct pinkish green stalks with conoidal internodes and leaves too showed pink tinge. *S.spontaneum* clones collected from Hawa Camp area ranged from 1.00m to 5.8m in height. Most of the *S.spontaneum* clones were in flowering. Other plants found in association were *Erianthus*, *Phragmites* and *Imperata*. *Erianthus longisetosus* covered the lower sections of the hill slopes in the area and was in early stages of flowering. Variability for *E.longisetosus* appeared low.

Sewak pass at 1640 m is the highest point in Tezu-Hayuliang sector. *Miscanthus nepalensis* was found along the moist hill slopes in Sewak pass. Its distribution was sparse, restricted to a narrow stretch of about 1 km between 1500m to 1600m altitude. *Miscanthus* clones found here were weak ones and

variability was very much limited. Short forms of *S. spontaneum* were found to occur in Sewak pass.

Banks of Tiding river are extensively colonised by medium type *S. spontaneum*, which showed very little variability. *Erianthus* also was available in this area. Beyond Tiding river, huge forms of *S. spontaneum* were found to occur. IND 90-796 collected from Nara was 7.8m tall with thick stalks (2.4cm). Similar clones were frequently observed upto Hayuliang, so also short and medium types. *Erianthus* had extensive distribution in Tafraliang, among forest vegetation and in open clearings. Variability was however limited. Most of the clones were tall forms (5m). Relatively large forms of *Imperata* were being cultivated in Tafraliang as thatching material. Different morphotypes of *S. spontaneum* were found to occur in Hayuliang-Suplang area. Tall and medium types were found on hill slopes. Dwarf forms were frequent along roadside and in open clearings. *S. spontaneum* collections ranged from 1.00m to 5.45m in height. Vast stretches of land were entirely occupied by *Erianthus*. *Erianthus* clone IND 90-781 collected from zero point was 7.6m tall. *E. longisetosus* also was well distributed in the area. At Khamba and Yathang, dwarf forms of *S. spontaneum* were also found. Other grasses found in association were *Neyraudia* and *Imperata*. Variability for *Saccharum* germplasm was limited in Hawaii. *Erianthus* and *Imperata* were the major plants of interest. *Erianthus* clones found were smaller compared to those found in Hayuliang area. *S. spontaneum* was sparsely distributed. *Erianthus* occurred in many places including Changwinti, Panch kilo and Hapak. Medium type *S. spontaneum* was found in Walong, but variability was poor. *S. officinarum* are grown in home gardens also in Walong.

#### COLLECTION IN TAWANG DISTRICT

Tawang is located at ca 3100m altitude. Major plant species of interest in Tawang were *S. sinense*, *Miscanthus nepalensis* and *Erianthus fulvus*. *M. nepalensis* and *E. fulvus* were extensively distributed in Tawang and both species occurred in close association. Variability for both the species was limited. *S. spontaneum* was sparsely distributed and only thin, medium tall types were found. Cultivated sugarcane (*S. sinense*) were collected from Kitpi, Audung and Namet villages in Tawang. In spite of the high altitude and extreme cold climate, these clones showed excellent growth. Sugarcane were being cultivated in home gardens in Lumla also. Distinctive types were found with thick stalks and broad leaves and impressive growth. *M. nepalensis* and *E. fulvus* were well distributed in Lumla. A total of 94 clones were collected from Lohit and Tawang Districts (Table 1).

**Table 1 : *Saccharum* germplasm collection from Arunachal Pradesh**

| Species                       | Lohit District | Tawang District | Total Collection |
|-------------------------------|----------------|-----------------|------------------|
| <i>Saccharum officinarum</i>  | 2              | -               | 2                |
| <i>Saccharum sinense</i>      | -              | 10              | 10               |
| <i>Saccharum spontaneum</i>   | 42             | 2               | 44               |
| <i>Erianthus</i> spp.*        | 24             | -               | 24               |
| <i>Erianthus longisetosus</i> | 3              | -               | 3                |
| <i>Erianthus fulvus</i>       | -              | 4               | 4                |
| <i>Miscanthus nepalensis</i>  | 3              | 2               | 5                |
| <i>Imperata cylindrica</i>    | 2              | -               | 2                |
| Total collections             | 76             | 18              | 94               |

\*includes cane forming types, viz., *E.arundinaceus* and *E.procerus*

#### SPECIES DISTRIBUTION AND VARIABILITY

There were three areas in Lohit District where considerable variability for *Saccharum* germplasm was found; (i) Paya-Sunpure areas, where medium and tall forms of *S.spontaneum* and *Erianthus* occurred in abundance (ii) Hawa Camp area where all morphotypes of *S.spontaneum* were found to occur and (iii) Nara-Hayuliang - Suplang area, where again all morphotypes of *S.spontaneum* were present. Tafraliang, Hawaii and Walong had limited variability and sparse distribution for *S.spontaneum*. In Tawang, *E.fulvus* and *M.npalensis* were widely distributed. *S.spontaneum* and cane forming types of *Erianthus* were not found. The locally adopted sugarcane (*S.sinense*) collected from Tawang could be important sources for cold tolerance.

Majority of the *S.spontaneum* and *Erianthus* (Cane forming types) were collected from Lohit District. Range and variability for stalk height and stalk thickness are given in Table 2. For *S.spontaneum*, stalk height ranged from 0.3m to 7.8m while for *Erianthus*, the range was from 1.9m to 7.6m. Distribution of *S.spontaneum* and *Erianthus* clones in the different stalk height/thickness groups is given in Tables 3 & 4. In the case of *S.spontaneum*, a continuous range from 0.3m to 7.8m was observed for stalk height and from 0.3cm to 2.8cm for stalk diameter. This probably covers the entire range of variability for these two characters, available in the world collections today. For *Erianthus*, variability for stalk height and diameter was less compared to *S.spontaneum*.

**Table 2 : Range and variation for stalk height and thickness**

|                             | Mean | Range   | CV%   |
|-----------------------------|------|---------|-------|
| <b>Stalk height(m)</b>      |      |         |       |
| <i>S.spontaneum</i>         | 3.07 | 0.3-7.8 | 68.19 |
| <i>Erianthus</i> spp.       | 4.06 | 1.9-7.6 | 31.18 |
| <b>Stalk thickness (cm)</b> |      |         |       |
| <i>S.spontaneum</i>         | 1.31 | 0.3-2.8 | 56.07 |
| <i>Erianthus</i> spp.       | 1.87 | 0.8-2.6 | 21.96 |

**Table 3 : Variability for stalk height (m)**

| Species                       | Stalk height (m) |     |     |     |     |     |     |   | Total clones |
|-------------------------------|------------------|-----|-----|-----|-----|-----|-----|---|--------------|
|                               | 1                | 1-2 | 2-3 | 3-4 | 4-5 | 5-6 | 6-7 | 7 |              |
| <i>S.spontaneum</i>           | 8                | 9   | 7   | 7   | 2   | 7   | 2   | 2 | 44           |
| <i>Erianthus</i> spp.         | -                | 2   | 2   | 13  | 1   | 5   | -   | 1 | 24           |
| <i>Erianthus longisetosus</i> | -                | 2   | 1   | -   | -   | -   | -   | - | 3            |
| <i>Erianthus fulvus</i>       | 2                | 2   | -   | -   | -   | -   | -   | - | 4            |
| <i>Miscanthus nepalensis</i>  | 1                | 4   | -   | -   | -   | -   | -   | - | 5            |
| <i>Imperata cylindrica</i>    | 1                | 1   | -   | -   | -   | -   | -   | - | 2            |
| Total clones                  | 12               | 20  | 10  | 20  | 3   | 12  | 2   | 3 | 82           |

**Table 4 : Variability for stalk thickness**

| Species                | Stalk thickness (cm) |     |     | Total clones |
|------------------------|----------------------|-----|-----|--------------|
|                        | 1                    | 1-2 | 2-3 |              |
| <i>S.spontaneum</i>    | 20                   | 12  | 12  | 44           |
| <i>Erianthus</i> spp.  | 1                    | 13  | 10  | 24           |
| <i>E. longisetosus</i> | 2                    | 1   | -   | 3            |
| <i>E.fulvus</i>        | 4                    | -   | -   | 4            |
| <i>M. nepalensis</i>   | 5                    | -   | -   | 5            |
| Total clones           | 32                   | 26  | 22  | 80           |

### ACKNOWLEDGEMENTS

Authors are thankful to the Director, Sugarcane Breeding Institute, Coimbatore and Director of Agriculture, Govt. of Arunachal Pradesh for facilities.

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## WILD RICE GENETIC RESOURCES OF NORTH-EAST INDIA

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The wild relatives of rice assume enough importance for rice improvement work especially when variability in cultivated rice is nearly exhausted for various stress characters. Genes from *Oryza nivara* incorporated in cultivated rice provide resistance to grassy stunt virus and blast disease. Similarly, *O. officinalis* resistant to brown planthopper, white-backed planthopper and green leafhopper. Semi-aquatic *O. rufipogon* species may contribute genes for adaptation to the stagnant flooding and resistant to bacterial blight. Wild species have also provided CMS lines for hybrid rice production in China. In this paper, an attempt has been made to elucidate wild relatives of rice available in north-eastern part of India.

**Key words :** Rice germplasm, wild *Oryza*, distribution, diversity

There are 22 species of *Oryza* (Vaughan, 1989) of which only two are cultivated. These are *Oryza sativa* L. (Asian rice) and *Oryza glaberrima* Steud. (African rice). Rest of the species occur in wild conditions and hardly a few of them are used as food. In India, *Oryza sativa* is the commonly cultivated species. In addition, 5 wild species including their different forms occur in the country including north-east India.

In the north-eastern parts of India, practically no serious efforts have been made to unravel the present status of wild relatives of rice germplasm. The BSI Herbarium (CAL and ASSAM) however, records the occurrences of the following species in the north-eastern region of the country. The classification of Vaughan (1989) for the genus *Oryza* have been followed in this paper. In the present account, in addition to seven north-eastern states, the adjacent states like Bihar, Orissa, West Bengal, Madhya Pradesh have also been included for better understanding of species distribution.

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## WILD SPECIES OF ORYZA

1. *Oryza granulata* Nees et Arn. ex Watt, Dict. Econ. Prod. Ind. 5: 500. 1891: Hook f. Fl. Brit. India 7: 93. 1896. *O. indandamanica* Ellis in Bull. Bot. Surv. India 27: 225. 1985.

Plant erect, tuft with short slender stolon, perennial; spikelet oblong to elliptic-oblong, shorter than 6 mm.; sterile lemma shorter than 1.5 mm, tapered from the base.

*Note*: The species is photoperiod insensitive; genomic group is diploid. It has got the capacity to thrive in shady forest place and adapted to aerobic red, clay soil.

*Distrib.*: Sikkim, Khasi hills and Bihar hills.

*Exsiccatae*: A.S. Rao, 38783 dt. 13.06.1964, Kamrup, Assam; A.C. Chatterjee, 5631 dt. May, 1902, Hathgaon Jungle, Assam; S.K. Mokim, May, 1902, Takreswari hills, Assam; Griffith, 6441, Assam; Sonaimukh Reserve Forest, Nagaon, Assam; R.S. Rao, 8874, 29.08.1952, Tripura; Balakrishnan, 39215, 18.06.1964, Bonaibuchi Reserve Forest, South of Naokhola town (Nagaon); D.B. Deb, 35265 dt. 22.06.1963, Diphu Reserve Forest, Karbi Anglong, Assam; Clarke, 33832, Bihar.

2. *Oryza officinalis* Wall. ex Watt. Dict. Econ. Prod. Ind. 5: 501. 1891. *O. latifolia* Hook. f., Fl. Brit. India 7: 92, 1896. *O. malampuzhaensis* Krishnaswami et Chandrasekharan in Mad. Agric. J. 45: 471-72. 1958. *Oryza minuta* J.S. Presl. ex C.B. Presl. Rel. Haenk. 1: 208. 1830; Bor, Grass. 605, 1960.

Perennial, rhizomatous; spikelet shorter than 6 mm, not inserted near base of lower whorled panicle branches; ligule glabrous or hairy; awn shorter than 2 cm or awnless.

*Note*: The genome group of the species is CC (diploid) The tetraploid population in southern India is known as *Oryza malampuzhaensis*. The species bears useful traits of multiple pest resistance (Heinrichs *et al.*, 1985).

*Distrib.*: Assam, Khasi hills and Sikkim Terai.

*Exsiccatae*: S.K. Sharma, 12319, 15841 dt. 23.09.1935, Nongpoh; G.K. Deka, 39896, Burnihat; R.N. De, s.n., Lakhimpur; Jenkins, 325921, Upper Assam; D.B. Deb, 2582, Lowbipak, 31.08.1954; J.D. Hooker, 525925, Sikkim; Bor, 17159, Dimapur; C.B. Clarke, 36729, Sikkim Terai; GVS Rao, 23188, Bihar (1150 ft.)

3. *Oryza rufipogon* Griff., Notul. Pl. 3: 5. 1851; Bor, Grass., 605. 1960; Sharma and Sastry, Ind. J. Genet. Pl. Breed. 25(2): 157. 1965.

Perennial, semi-aquatic to aquatic grass with decumbent or floating stem; adventitious roots and extravaginal branching at higher nodes; ligule membranous, panicle well-exserted and lax; spikelet laterally compressed; awns more than 4-5 times longer than lemma, scabrid, reddish; caryopsis red, 7-9 mm × 1.9-2.6 mm.

The highly polymorphic species grows well in marshy habitat and edges of forest areas. Tolerant to stagnant flooding and acid sulphate soils.

*Note:* Genomic group of the species is AA (diploid). A photoperiod sensitive short day plant. The flowering season is between October to February. The species has low seed set and the grains are highly shattered. The species high rate of natural crossing (5-40%) (Chang *et al.*, 1982). The species is resistant to bacterial blight disease (Vaughan and Sitch, 1991). The species can reproduce both vegetatively and sexually.

*Exsiccatae* : R.K. Basak, 1261 dt. 18.12.1969, Moshmara, Birbhum; R.K. Basak, 1572 dt. 11.01.1971, Daskalgram, Birbhum; S.S.R. Bennet, 1045 dt. 10.11.1964, Panchala, Howrah; S.C. Agarwal, 278 dt. 11.01.1956, Harincghata Farm, Nadia; Bor 13747 (ASSAM): Deka, Jaintiapur, 12538 (ASSAM): Bor 6544, Loktak, Manipur.

4. *Oryza meyeriana* (Zoll. et Mor. ex Steud.) Baill, Hist. Pl. 12: 166. 1894. *Padia meyeriana* Zoll. et Mor. Syst. Verz. 103 1845.

Perennial, ca. 1m. tall, plant, rootstalk small, compact, leaves dark green, spikelet narrowly oblong to lanceolate, longer than 6 mm.; awnless sterile lemma shorter than 2 mm, tapered from the base.

*Note* : The species is photoperiod insensitive; the genomic status is diploid. It can tolerate shade is adapted to aerobic soil. It is found in well drained soils from plains to altitudes upto 1000m, along streams under shade. The grains have a good flavour.

*Exsiccatae*: S.K. Mokim, s.n. dt. 18.08.1902 (ASSAM); I.H. Burkill, 35316 dt. 19.06.1911, Lumding, Assam.

5. *Oryza nivara* Sharma and Sastry, Ind. J. Genet. Pl. Breed. 25: 161. 1965; *O. sativa* var. *fatua* Prain, Beng. Pl. 2: 1184. 1903. *O. sativa* var. *spontanea* Roshev, Bull. Appl. Bot. Pl. Breed 27(4): 37. 1961 (*Proparte*).

Annual, semi-erect to decumbent, intravaginal branching, panicle semi-open at maturity, spikelets usually 6-8 mm long and 2-3 mm wide, 1.2-2 mm thick, awn 4-10 cm long, thick, grain deciduous at maturity.

*Note:* Essentially self-pollinated plant. Usually insensitive to photoperiod. Genomic constitution of the species is AA (diploid). It has strong seed dormancy. The species can withstand drought and possesses the characteristics traits of virus resistance. One strain of *O. nivara* (IRRI acc. No. - 101 508) has contributed the grassy stunt virus resistance character which has been successfully incorporated and used in breeding purpose.

*Distrib* : The species has wider distribution which started from Deccan, Madhya Pradesh Bihar and extended to Upper Myanmar (Burma). Thus it indicated that the species may found in N.E. India also if it explored thoroughly because of its trend in continuous distribution.

*Exsiccatae*: Mokim, 1381, Gaya, Bihar; Kurz, s. n., 1869, Araccan, Myanmar (Burma); S.D. Sharma, 69, Kandagarh, M.P. (CAL); G.K. Deka, 12612, Byrni forest (ASSAM)

#### OTHER RELATED TAXA OF ORYZA

The closely related wild taxa of *Oryza* that are occurring in north-eastern India are mainly *Hygrorhiza*, *Leersia*, *Porteresia* and *Zizania*. Each genus is represented by a single species in the region.

1. *Hygrorhiza aristata* (Retz.) Nees ex Wight and Arn. in Edimb. New Phil. Jour. 15: 380. 1833; Hook. f. Fl. Brit. India 7: 95. 1896; Bor, Grass 597. 1960 & Fl. Assam 174. 1982 (Rpt.). *Pharus aristatus* Retz. Obs. Bot. 5: 23. 1789.

Perennial, aquatic grass, stem 30-50 cm, roots feathery at nodes; leaves ovate-lanceolate to linear-oblong, rounded both at apex and base or tip acute, base-cordate; leaf sheaths inflated; panicle 5-8 cm, long, slender; spikelet bisexual, 12-15 mm. long; glumes dorsally convex; awn longer than glume; grains narrowly-oblong.

*Note*: Monotypic genus having chromosome number  $2n=24$ . In north-eastern region, it has been collected from Bengal, Assam, Meghalaya and Tripura. The species is found in slow moving streams and yields a good fodder.

*Exsiccatae*: Bengal, Griffith, 6442; Anon, 21554 dt. 20.10.1960. Diphu Reserve Forest, Assam; Anon, 525762 dt. April, 1891, Nongpoh, Meghalaya; Deb. 569, 581, Agartala, Tripura.

2. *Leersia hexandra* Swartz, Prod. Veg. Ind. Occ. 21. 1788; Hook. f., Fl. Brit. India 7: 94. 1896; Bor, Grass, 599. 1960 and Fl. Assam 5: 173. 1982 (rpt.); Deb, Fl. Tripura 520. 1983.

Perennial bisexual, aquatic grass, extensively creeping runners, rhizome leafy; stem *ca* 1 m, weak; nodes hairy; leaves erect, rigid, acuminate; ligule truncate panicle branched, 5-10 cm. long; few flowered; empty glume 0, flowering glume thin, awnless.

*Note*: The species occurs in swampy and marshy area from sea level to 2100 m altitude. The species having different chromosome numbers  $2n=48$ , 60 and 96.

*Exsiccatae*: Meebold, 6446, Manipur; D.C. Mukherjee 38, Assam; Naskar, 1234, Bengal; Deb, 100, 477, Agartala, Tripura.

3. *Porteresia coarctata* (Roxb.) Takeoka in Bull. Nat. Sci. Mus. Tokyo 8: 406. 1965. *Oryza coarctata* Fl. Ind. ed. 2(2): 206. 1832; Hook. f. Fl. Brit. India 7: 93. 1896.

Aquatic bisexual, robust grass; leaves caudate-acuminate spinous-serrate; ligule short; panicles piniform, few flowered; spikelet *ca* 1 cm; anthers long, slender; ovary narrow, elongate.

*Note*: The species grows in brackish water, tidal swamps and is adapted to salinity in the soil. The grains resemble wheat and are said to be edible. This monotypic species bears the chromosome number  $2n=48$ . Common in delta region of Sunderban (West Bengal), Mahanadi (Orissa and Godavari (Andhra Pradesh).

*Exsiccatae*: Bengal, *s.n.* Kakdwip, 24 Parganas; Sunderban, West Bengal; R.S. Rao, 20749 (ASSAM).

4. *Zizania latifolia* (Griseb.) Stapf. in Kew Bull. 385. 1909; Bor., Fl. Assam 5; 175. 1982 (Rpt.). *Hydropyrum latifolia* Griseb. in Ledeb. Fl. Ross. 4 : 466. 1853.

Perennial, aquatic, tall grass with well developed stolons and rhizomes. Culms 0.9-1.8m high, erect, glabrous, very thick but spongy below, leaves flat, 30-100 x 2-3 cm; inflorescence 30-50 cm. long; flower unisexual; female spikelet 5-17 mm long produced at upper branches while male spikelet 8-12 mm long and occur in lower branches; caryopsis cylindrical, ca. 1.5 cm long.

*Note* : Rhizomes and grains are eaten. The seeds are recalcitrant and hence propagated vegetatively. Well adapted to aquatic or marshy habitats. The chromosome number of the species reported as  $2n = 30$  and  $34$ .

*Exsiccatae* : Manipur, Loktak, Meebold, 6448.

## DISCUSSION

This review is entirely based on literature and herbarium records. The present status of occurrence of wild *Oryza* spp. and its close relatives in the north-eastern region of India is not well known. The Rice Germplasm Conservation Workshop (sponsored by IRRI and IBPGR (now named as IPGRI)) was held at IRRI, Manila (Philippines) in 1983. Resolution of collection programme conceived in the Workshop is still to be implemented for this country in general and north-eastern India in particular. The importance of wild species of rice is now well established due to their various stress tolerant characters.

The species of *Oryza granulata* and *O. meyeriana* usually grow in aerobic soil, shady forest places or edges and hence they are well adapted to low light intensity. The latter species can grow even up to 1000 m altitude and may have genes for low temperature tolerance. *O. officinalis* has genes for multiple pest resistance, while *O. rufipogon* possesses the resistance to bacterial blight. *O. nivara* can withstand drought situation and also has the gene to protect from the grassy stunt virus and from the blast disease. *Leersia hexandra* can thrive well in varied ecological conditions (0-2100 m altitude). This character may be useful in producing high altitude/cold tolerant variety. *Porteresia coarctata* has got the capacity to grow well in saline soils. Therefore, salt tolerant traits may be located in this. Likewise, the unisexual flower of *Zizania latifolia* also can offer unique opportunity to develop male and female lines separately for easy hybridization. The basic need is to obtain the materials through collection and a recourse to successive stages (i.e. maintenance, evaluation, cytological and crossing relationships) for its establishment before a rational enhancement programme can be undertaken.

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## SURVEY AND PERFORMANCE OF *CYMBOPOGON* SPECIES OF INDIAN THAR DESERT

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*Cymbopogon* species is widely distributed in the uncongenial arid environment of Indian Thar desert of Western Rajasthan. The available *Cymbopogon jwarancusa* (Jones) Schult from Bikaner site exhibited 1.26% essential oil content, corresponding to 55% piperitone as the major chemical constituent. *Cymbopogon jwarancusa* (Jones) Schult. sub species *olivieri* (Boiss.) Soenakro has been reported mainly from Osian and Luhawat villages of Jodhpur district but during the survey, this aromatic grass was found at Chandan village of Jaisalmer district also. It contained essential oil content of 0.4%, having 62% citral, 8.12% geraniol and 13% of geranyl acetate as the major chemical constituents. Estimation of some morphological characters alongwith the variation in essential oil contents and their major chemical constituents have been discussed.

**Key words :** *Cymbopogon*, germplasm variability, coefficient of variation, phytochemistry

Considerable research on pasture grasses has been carried out by several workers (Chakraborty, 1971; Ahuja & Mann, 1975) for improvement of rangelands in Indian desert. Apart from pasture grasses, India has vast resources in aromatic grasses, especially *Cymbopogon*, mostly wild, distributed all over the country. A number of *Cymbopogon* species are of great commercial importance as a source of essential oil for use primarily in perfume and pharmaceutical preparations. As part of research programme of survey of the natural resources of Indian Thar desert, collection of two *Cymbopogon* forms, viz., *C. jwarancusa* and *C. jwarancusa* subspecies *olivieri* was done. Shahi and Sen (1989 a, 1980 b) earlier reported the existence of *C. jwarancusa* grass in Indian Thar desert whereas Shahi (1992) reported the presence of *C. jwarancusa* sub sp. *olivieri*. from Jodhpur district. The latter was however, collected from Jaisalmer also.

### MATERIALS AND METHODS

The availability of *C. jwarancusa* is mainly confined to Bikaner (Udasar and Devkundsagar), Deshnoke, Nokha, Sri Dungargarh, Churu and Sardarshahr. *C. jwarancusa* sub-species *olivieri* is collected from Osian and Luhawat villages of Jodhpur district (Shahi, 1992) but the same is also reported from

Chandan village of Jaisalmer district of western Rajasthan. The study was confined to selected sites on ecological perspective with a special emphasis on morphological characters in relation to essential oil content and its quality. In general, the above mentioned sites are hot and arid (xerothermic index 300) (Duggal, 1968; Shahi, 1990). The soil of each site is sandy in texture.

The morphometric characters, viz., plant height, effective tillers, plant circumference and weight were noted for the study of intra specific variations. The essential oils of *Cymbopogon* species were obtained by hydro-distillation method using a Clevenger apparatus. The oils dried over anhydrous sodium sulphate, were used for analysis. Identification and percentage of major chemical constituents was determined by GLC method.

### RESULTS AND DISCUSSION

A wide variability was observed among the morphological characters of both the *Cymbopogon* forms, as signified by higher coefficients and variation (Table 1). This would help in isolation of superior strains from wild populations having higher percentage of essential oil content and major chemical constituent (s) in it. The variation in essential oil content of these *Cymbopogon* taxa was also quantified and depicted in Table 2. The maximum oil content was observed in *C. jwarancusa* (1.26%) collected from Bikaner (Devkundsagar) site, possibly due to appropriate vegetative phenophase. The other plants exhibited reproductive phase (anthesis) at the time of collection.

**Table 1 : Means and coefficients of variation (cv) of various morphological characters of *Cymbopogon* species of Indian Thar desert**

| Characters                    | Site/Species         |       |                                                    |       |
|-------------------------------|----------------------|-------|----------------------------------------------------|-------|
|                               | Bikaner              |       | Jaisalmer                                          |       |
|                               | <i>C. jwarancusa</i> |       | <i>C. jwarancusa</i><br>subspecies <i>olivieri</i> |       |
|                               | Mean                 | C.V.  | Mean                                               | C.V.  |
| Plant height (cm)             | 110.00               | 21.12 | 89.90                                              | 23.50 |
| Effective tillers/plant (No.) | 85.00                | 30.32 | 68.00                                              | 26.95 |
| Plant circumference (cm)      | 50.00                | 25.31 | 60.32                                              | 36.95 |
| Fresh weight / plant (kg)     | 0.82                 | 20.01 | 1.42                                               | 19.01 |

*C. jwarancusa* collected from Bikaner site, exhibited the presence of piperitone (45 to 54%) as the major chemical constituent in the oil. This confirms with the earlier observations of Shahi and Sen (1989 a; 1989 b). *C.*

*jwarancusa* subspecies *olivieri* exhibited the presence of citral (42-62%), geraniol (8-19%) and geranylacetate (10-13%) as the major chemical constituents (Table 2), which confirms the findings of Shahi (1992). The plants of the same species, collected from Chandan village of Jaisalmer district, exhibited similar pattern of chemical profile (Table 2). Thus, these species can become important basic material for breeding an alternative source of piperitone and citral.

**Table 2 : Essential oil contents and major chemical constituents of *Cymbopogon* species of Indian Thar desert at different sites**

| Sites             | Plant species                                      | Pheno-<br>phase | Essential<br>oil<br>content<br>%, V/W,<br>fr. wt.<br>basis | Parameter (s)                      |        |          |                         |
|-------------------|----------------------------------------------------|-----------------|------------------------------------------------------------|------------------------------------|--------|----------|-------------------------|
|                   |                                                    |                 |                                                            | Major chemical constituents<br>(%) |        |          |                         |
|                   |                                                    |                 |                                                            | Piperi-<br>tone                    | Citral | Geraniol | Gera-<br>nyl<br>acetate |
| <i>Bikaner</i>    |                                                    |                 |                                                            |                                    |        |          |                         |
| (i) Udasar        | <i>C. jwarancusa</i>                               | Flowering       | 0.73                                                       | 45.06                              | -      | -        | -                       |
| (ii) Devkundsagar | <i>C. jwarancusa</i>                               | Vegetative      | 1.26                                                       | 54.91                              | -      | -        | -                       |
| <i>Jodhpur</i>    |                                                    |                 |                                                            |                                    |        |          |                         |
| (i) Lohawat       | <i>C. jwarancusa</i><br>(sub sp. <i>olivieri</i> ) | Flowering       | 0.60                                                       | -                                  | 42.49  | 19.93    | 10.08                   |
| <i>Jaisalmer</i>  |                                                    |                 |                                                            |                                    |        |          |                         |
| (i) Chandan       | <i>C. jwarancusa</i><br>(sub sp. <i>olivieri</i> ) | Flowering       | 0.40                                                       | -                                  | 62.04  | 8.12     | 12.90                   |

The initial phytochemical estimation of the quantity and quality of essential oils of *Cymbopogon* species of the Great Indian Thar desert is reported. These species may also be tested for yield potential. Further exploration and selection can be undertaken for high yielding, drought tolerant strains. Breeding work may also be initiated to have desirable varieties suitable to arid/xeric conditions.

#### ACKNOWLEDGEMENTS

Authors express their gratitude to Dr.R.S. Kapil, Director, RRL, Jammu for providing necessary facilities. Thanks are also due to Miss R.K. Jamwal, Scientist, RRL, Jammu for GC analysis of essential oils.

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## IN VITRO PLANTLET REGENERATION FROM EMBRYOS OF INTER-SPECIFIC HYBRIDS OF CAPE GOOSEBERRY (*PHYSALIS PERUVIANA* L.)

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Hybrids were successfully obtained from crosses involving *Physalis minima* L. and *Physalis peruviana* L. by culturing the excised embryos *in vitro* after 20-25 days from pollination on MS medium supplemented with Kinetin (0.2 mg/l) and  $\alpha$ -naphthalene acetic acid (0.1 mg/l). The crossed fruits possessed same colour as that of wild male parent but with a varied intensity. The regenerated plantlets were transferred to pots and watered with nutrient solution. Sixty four per cent of the transferred plantlets established well.

**Key words :** Cape gooseberry, *Physalis peruviana*, *in vitro* hybrids

Cape-gooseberry (*Physalis peruviana* L. syn. *P. edulis*), native of Peru and Chile is recent introduction in India. The fruits are delicious, rich source of carotene, vitamin C, pectins and minerals (phosphorus and iron) and seeds have abundance of flavourless oil (Mazumdar, 1979). Ripe berries are also used in preparation of enriched meal and curries. Being an annual crop, cape gooseberry can be grown as intercrop in the orchards. This crop is highly susceptible to leaf curl mosaic virus (LCMV) having more than 60 per cent of disease incidence (Pal *et al.*, 1993) and no resistant source to LCMV among the existing cultivated species is available. During a survey, it was observed that the wild type **Bhambola** (*Physalis minima* L.), characterized by fruits with purple patches, possesses resistance against the LCMV. The LCMV free material is reported to increase the yield by 26.7 per cent (Pal *et al.*, 1993). Hence, the present attempt was made to introgress the gene(s) for resistance against LCMV into the local cultivated variety of Cape gooseberry using embryo rescue technique. Embryo culture has been used to rescue the hybrid embryos in a number of plant species which are otherwise incompatible (Khush and Brar, 1986).

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## MATERIALS AND METHODS

Interspecific hybridization was carried out by using wild species, *Physalis minima* as male parent and cultivated *P. peruviana* as female parent. Crosses were made during October-November by emasculating the flower buds; which were about to bloom within 2-3 days. The emasculated pistils were pollinated by rubbing pollen on receptive sticky stigma using camel hair brush. The pollinated pistils were bagged thereafter for a week. The resultant fruits from the crosses were harvested after 20-25 days from pollination and the embryos were excised aseptically. The  $F_1$  embryos were then cultured on  $MS_1$ ,  $MS_2$  and  $MS_3$  medium (Table 1) having nutrient salts of MS medium (Murashige and Skoog, 1962). The culturing was performed under aseptic conditions in a laminar-flow cabinet and the cultures were incubated at  $25 \pm 2^\circ\text{C}$  and 3000 Lux light intensity. The regenerated plantlets were washed with water to remove *agar agar* and transferred to soil.

**Table 1 : *In vitro* regeneration of cultured hybrid embryos of cape gooseberry**

| Medium                                     | Embryos<br>cultured (No.) | Regeneration<br>(%) | Survival in<br>pots (%) | Remarks                                                                                |
|--------------------------------------------|---------------------------|---------------------|-------------------------|----------------------------------------------------------------------------------------|
| $MS_1$ NAA (0.1 mg/l) +<br>Kin. (0.2 mg/l) | 126                       | 92.8                | 64.2                    | Normal rooting and<br>shooting                                                         |
| $MS_2$ NAA (1.0 mg/l)                      | 50                        | 70.0                | 0.0                     | Embryo derived<br>shoots showed<br>callusing at their<br>base and rooting<br>therefrom |
| $MS_3$ Kin. (0.5 mg/l)                     | 50                        | 70.2                | 0.0                     | No rooting of<br>shoots, some<br>callusing                                             |

## RESULTS AND DISCUSSION

Interspecific hybrids were successfully obtained involving wild *P. minima* and cultivated *P. peruviana*. No fruit setting was observed in the emasculated and unpollinated flowers indicating that pollination is prerequisite for fruit setting in gooseberry. The open-pollinated flowers showed higher fruit setting (77.0%) as compared to hand cross pollinated (26.8%). Similar observations pertaining to higher fruit set in open pollinated flowers as compared to hand cross pollinated flowers has been made in *Citrus* (Singh and Joomer, 1949; Raman, 1990). It was interesting to note that crossed fruits possessed the metaxenia effect but with varying magnitude. Some fruits were dark purple to blackish, while the others had a mosaic pattern of purple black with greenish tinge. No such pattern on fruits was observed from open pollinated flowers.

Upon culturing the  $F_1$  embryos, green and healthy plantlets were regenerated *in vitro*. The radical began to emerge within 3-5 days after culturing followed by opening of green and/or partly etiolated cotyledons. The primary leaves were initiated after 10-12 days followed by elongation of epicotyl. The immature embryos excised from younger fruits (20-25 DAP) showed lower regeneration (22%) as compared to mature fruits (99 %), 45-50 days after planting.

Among the different media tried (Table 1),  $MS_1$  was found to be the best for high plantlet regeneration (92.8%). The regenerated plantlets had normal shoot and roots capable of supporting further plant growth (Fig. 1A).

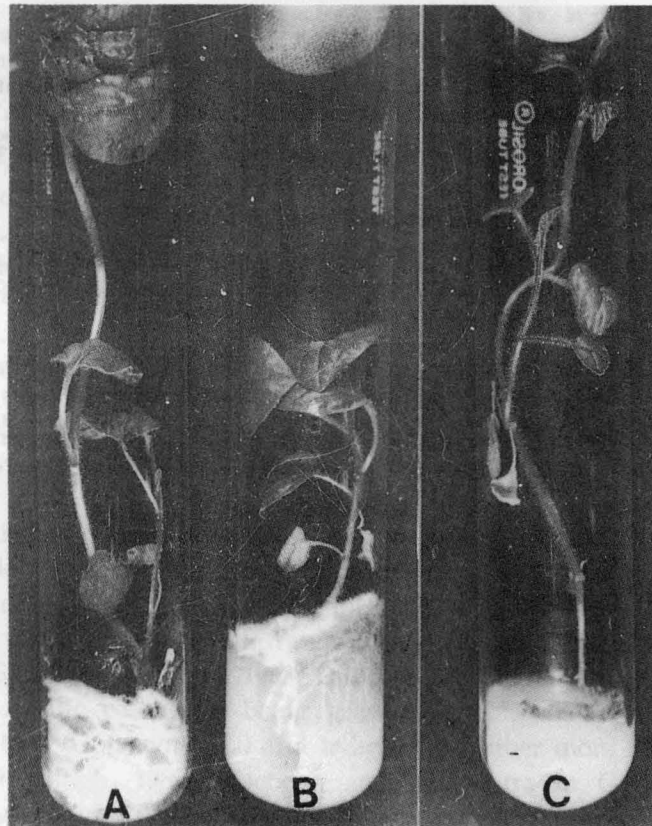


Fig. 1.A-C. *In-vitro* culture of  $F_1$  hybrid embryos

- (A) Showing normal plantlet regeneration on MS medium supplemented with NAA (0.1 mg/l) and Kin (0.2 mg/l)
- (B) Showing extensive rooting but from callused regions on MS medium supplemented with NAA (1 mg/l)
- (C) *In-vitro* raised shoot from cultured embryo showing callusing but no rooting on MS medium supplemented with Kin (0.5 mg/l)

These plantlets showed the maximum survival (64.2%) under field conditions. Though shoot regeneration frequency was also high on MS<sub>2</sub> and MS<sub>3</sub> but these media did not support a root system capable of successful transfer to field. It was seen that on MS<sub>2</sub> medium, there was extensive rooting but from the callusing area of the shoot (Fig. 1B). On MS<sub>3</sub> medium, the embryo derived shoot did not root, but some callusing was observed at the base of shoot (Fig. 1C). This may be due to higher level of auxin-cytokinin ratio. The embryo derived plants (F<sub>1</sub>) have been transferred to the field and are being further evaluated. The screening of hybrids for LCMV and other desirable traits alongwith backcrossing programme is underway to develop better cape gooseberry types with increased level of resistance.

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## COLLECTING COTTON (*GOSSYPIMUM* SPP.) GERMPLASM IN KACHCHH AND SAURASHTRA REGIONS OF GUJARAT

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In an exploration undertaken in January, 1991, 77 germplasm comprising 3 cultivated species of cotton were collected from 67 sites in Kachchh and Saurashtra regions in Gujarat. Forty two samples in *Gossypium herbaceum* L. and 32 in *G. arboreum* L. represented the local diversity in Asiatic diploid cottons and 3 in *G. hirsutum* L. in American cotton. The collections showed a wide range of variability in plant height, plant habit, plant pigmentation, leaf lobing, boll number, size, shape and bursting, fibre length, ginning out-turn and resistance to salinity, drought and shattering. The primitive **Dhumad** types with indehiscent ripe bolls and **Wagad** types with semi dehiscent bolls in *G. herbaceum*, L. were observed to be important genetic resources for resistance to salinity, drought and non-shattering habit. Red and green pigmented open boll **mathio** types in *G. arboreum* L. were identified as desirable donors for high fibre length and boll number. Based on passport and laboratory data, some of individual plant selections were identified as promising for direct utilization in breeding as straight selections.

**Key words :** Cotton, *Gossypium* spp., variability, primitive types, salinity, drought, exploration

Cotton, in India, is grown under diverse edaphic and climatic conditions. Asiatic diploid cottons (*Gossypium herbaceum* L. and *G. arboreum* L.), in view of their local origin, have remarkable adaptability to these divergent conditions and are less vulnerable to a wide range of diseases and pests (Hussain and Khan, 1940; Singh and Bhutani, 1963; Duhoon and Singh, 1980). The existing diversity in Asiatic cottons is being gradually replaced by high yielding American cottons (*G. hirsutum* L.) and hybrids and other more remunerative crops (Munshi Singh, 1989). Kachchh and Saurashtra in Gujarat are the important regions of diversity in Asiatic cottons particularly for drought, salinity and shattering resistance in *G. herbaceum* and fibre length in *G. arboreum*. Therefore, the present exploration was conducted with an objective to collect and conserve the local diversity in these cottons from these regions for future use, besides using them in the present programmes.

### SAMPLING STRATEGIES

The collections consisted of randomly drawn 77 samples of seed cotton representing diversity in populations belonging to 3 cultivated species of genus *Gossypium*. The samples were collected in January 1993, from randomly selected populations at 67 sites in diverse habitats in 10 districts, viz., Palanpur, Kachchh, Banaskantha, Rajkot, Jamnagar, Junagadh, Amreli, Bhavnagar, Sundarnagar and Mehsana comprising Kachchh and Saurashtra regions in Gujarat. Fully matured single bolls from each of the 40-50 (as per availability) random plants in each population, were picked up to represent the diversity and to study the variability within and between populations. Passport data were recorded on each site alongwith important plant characters. The observations on most important post-harvest characters like boll weight, fibre length and ginning out-turn were recorded at Genetics Division, Indian Agricultural Research Institute, New Delhi. 100 seed cotton was ginned and the weight of lint was measured as ginning out-turn (%). The coarse grid methods with circular route was followed with main emphasis given to cover the periphery of the regions. Seperate samples were drawn wherever two or more distinct morphotypes occurred simultaneously in the same population. A few outstanding plants were also separately picked for utilization as selections.

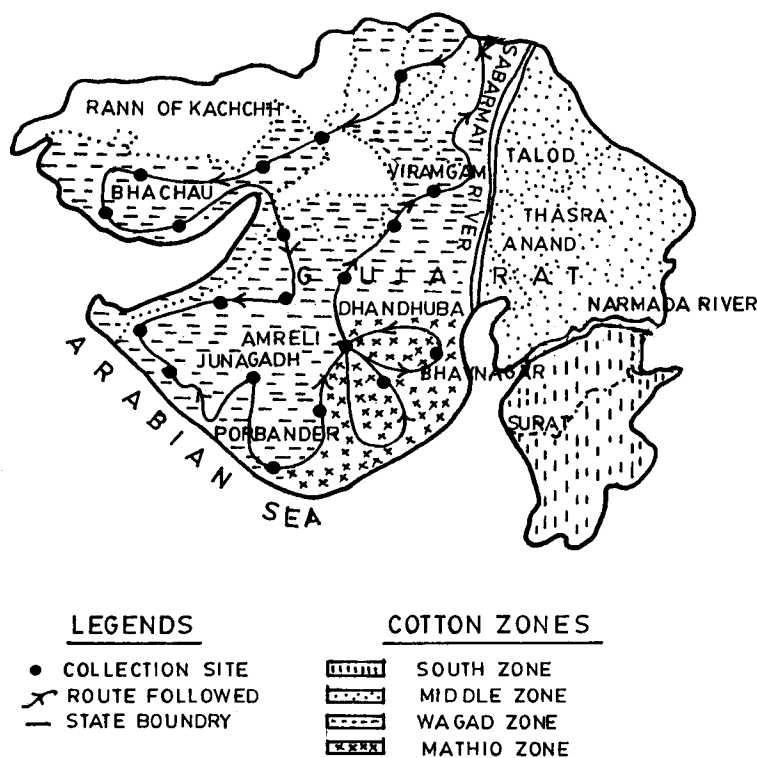


Fig. 1. Route map for cotton collecting in Gujarat

### DETAILS OF COLLECTIONS

Saurashtra and Kachchh regions lie between 20°5' to 25° North latitude and 68° to 72°5' East longitudes (Fig.1). The gravelly, salt affected poor soils to clayey black fertile soils in Kachchh and sandy loam in mathio zone are common and the rainfall is scanty in these regions. The pH of the soils varied from 7.5 to 9.5 (NBSS & LUP, 1993).

#### Species variability

*Gossypium herbaceum*, *G. arboreum*, *G. hirsutum* and hybrids are grown in this region. The old world diploid cottons (*G. herbaceum* and *G. arboreum*) are grown mainly in problem soils under rainfed conditions whereas the cultivation of American cotton (*G. hirsutum*) and hybrids is confined to fertile soils where irrigation facilities exist. Out of 77 collections of cotton, 42 represented *G. herbaceum*, 32 *G. arboreum* and 3 *G. hirsutum*. The species-wise range of variability in the characters of major importance is presented in Table 1.

**Table 1 : Range of variability in cotton samples collected from Gujarat**

| Characters           | Species                                       |                                              |                                             |
|----------------------|-----------------------------------------------|----------------------------------------------|---------------------------------------------|
|                      | <i>Gossypium herbaceum</i><br>(42 accessions) | <i>Gossypium arboreum</i><br>(77 accessions) | <i>Gossypium hirsutum</i><br>(3 accessions) |
| Plant height (cm)    | 30-125                                        | 85-158                                       | 40-110                                      |
| Bolls/plant          | 6-64                                          | 8-75                                         | 3-22                                        |
| Bolls weight (g)     | 2.5-3.5                                       | 2.0-3.0                                      | 2.8-4.0                                     |
| Fibre length (mm)    | 12-19                                         | 15-25                                        | 20-24                                       |
| Ginning Out-turn (%) | 32.4-35.1                                     | 32.0-34.3                                    | 34.7-37.0                                   |
| Crop duration (days) | 135-150                                       | 125-145                                      | 100-110                                     |

*Gossypium herbaceum* L. is grown in Kachchh and Ghed regions. About 100 low lying villages around Kutiana in Junagadh district where water remains stagnant in rainy season, comprise the Ghed region. Cotton is sown when rain water recedes and grown with conserved moisture in black soils, having high water holding capacity. The diversity in this species is represented by two distinct types (i) **Dhumad** types with closed bolls and (ii) **Wagad** types with semi-open bolls. The deep root system and indehiscent/semi-dehiscent ripe bolls are adapted to escape drought and salinity **Dhumad** and **Wagad** types are believed to be an evolutionary link between wild South African perennial (*G. herbaceum* race *africanum*) and open boll cultivated, annual forms of *G. herbaceum* and *G. arboreum* L. (Munshi Singh, 1989).

*G. arboreum* is grown in some parts of Amreli and Bhavnagar districts. These cottons with open relatively smaller bolls are popularly known as **mathio** cottons because their leaves resembles those of moth bean (*Phaseolus aconitifolius*). Four morphotypes distinguished by plant pigmentation and leaf lobing were observed in this species, occasionally within the same populations. The morphotypes with red and green pigmented plants were equally frequent. In both red and green pigmented types, narrowly and broadly lobed leaf types occurred and were collected. The distribution of these species is overlapping at some places, particularly in the periphery of these regions.

In *G. hirsutum*, three samples having desirable canopy with small sized, uprightly thick, hairy leaves were collected. The collections exhibited a wide range of variability for plant height (30-158cm.), crop maturity (100-150 days), plant habit (sympodial types with compact habit, monopodial types with bushy habit and pyramid shaped), plant pigmentation (red, green and intermediate types), leaf size (small, large), leaf lobing (narrow deep to broad shallow), boll weight (2.4 g.), boll shape (round, conical and tapering), boll type (pendulous/upright), boll bursting (closed, semi-open to open), boll number (6 to 75/plant), fibre length (12-25 mm), ginning out-turn (32-37%) and field resistance to drought, salinity and shattering.

One set of collections has been deposited in the National Gene Bank for conservation and another set sent to the active germplasm site at Central Institute for Cotton Research, Nagpur for characterization, maintenance and

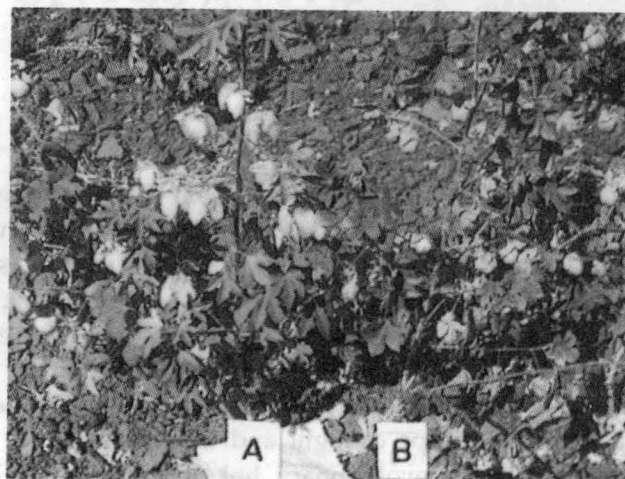


Fig. 2. Waged types with semi-open bolls (A) and Dhumad types with closed ripe bolls (B) in *G. herbaceum* L. from Kachchh region in Gujarat

enhancement. These genetic resources have the potential for direct and indirect utilization in breeding particularly for fibre length and resistance to drought, salinity and shattering, the main problems in Asiatic diploid cottons.

#### ACKNOWLEDGEMENTS

The authors are grateful to Dr. R.S. Rana, Director, National Bureau of Plant Genetic Resources, New Delhi for providing necessary facilities and Dr. R.L. Savalia, Associate Cotton Breeder, Gujarat Agricultural University, Agricultural Research Station, Amreli, for his help in surveying **Mathio** cotton zone.

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## GENETIC DIVERGENCE IN OKRA (*ABELMOSCHUS ESCULENTUS* (L.) MOENCH)

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Twenty genotypes of okra were grouped in nine constellations utilizing eleven characters by  $D^2$  statistics and canonical test. Clusters I and II comprised four and three genotypes respectively. The maximum divergence was observed between cluster VII (G-2 and HB-57) and IX (Sel. I). G-2 was highly divergent from all other genotypes for plant height, HB-57 for earliness and Sel. I for number of pods per plant.

**Key words :** *Abelmoschus esculentus*, genetic diversity, cluster analysis

A crop improvement programme is based either in utilizing plant variation already present in the population or generating broad spectrum of variability by crossing genetically diverse plants. Mahalanobis (1928) suggested  $D^2$  technique, a parameter to measure inter and intra-group distances to isolate the genotypes of divergent and distinct characteristics to be further used as donor parents. Meagre information is available on this aspect in okra, hence there is a need for further studies.

### MATERIALS AND METHODS

A trial of twenty genotypes of okra (*Abelmoschus esculentus* (L.) Moench) was conducted in a randomised complete block design with three replications at G.B. Pant University of Agriculture and Technology, Pantnagar. Each replication had a row of twelve plants of each genotype spaced 75 x 60 cm apart. The crop was raised by adopting standard cultural practices. Transformation of variables was carried out by pivotal condensation method reported by Rao (1948). Group constellations were formulated after computation of  $D^2$  values by method suggested by Tocher and reported by Rao (1952), and confirmed by canonical test.

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## RESULTS AND DISCUSSION

The mean data of different characters are given in Table 1. The germplasm showed significant variation for all the quantitative characters. The variability ranges were observed for plant height (65 - 116 cm), branches per plant (2.5 - 5.0), leaves per plant (39 - 60), stem thickness (22 - 30 mm), 50% flowering (47 - 60 days), nodes to first pod (6 - 11), pod length (7 - 13 cm), pod thickness (15 - 19 mm), weight per pod (9-14 g), number of pods per plant (21-31) and yield per plant (214-418 g).

Based on  $D^2$  values, the 20 varieties of okra were grouped in 9 constellations. The calculated  $D^2$  values ranged from 1.91 to 36.55. Accordingly, cluster I contains 4 genotypes followed by cluster II with 3 genotypes. The rest of clusters include 2 genotypes each besides solitary representation by the variety Sel-1 in cluster IX. The cluster means (Table 2) revealed that cluster VII produced maximum height (103.30 cm), Pod thickness (18.90 mm), weight per edible pod (22.86 g) and early flowering (49.33 days). Higher cluster means were also obtained in cluster IX for the number of pods per plant and yield per plant, whereas cluster III produced maximum leaves (64.65). The contribution of individual characters towards divergence indicated higher magnitude (14.09%) for primary branches per plant and number of pods per plant followed by stem thickness (10.91%), plant height (10.45%) and leaves per plant (10%). However, contribution due to yield per plant was observed to be much lower (3.18%). Martin *et al.* (1981) also examined variation in okra genotypes and distinguished 5 out of 29 characters.

Maximum genetic diversity (28.85) was present between cluster VII and IX followed by VII and VIII clusters (Table 3). The minimum divergence was exhibited between I and VI clusters, indicating their close relationship. Intracluster distance ranged from 0 to 3.59 (Fig.1). The larger intracluster distance was observed in VIII followed by VII clusters (3.40). The close distance other than those where single genotype formed was observed in a cluster II and represented by varieties Clemson Spineless, KS-312 and Punjab-7.

The intracluster distance was less than the corresponding  $D^2$  values indicating more divergence of genotypes between the clusters. Girinko and Pugachev (1985) and Koechlin (1991) observed higher diversity in West African cultivars of okra than others and reported 11 clusters represented by 15 attributes. The most divergent parents were G-2 for plant height, pod thickness; HB-57 for earliness and Sel-1 for number of pods per plant and yield per plant.

Table 1 : Mean data for different characters

| Sr. No. | Genotype          | Plant height (cm) | Branches per plant | Leaves per plant | Stem thickness (mm) | Days to 50% flowering | Nodes to first pod | Length of pod (cm) | Pod thickness (mm) | Wt. per edible pod (g) | Number of pods per plant | Yield per plant (g) |
|---------|-------------------|-------------------|--------------------|------------------|---------------------|-----------------------|--------------------|--------------------|--------------------|------------------------|--------------------------|---------------------|
| 1       | Clemson Spineless | 91.33             | 3.33               | 53.47            | 25.00               | 52.67                 | 8.60               | 10.00              | 17.87              | 13.13                  | 28.47                    | 354.00              |
| 2       | KS 312            | 93.20             | 3.63               | 57.50            | 23.33               | 49.67                 | 9.40               | 10.20              | 17.33              | 11.27                  | 28.77                    | 312.00              |
| 3       | Sel.2             | 105.47            | 3.67               | 53.60            | 30.33               | 56.00                 | 10.20              | 9.70               | 16.03              | 10.30                  | 25.47                    | 242.00              |
| 4       | 12/21             | 65.13             | 4.97               | 52.87            | 30.00               | 60.33                 | 11.13              | 7.27               | 17.33              | 9.90                   | 23.43                    | 214.33              |
| 5       | IC 10643          | 90.23             | 3.70               | 47.00            | 25.33               | 50.67                 | 8.37               | 11.27              | 18.27              | 13.13                  | 27.13                    | 349.33              |
| 6       | IC 1542           | 98.57             | 3.37               | 68.17            | 25.00               | 58.33                 | 9.60               | 9.60               | 17.87              | 12.87                  | 27.43                    | 344.67              |
| 7       | Sel. I            | 91.67             | 3.10               | 61.17            | 25.67               | 49.67                 | 7.43               | 11.17              | 16.27              | 13.63                  | 30.90                    | 403.67              |
| 8       | Pusa Makhamali    | 92.10             | 3.80               | 53.10            | 23.33               | 55.33                 | 8.60               | 8.77               | 17.20              | 8.87                   | 26.03                    | 230.00              |
| 9       | Sel. 6-2-3        | 102.43            | 3.90               | 61.13            | 29.00               | 56.67                 | 8.07               | 9.80               | 17.53              | 12.67                  | 29.30                    | 323.00              |
| 10      | 6-2 HP            | 112.60            | 3.77               | 61.60            | 22.00               | 52.00                 | 9.33               | 11.23              | 16.60              | 12.20                  | 30.67                    | 355.00              |
| 11      | Punjab 7          | 115.40            | 3.07               | 52.93            | 23.67               | 49.33                 | 8.13               | 12.47              | 16.46              | 14.30                  | 31.00                    | 418.00              |
| 12      | G-2               | 114.60            | 2.53               | 47.33            | 23.67               | 52.33                 | 9.27               | 10.53              | 19.20              | 13.53                  | 24.90                    | 316.67              |
| 13      | Pb-57             | 115.73            | 3.20               | 57.67            | 21.67               | 52.67                 | 8.13               | 13.07              | 16.00              | 12.20                  | 25.20                    | 288.33              |
| 14      | MDU-1             | 94.97             | 3.80               | 46.47            | 24.67               | 49.33                 | 7.80               | 11.90              | 16.60              | 12.87                  | 25.57                    | 316.00              |
| 15      | Vaishali Vadhu    | 101.77            | 3.60               | 48.93            | 22.33               | 48.33                 | 7.07               | 11.40              | 16.07              | 11.80                  | 25.70                    | 283.00              |
| 16      | Pusa Sawani       | 96.87             | 3.93               | 46.13            | 27.33               | 51.33                 | 7.73               | 10.30              | 16.67              | 10.67                  | 27.60                    | 282.67              |
| 17      | Punjab Padmini    | 83.03             | 3.30               | 54.13            | 22.33               | 54.00                 | 8.87               | 12.10              | 17.80              | 11.20                  | 25.40                    | 267.67              |
| 18      | Sel. 2-2          | 94.83             | 3.17               | 41.20            | 24.33               | 52.33                 | 7.23               | 12.10              | 15.43              | 10.87                  | 21.60                    | 220.00              |
| 19      | HB 57             | 92.00             | 3.23               | 40.13            | 28.67               | 46.33                 | 6.67               | 10.23              | 18.60              | 12.20                  | 22.47                    | 267.33              |
| 20      | HB 58             | 88.13             | 3.70               | 39.03            | 24.67               | 47.33                 | 6.07               | 10.73              | 17.20              | 11.63                  | 21.23                    | 238.00              |
|         | Mean              | 96.440            | 3.606              | 52.044           | 23.860              | 53.127                | 8.747              | 10.551             | 17.025             | 11.990                 | 25.629                   | 293.445             |
|         | SEM ±             | 3.904             | 0.198              | 2.036            | 1.357               | 1.680                 | 0.520              | 0.597              | 0.852              | 0.642                  | 0.680                    | 19.140              |
|         | CD at 5% level    | 10.821            | 0.549              | 5.644            | 3.760               | 4.687                 | 1.442              | 1.655              | 2.363              | 1.779                  | 1.850                    | 54.163              |

Table 2 : Cluster means for 20 genotypes of okra for genotypic divergence

| Cluster                                 | Genotype*     | Plant height (cm) | Branches per plant | Leaves per plant | Stem thickness (mm) | Days to 50 per cent flowerin | Nodes to first pod | Length of pod (cm) | Pod thickness (mm) | Weight per edible pod (g) | Pods per plant | Yield per plant (g) |
|-----------------------------------------|---------------|-------------------|--------------------|------------------|---------------------|------------------------------|--------------------|--------------------|--------------------|---------------------------|----------------|---------------------|
| I                                       | 5, 15, 16, 20 | 94.25             | 3.73               | 45.27            | 24.91               | 49.41                        | 7.32               | 10.92              | 17.05              | 18.81                     | 24.91          | 287.08              |
| II                                      | 1, 2, 11      | 99.97             | 3.34               | 54.63            | 24.00               | 50.55                        | 8.71               | 10.89              | 17.22              | 12.20                     | 29.41          | 361.33              |
| III                                     | 6, 9          | 100.50            | 3.63               | 64.65            | 27.00               | 57.50                        | 8.83               | 9.70               | 17.70              | 12.77                     | 28.36          | 33.83               |
| IV                                      | 17, 18        | 88.93             | 3.23               | 40.66            | 23.33               | 53.16                        | 8.06               | 12.10              | 16.61              | 11.03                     | 23.50          | 243.83              |
| V                                       | 10, 13        | 114.16            | 3.48               | 59.63            | 21.83               | 52.33                        | 8.77               | 12.15              | 16.30              | 12.20                     | 27.93          | 321.66              |
| VI                                      | 3, 14         | 100.22            | 3.73               | 50.03            | 27.50               | 52.66                        | 9.00               | 10.80              | 16.01              | 11.58                     | 25.52          | 279.00              |
| VII                                     | 12, 19        | 103.30            | 2.88               | 43.73            | 26.17               | 49.33                        | 7.97               | 10.38              | 18.90              | 22.86                     | 23.68          | 292.00              |
| VIII                                    | 4, 8          | 78.61             | 4.38               | 52.98            | 26.66               | 57.83                        | 9.86               | 8.02               | 17.26              | 9.58                      | 24.73          | 222.17              |
| IX                                      | 7             | 91.67             | 3.10               | 61.17            | 25.67               | 49.67                        | 7.43               | 11.17              | 16.27              | 13.67                     | 30.90          | 403.67              |
| No. of times appearing first in ranking |               | 23                | 31                 | 22               | 24                  | 21                           | 13                 | 18                 | 10                 | 20                        | 31             | 7                   |
| Per cent contribution                   |               | 10.45             | 14.09              | 10.00            | 10.91               | 9.45                         | 5.91               | 8.18               | 4.55               | 9.09                      | 14.09          | 3.18                |

\*refer to Table 1 for genotype identification against Sr. Nos. mentioned below

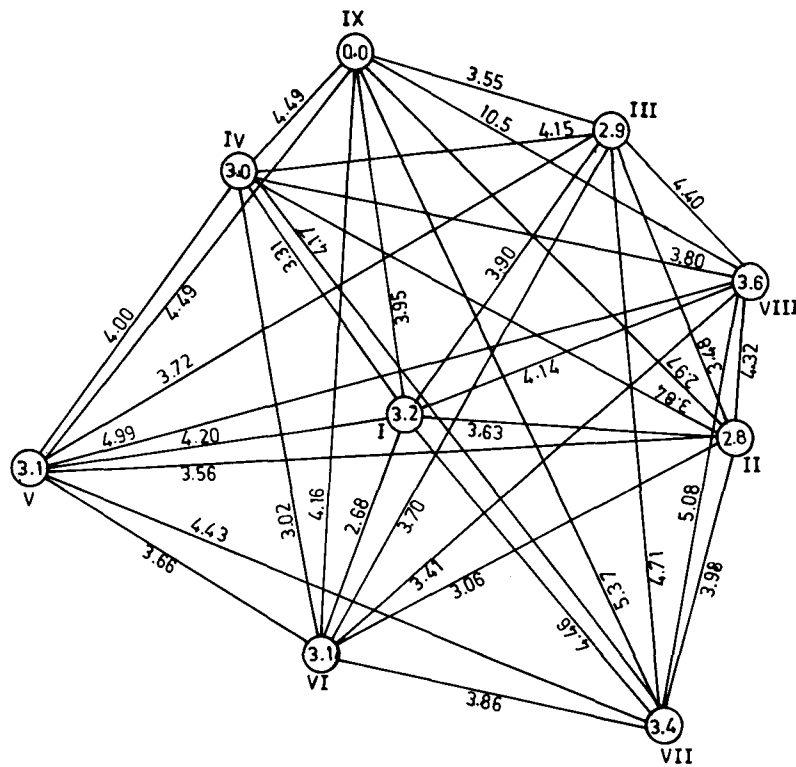


**Fig. 1. Mutual relationship between population**

**Table 3 : Average Intra (diagonal) and Inter cluster D<sup>2</sup> values**

[illegible]

### ACKNOWLEDGEMENT

The authors are grateful to Director, NBPGR, New Delhi for providing the okra germplasm for carrying out this experiment.

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## COLLECTING DIVERSITY IN EGGPLANT GERMPLASM FROM NORTH - CENTRAL INDIA

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Three explorations were undertaken in north-central parts of India covering 39 districts in Uttar Pradesh, 14 in Bihar, 7 in Madhya Pradesh and 4 in Maharashtra during 1990 and 1991 for the collection of eggplant diversity including its wild relatives. A total of 486 accessions, comprising cultivated eggplant (*Solanum melongena* L) (451) and related wild species viz., *S. violaceum* Ortega (12), *S. surattense* Burm. (5), *S. nigrum* L (4), *S. viarum* Dunal (5), *S. torvum* Sw (5), *S. sisymbriifolium* Lam (1), *S. gigantium* Jacq. (1); *S. memmosum* Lind. (1) and *S. hispidum* Pers (1) were collected. A wide range of diversity in agrobotanical and morphological characters was observed in *S. melongena* and *S. violaceum*. A good number of landraces/primitive cultivars developed as a result of continuous selection by the farmers in different belts were also sampled. Most notable donor genotypes include **Bundelkhand Desi** for drought tolerance, **Ramnagarawa** for large size fruits, **Jethuwa baingan** for growing in hot summer and **Kuchbachia baingan** for early bearing and hot summer crop.

**Key words :** Eggplant, *Solanum* sps, distribution, diversity, promising landraces

Eggplant (*Solanum melongena* L) is an established crop of commercial significance, grown round the year in almost all parts of India, extending upto 1100 m. above m.s.l. On the basis of distribution of variability, Vavilov (1926) regarded the crop to be of Indian origin and stated that China is the secondary centre of diversity. It is one of the oldest vegetable crop of India as is evident from the ancient literature. Efforts made in the past to develop promising types through selection/improvement have resulted in a number of new varieties. Adoption of such high yielding varieties/hybrids pose threat of erosion to primitive cultivars/landraces/genetic diversity which could be of great significance in present context for crop improvement. However, most of these varieties lack in resistance to specific biotic and abiotic stresses. Therefore, areas in north-central parts of the country possessing rich diversity, were surveyed and eggplant germplasm including their wild relatives were sampled.

### REGIONS SURVEYED AND SAMPLING STRATEGIES

The diverse agro-ecological habitats, including parts of humid western Himalayan region; Bundelkhand region; sub-Himalayan *tarai* belts of Uttar Pradesh and Bihar; Gangetic plains of Uttar Pradesh and Bihar; Chhotanagpur region; Satpura hill ranges and Narmada river beds were extensively surveyed. The entire region is located between latitude 16.50° to 30.10° N and longitude 77.12° to 87.02°E. In all, 64 districts in north-central parts of India, comprising 39 in Uttar Pradesh, 14 in Bihar, 7 in Madhya Pradesh and 4 in Maharashtra were surveyed for collection of diversity in *Solanum melongena* and its wild relatives. The explorations were undertaken when crops were in full fruiting stage and had also started physiological maturity. Observations on important morphological traits of the plants and fruit characteristics were recorded before sampling. District horticulture/Agriculture officers and progressive vegetable growers were contacted to get first hand information about the genetic diversity/landraces/primitive cultivars available in the specific pockets and accordingly exploration, route was followed (Arora, 1981). Diverse genotypes within the landrace/primitive cultivars were separately sampled avoiding duplicates. Random sampling was done from the farmers field, kitchen gardens, and bulk from farm store in cases where the crop was not available in the field. Biased sampling was done in case of particular landrace/primitive cultivar/genotype (Sinha, 1981). Exploration route map is depicted in Fig. 1 and a list of the state/district covered during the exploration is presented in Table 1.

**Table 1 : The states/districts surveyed and germplasm collected**

| Explorations                              | States/Districts covered                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Exploration I<br>(18 Jan. to 2 Feb '90)   | <b>Madhya Pradesh</b> - Seoni, Jabalpur, Narsinghpur, Hoshangabad and Betul.<br><b>Maharashtra</b> - Amravati, Nagpur, Akola and Wardha                                                                                                                                                                                                                                          |
| Exploration II<br>(17 March to April '90) | <b>Bihar</b> - Ranchi, Hazaribagh, Giridih, Dumka, Bhagalpur, Munger, Begusarai, Samastipur, Chhapra, Siwan, Gopalganj, Sasaram, Aurangabad and Gaya<br><b>Uttar Pradesh</b> - Deoria, Gorakhpur, Siddhartha Nagar, Basti, Faizabad, Jaunpur, Allahabad and Varanasi                                                                                                             |
| Exploration III<br>(16-30 March '92)      | <b>Uttar Pradesh</b> - Ghaziabad, Meerut, Muzaffarnagar, Saharanpur, Rampur, Hardwar, Dehradun, Bijnaur, Moradabad, Bareilly, Shahjahanpur, Kheri, Sitapur, Lucknow, Unnao, Kanpur, Fatehpur, Banda, Hamirpur, Jhansi, Orai, Jalaun, Farrukhabad, Mainpuri, Etawah, Etah, Firozabad, Agra, Mathura, Aligarh and Bulandshahr<br><b>Madhya Pradesh</b> - Chhattarpur and Tikamgarh |



Fig. 1. Exploration route for collection of eggplant and its wild relatives from parts of Bihar, Uttar Pradesh, Madhya Pradesh and Maharashtra

### DISTRIBUTION AND DIVERSITY PATTERN

A total of 436 germplasm accessions of cultivated and related wild species of *Solanum* comprising *S. melongena* (451), *S. violaceum* (12), *S. surattense* (5), *S. nigrum* (4), *S. viarum* (5), *S. torvum* (5), *S. sisymbriifolium* (1), *S. giganteum* (1), *S. memmosum* (1) and *S. hispidum* (1) were collected during three explorations conducted in north-central India, viz., parts of Uttar Pradesh, Bihar, Madhya Pradesh and Maharashtra.

Eggplant is grown in almost all places for its immature fruits. *S. violaceum* was also seen growing in natural habitats in most of the places along with undisturbed flora, under the trees and shrubs, its distribution is concentrated in humid western Himalayan region, and Satpura hill ranges. The species *S. surattense* was occasionally seen growing in sandy soils throughout the exploration route along the roadside. It appears to be a drought tolerant species since it was growing well where the surrounding weed flora had dried. The distribution of *S. viarum* is localised in humid Western Himalayan belt and also in Satpura hill ranges. *S. nigrum* was found to be most adaptable

species growing in humid places particularly along the channels and under the tree shade. *S.torvum* was seen growing on roadside and in undisturbed forest flora in humid western Himalayan belt, and one accession was collected from the kitchen garden in tribal belt of Chhotanagpur area. It was reported that the fruit of this species is fried and consumed in constipation. One accession each of *S.giganteum* and *S. sisymbriifolium* was located in Jabalpur in Madhya Pradesh and *S.memmosum* in Varanasi (U.P.) which were grown for ornamental purpose. One accession of *S.hispidum* collected from Dehradun (western Himalayan belt) is characterised by tall growth (up to 2.5m.) and profuse branching from the ground.

The germplasm exhibited wide range of variability in plant height, growth habit (bushy, spreading, tall), branching pattern, pubescence on stem and leaf; spininess on stem, leaf, petiole and calyx; leaf size, flowers per cluster (1-8); flower colour (white, light purple, deep purple), fruiting habit (solitary/cluster); fruits per cluster; fruit shape (round, oval, oblong, long); size (very small to large) and colour (white, light green, green, deep green, whitish green, light purple, purple, deep purple and stripes on surface). Variability was also observed among "Cluster type", in fruits per cluster (2-7); fruit shape (round, oval, oblong, long); colour (milky white, green, purple), fruit size (small, medium, large). However, cultivation of "Cluster type" eggplant is concentrated in eastern Uttar Pradesh, north Bihar, south Bihar, Chhotanagpur and adjoining areas.

**Table 2 : Important primitive cultivars/landraces sampled**

| Areas covered                                     | Germplasm collected                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Parts of Madhya Pradesh and Maharashtra           | Wange, Bhathai local, Bhatia baingan, Jabalpur local baingan, local bhata, Narmada bhata, Baingan Lamba, Hara lamba baingan                                                                                                                                                                                                                                                                  |
| Parts of Bihar and Uttar Pradesh                  | Hara Chugalia, Safed Hara Desala baingan, Safed baingan, Satputia baingan, Jafrabadi baingan, Jafrabadi baingan II, Jafrabadi bhatani, Hara Jafarabadi, Jafrabadi Desi, Bhatania, Patanahia baingan, Balfahawa Jethuwa bhata, Banarasi Desi, Siliguri Local, Gola baingan, Ramnagarwa Local, Desi Bhatia, Dudhia baingan, Desi bhatania, Dudhia Gola baingan, Safed bhatani, Jethuwa baingan |
| Parts of Uttar Pradesh and adjoining area of M.P. | Gola baingan, Surkha baingan, Baingani bhata, Golaki bhata, Nariyal baingan, Desi Gola, Desi baingan, Maru baingan, Kala baigan, Kala Gola, Gola Hara, Desi bhati, Desi baigan, Nawari bhata, Desi baigan, Lambi bhati, Dhamaria Bhanta, Desi bhata kali, Bundel khand Desi, Desi safed bhata, Neelam Bhanta, Bhatia baigan, and Baramasi bhata                                              |

The colour and shape of fruits was observed to be associated with regional preferences. Continuous selection by farmers for desirable types in particular agro-climatic region has resulted in developing several landraces/genotypes. It was noted that light purple to deep purple fruits in round, oval and long shape are most esteemed in western Himalayan region, sub-Himalayan *tarai* belts of Uttar Pradesh and Bihar; green fruits in different shapes in Bundelkhand and Chhotanagpur region; green and green with purple stripes in Satpura hill ranges and in parts of Maharashtra. Small size round to oval fruits in purple, green and white colour were also preferred in eastern Uttar Pradesh, north and south Bihar. Light-green fruits in round to oval shape were commonly grown in Varanasi and nearby area. A number of landraces/primitive cultivars popular for their quality and adapted in different eggplant growing belts were sampled (Table 2) during the explorations.

In *S. violaceum*, wide range of diversity in plant morphological traits and vegetative characters was observed. Variability in fruit colour (orange and black) was recorded in *S. nigrum*. Less variability was observed in *S. viarum* Dunal and *S. torvum* in vegetative and fruit characteristics.

**Table 3 : List of *Solanum melongena* and its wild relatives sampled from different states**

| Species                        | States/Number of germplasm collected |       |                |             | Total |
|--------------------------------|--------------------------------------|-------|----------------|-------------|-------|
|                                | Uttar Pradesh                        | Bihar | Madhya Pradesh | Maharashtra |       |
| <i>Solanum melongena</i> L.    | 283                                  | 113   | 41             | 14          | 451   |
| <i>S. violaceum</i> Ortega     | 6                                    | 3     | 1              | 2           | 12    |
| <i>S. surattense</i> Burm. f.  | 5                                    | -     | -              | -           | 5     |
| <i>S. nigrum</i> L.            | 4                                    | -     | -              | -           | 4     |
| <i>S. viarum</i> Dunal         | 4                                    | 1     | -              | -           | 5     |
| <i>S. torvum</i> Sw.           | 2                                    | 1     | -              | -           | 5     |
| <i>S. sisymbriifolium</i> Lam. | -                                    | -     | 1              | -           | 1     |
| <i>S. giganteum</i> Jacq.      | -                                    | -     | 1              | -           | 1     |
| <i>S. memmosum</i> Lind.       | 1                                    | -     | -              | -           | 1     |
| <i>S. hispidum</i> Pers.       | 1                                    | -     | -              | -           | 1     |
| Total                          | 306                                  | 118   | 46             | 16          | 486   |

### PROMISING LANDRACES/PRIMITIVE CULTIVARS

**Bundelkhand Desi** : A primitive type, cluster bearing, light green to deep green with whitish stripes on the tip, in different shapes of fruits was collected from Bundelkhand region (Hamirpur, Banda, Orai and Jhansi). This genotype is said to be drought tolerant. Local preference and long storage life are the main attributes.

**Dudhiya baingan** : It is another primitive type grown in eastern Uttar Pradesh and adjoining areas of Bihar. The plant is tall growing upto 1.2m. and non spiny, fruits in cluster of 4-6, smaller (45 to 70 g), milky-white, and round to oval resembling an egg. These were preferred for frying.

**Ramnagarwa baingan** : This is one of the most popular primitive cultivar grown in fertile river belt of Ganges in Varanasi and nearby area. It bears large light green fruits in different shapes. Because of large fruit size it is also known as "Varanasi Giant". Variability in fruit shape, size, and colour was observed among the Ramnagarwa, which may be due to segregation from natural crossing with adjoining cultivars.

**Jethuwa baingan** : Fruits mature during the month of *Jeth* (June-July) when other brinjal cultivars are not available in the market. Its cultivation is concentrated in 'Sawai Pattidari' area of Varanasi district. The plant is highly bushy with dense spines on stem, leaf, lamina, petiole and calyx. The round to oval purple colour fruits have thick skin suitable for long distance transportation but contain more seeds. It is grown in off season (hot summer) when availability of green vegetables is less. It is also preferred because of better quality for curry purposes. It is consumed locally and sent to long distance market because of better keeping quality.

**Kuchbachia baingan** : It is one of the most important primitive cultivar grown in large area as winter and summer crop in Muzaffarpur and Samastipur district of Bihar. It is an early bearing genotype, suitable for long distance transportation. It bears light-purple fruits in clusters of 3-5; medium in size (40-80g); round to oval in shape.

**Jafrabadi baingan** : It is a primitive cultivar developed at Jafrabad area in Muzaffarpur district of Bihar. The fruits are deep purple; round oval and long in shape weighing 250-400g and contain less seeds. It is most popular in Muzaffarpur and adjoining areas.

**Balfahwa Jethuwa bhanta** : Cultivation of this genotype is concentrated in Allahabad district of the central Uttar Pradesh for local consumption as well as for long distance markets like Tata Nagar, Patna, Calcutta and Delhi during March to June. The plant is tall growing (1.4 to 1.8m), with profuse branching, hence planting is done at a distance of 1.5m between the rows and 80-100cm within the row. The deep purple fruit is round to oval in shape

and of medium size (80-100g). The fruit is having better shelf storage life and suitable for long distance transportation.

**Siliguri baingan** : It is an introduction from Siliguri, West Bengal. It bears long slender fruits of attractive deep purple colour, weighing 200- 300g. It is preferred due to its better taste and less seed.

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## SOME LATE FLOWERING AND EARLY MATURING ALMONDS (*PRUNUS AMYGDALUS* BATSCH) GERMPLASM

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Almond cultivation in the north-western Himalayas is greatly hampered by extremely low temperature during flowering and onset of the monsoons at the time of fruit ripening. This necessitates selection of late blooming and early maturing almonds for the region. As many as eight exotic cultivars including Non Pareil and six indigenous seedling selections were observed for time of bud break, flowering (full bloom) and fruit maturation for three consecutive years (1990 to 1992). Both the time of flowering and fruit maturation exhibited a great deal of variation indicating a part of it being due to genotypic variation. Five cultivars namely Nikitskyi, Prianyi, Tree No.2, Tree No.125 and White Brandis flowered 11 to 27 days late but matured 12 to 21 days earlier than the most popular cultivar Non Pareil. The utilization of these selections in commercial production and breeding programme is suggested.

**Key words :** Almond, *Prunus amygdalus*, evaluation, late flowering, early maturing, genetic diversity

Spring frost at the time of flowering and the onset of the monsoon rains towards fruit maturation are the major limiting factors in the cultivation of almond (*Prunus amygdalus* Batsch) in the north-western Himalayas. In such a situation, the fruit breeders opt for avoiding the climatic adversities by selecting late flowering and early maturing cultivars rather than selecting genotypes tolerant to environmental stresses (Alston and Roy, 1985; Kester *et al.*, 1990). This is more feasible in a crop like almond which has shown extensive variability in morphological, metric and electrophoretic traits (Aruleskar *et al.*, 1986), mainly because of its outcrossing nature. In the past, many workers have reported the occurrence of very early to very late flowering and maturing almond cultivars in a given set of environmental conditions (Agabbio and Ortu, 1974; Felipe, 1977; Rough *et al.*, 1978). However, only a few almond cultivars and some wild forms have been indicated to be late blooming and early maturing (Denisov, 1988; Kester *et al.*, 1990). On the lines indicated above, the present study was specifically undertaken to spot out late flowering as well as early maturing almond genotypes, either for use as direct cultivars or as donor parents in future breeding programmes.

## MATERIALS AND METHODS

The evaluation studies were carried out in the Almond Collection Block of the Department of Fruit Breeding, University of Horticulture and Forestry, Nauni, Solan (H.P.) located at a height of around 1200 metres above msl and situated at 31°N latitude and 77°E longitude. The experimental material consisted of 16 year old bearing trees of 13 almond cultivars and selections on wild peach rootstock. The observations for time of bud-break, full bloom and fruit maturation were recorded during 1990 to 1992. The time of bud break was recorded when the green calyx was evident and scales of swelling buds had just begun to separate. The time of full bloom was recorded when more than 75 per cent flowers had reached anthesis stage and that of fruit maturation when first hull dehiscence took place. Days to maturation were counted from the date of full bloom to the date of hull dehiscence. For comparison, similar observations were recorded on cultivar Non Pareil, the most important commercial cultivar of the region where these studies were conducted.

## RESULTS AND DISCUSSION

The lateness in time of bud break as compared to standard cultivar 'Non Pareil' ranged from as many as 31 days (Tree No. 125) to two days (Badamjor Spillo No. 2) in 1990; 19 days (Badamjor Spillo No. 2) to two days (Local Selection, Pethick's Wonder) in 1991 except Ne Plus Ultra (early by four days) and 16 days (Ribba Selection, Star Basin) to two days (Drake, Local Selection) in 1992 (Table 1). Cultivars Ribba Selection, Spillo No. 7, Star Basin, Tree No. 2, Tree No. 125 and White Brandis showed bud break late by atleast ten days than Non Pareil during all the three years. However, cultivar Nikitskyi showed late bud break by ten days than the check in 1991 and 1992 while similar observation was recorded for Badamjor Spillo No. 2 in 1991 and for Prianyi in 1992.

All the cultivars and selections under study reached full bloom stage later than Non Pareil during three years except in 1991 when Drake Ne Plus Ultra, Pethick's Wonder and Local Selection reached full bloom stage almost alongwith Non Pareil, the last one behaving similarly in 1992 also (Table 1). Time of full bloom was late than that of Non Pareil by 38 days (Tree No. 125) to three days (Badamjor Spillo No. 2, Local Selection), 27 days (Ribba Selection) to eight days (Prianyi) and 22 days (Ribba Selection) to nine days (Badamjor Spillo No. 2, Ne plus Ultra, Pethick's Wonder) in 1990, 1991 and 1992, respectively. Eight cultivars, namely, Nikitskyi, Prianyi, Ribba Selection, Spillo No. 7, Star Basin, Tree No. 2, Tree No. 125 and White Brandis attained full bloom stage after eight or more number of days than the check during all the three years.

**Table 1 : Time of flowering and maturation in some almond cultivars/selections**

| Cultivar/<br>Selection | Date of bud break |      |      | Date of full bloom |      |      | Date of hull dehiscence |      |      | Days to maturation |      |      |
|------------------------|-------------------|------|------|--------------------|------|------|-------------------------|------|------|--------------------|------|------|
|                        | 1990              | 1991 | 1992 | 1990               | 1991 | 1992 | 1990                    | 1991 | 1992 | 1990               | 1991 | 1992 |
| Badamjor Spillo No. 2  | 12/1              | 23/2 | 8/2  | 26/1               | 4/3  | 26/2 | -                       | 24/7 | 10/7 | -                  | 142  | 135  |
| Drake                  | 15/1              | 9/2  | 2/2  | 5/2                | 17/2 | 28/2 | 7/7                     | 8/7  | 27/7 | 152                | 141  | 150  |
| Local Selection        | 10/1              | 6/2  | 2/2  | 26/1               | 17/2 | 16/2 | 8/7                     | 20/7 | 6/7  | 163                | 153  | 141  |
| Ne Plus Ultra          | 10/1              | 31/1 | 8/2  | 28/1               | 19/2 | 26/2 | 30/6                    | 20/7 | 10/7 | 153                | 151  | 135  |
| Nikitskyi              | 15/1              | 14/2 | 10/2 | 2/2                | 28/2 | 28/2 | 30/6                    | 8/7  | 9/7  | 148                | 130  | 132  |
| Pethick's Wonder       | 15/1              | 6/2  | 8/2  | 30/1               | 18/2 | 26/2 | 2/7                     | 20/7 | 24/7 | 153                | 152  | 149  |
| Prianyi                | 16/1              | 12/2 | 10/2 | 4/2                | 27/2 | 4/3  | 11/7                    | 8/7  | 1/7  | 157                | 131  | 119  |
| Ribba Selection        | 20/1              | 14/2 | 16/2 | 10/2               | 18/3 | 10/3 | 27/7                    | -    | 27/7 | 167                | -    | 139  |
| Spillo No. 7           | 20/1              | 15/2 | 14/2 | 5/2                | 2/3  | 5/3  | 20/7                    | -    | 27/7 | 165                | -    | 144  |
| Star Basin             | 22/1              | 14/2 | 16/2 | 9/2                | 2/3  | 8/3  | 27/7                    | 11/7 | 1/8  | 168                | 130  | 146  |
| Tree No. 2             | 31/1              | 18/2 | 10/2 | 18/2               | 2/3  | 8/3  | 11/7                    | 11/7 | 26/6 | 143                | 130  | 110  |
| Tree No. 125           | 10/2              | 14/2 | 10/2 | 2/3                | 8/3  | 28/2 | 2/7                     | 27/6 | 1/7  | 121                | 111  | 124  |
| White Brandis          | 22/1              | 17/2 | 14/2 | 8/2                | 7/3  | 6/3  | 2/7                     | 16/7 | 9/7  | 144                | 131  | 125  |
| Non Pareil (Check)     | 10/1              | 4/2  | 31/1 | 23/1               | 19/2 | 19/2 | 19/7                    | 25/7 | 20/7 | 177                | 156  | 154  |

Eight out of 13 cultivars, viz., Local Selection, Drake Ne Plus Ultra, Nikitskyi, Prianyi, Tree No. 2, Tree No. 125 and White Brandis matured earlier than Non Pareil during all the three seasons (Table 1). Badamjor Spillo No. 2 also matured earlier except in 1990. The earliness in fruit maturation ranged from 19 days (Ne Plus Ultra, Nikitskyi) to eight days (Prianyi) in 1990, 28 days (Tree No. 125) to one day (Badamjor Spillo No. 2) in 1991 and from 24 days (Tree No. 2) to ten days (Badamjor Spillo No. 2, Ne Plus Ultra) in 1992.

In almonds, both the time of flowering and fruit maturation are quantitatively inherited and are dependent upon multiple factors (Kester and Asay, 1975). Such an inheritance pattern makes a particular trait more vulnerable to express variably under specific environments particularly the temperature (Rattigan and Hill, 1988). Similar observations have been made in the present study as evident from the fluctuating temperatures during flowering (Fig. 1) where the bud break in early flowering cultivars got initiated in second week

of January in 1990 and three weeks later in 1991 and 1992. High post-dormant temperatures (15-20° C) are known to enhance flower development, thereby shortening the flowering period (Neiddu *et al.*, 1990). Relatively less number of days taken from bud break to full bloom in 1991 in most of the cultivars and selections are indicative of the above contention. In 1990, the overall blooming was earlier in all the genotypes; early blooming genotypes flowered 3-4 weeks earlier while late blooming genotypes flowered 1-4 weeks earlier than they did in 1991. Almost the same trend for early and late flowering cultivars has been reported earlier (Hill *et al.*, 1985). The latest flowering entry

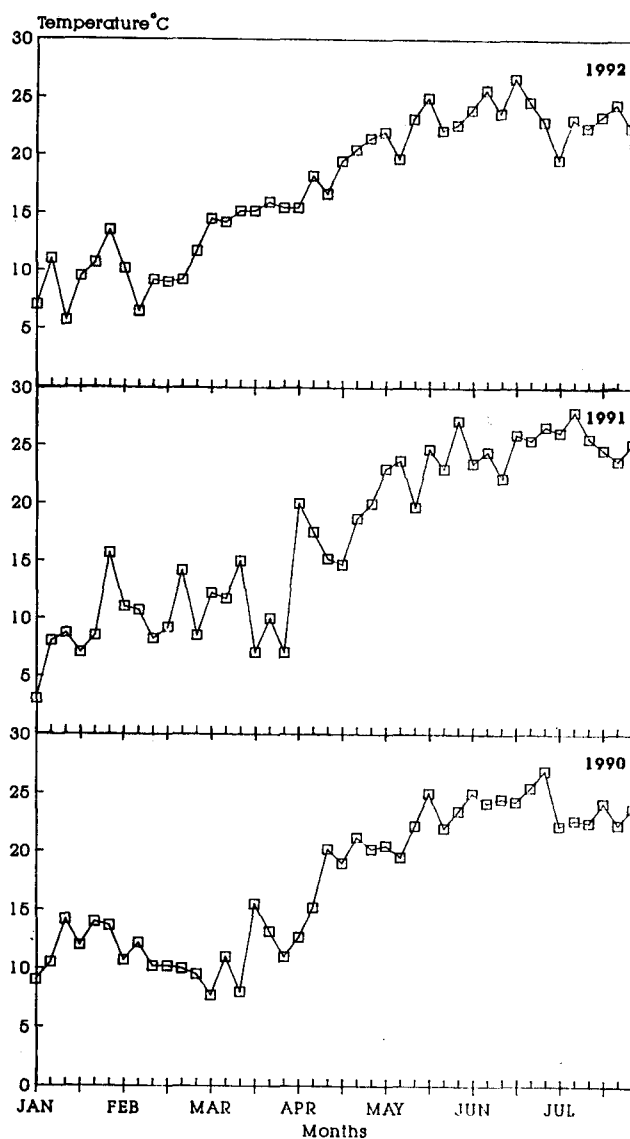


Fig. 1. Daily mean temperature (at 5-day interval) from bud-break to fruit maturation

Tree No. 125 did not vary significantly in its trend over the years. This may be due to resistance of this particular genotype to frequent winter thaws whereby the time of flowering is advanced by several weeks as a result of sudden changes in temperature (Denisov, 1988). The data in Table 1 indicated that date of bud break and the date of full bloom, showed similar trends and hence can be considered a selection criterion for late flowering as pointed out earlier by Tydeman (1964) for apples.

Fruit maturation in almond as judged by the onset of hull splitting also depicted a great deal of variation in the germplasm under study (Table 1) further implying that this trait is cultivar specific (Kester and Asay, 1975). The year to year variation in days taken by fruits to mature is partly attributed to fluctuations in temperatures, which advanced the date of flowering (full bloom) by two to three weeks in 1990 and partly due to varied heat requirement (Ratigan and Hill, 1988). The different maturation times of similar genotypes over the seasons may be due to varied number of degree days received during the three years reckoned from date of full bloom to harvest time as has been reported for other stone fruit crops. This gets the support from the findings of Kester *et al.* (1977) who reported that fruit maturity in almond shows large genotype  $\times$  year interaction. In almonds, there is no set association between the time of flowering and fruit ripening (Rugini and Monastra, 1991), yet cultivars namely Ferralise, Distomou Viotias and some wild forms (*Amygdalus arabica* and *Amygdalus spinosissima*) are reported to be late blooming as well as early maturing (Denisov, 1988; Kester *et al.*, 1990). In our study, Nikitskyi, Prianyi, Tree No. 2, Tree No. 125 and White Brandis (Table 2) have been found to be late flowering as well as early maturing than 'Non Pareil'. The five selections spotted out as mentioned above hold promise for overcoming the major environmental problems of almond cultivation in the north-western Himalayas.

**Table 2 : Almond cultivars/selections showing late flowering and early maturity**

| S. No. | Cultivar/selection | Date of full bloom<br>(days after cv. Non Pareil) |      |      |      | Date of hull dehiscence<br>(days before cv. Non Pareil) |      |      |      |
|--------|--------------------|---------------------------------------------------|------|------|------|---------------------------------------------------------|------|------|------|
|        |                    | 1990                                              | 1991 | 1992 | Mean | 1990                                                    | 1991 | 1992 | Mean |
| 1.     | Nikitskyi          | 10.0                                              | 9.0  | 11.0 | 10.0 | 19.0                                                    | 17.0 | 11.0 | 15.6 |
| 2.     | Prianyi            | 12.0                                              | 12.0 | 16.0 | 13.3 | 8.0                                                     | 17.0 | 19.0 | 14.6 |
| 3.     | Tree No. 2         | 26.0                                              | 11.0 | 20.0 | 19.0 | 8.0                                                     | 14.0 | 24.0 | 15.3 |
| 4.     | Tree No. 125       | 38.0                                              | 17.0 | 16.0 | 27.0 | 17.0                                                    | 28.0 | 19.0 | 21.3 |
| 5.     | White Brandis      | 16.0                                              | 16.0 | 18.0 | 16.7 | 17.0                                                    | 9.0  | 11.0 | 12.3 |

It is concluded that late flowering and early maturing selections may be tested under different agro-climatic conditions for determining their suitability as commercial cultivars or may be used as parents in breeding programme aimed at developing improved cultivars possessing these characteristics.

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## INDIGENOUS RICES OF MIZORAM STATE

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The explorations undertaken in Mizoram state revealed enormous germplasm diversity of rice. A total of 90-95 landraces were grown under *jhum* (upland) and wetland conditions. These differed highly in growth duration, grain quality, yield potential, disease and pest resistance and cultural practices. Some of the varieties were drought tolerant (Hmawrhlang), well adapted to high altitudes (Buhtawi) and highly acidic soil conditions (Liachai).

**Key words :** Rice, genetic diversity, landraces, upland and lowland varieties

Rice mainly grown on *jhums* in Mizoram is the staple cereal food of Mizo people. Mizoram is situated between 22°12' to 24°90'N latitude and 92°20' to 93°29'E longitude. The altitude ranges from 30 m to 2210 m and the area is characterised by a humid temperature at (8° to 23°C) climate over high hills and warm humid subtroical (15° to 30°C) climate in valleys and low hills. The mean annual rainfall is about 2, 640 mm of which 90 per cent is received in monsoon season (May to October). The soils are loamy to clayey and acidic (pH 4.1 to 5.8), high in organic matter (1.30% to 4.60%), low in available phosphorus (2.0 to 13.9 ppm) and medium in available potash (60.9 to 522.8 ppm) (Anon. 1989). The three districts (Aizawl, Lunglei & Chhimituipui) have been further divided into 5 agricultural districts, viz., Aizawl east, Aizawl west, Lunglei, Saiha and Kolasib. Such diverse agro-ecological conditions host a large number of paddy varieties well adapted to different situations. The present study is an attempt to list all the indigenous resources of rice varieties in Mizoram.

### REGIONS SURVEYED AND SAMPLING STRATEGIES

Collection of indigenous rice germplasm was carried out in three exploration and collection tours. These were conducted in March, 1989; November, 1990 and April, 1991. During these trips, 35 sites were covered. These sites fall under the major rice growing areas of Aizawl, Champhai, Lunglei, Sercchip, Saiha, Keifang, Khawzawl and Kolasib. Sampling was done from the represented places where it is grown, especially the valley and river bed areas. The distance

between the sampling places were almost 20-30 km or more apart. The altitude of these sites varied from 200 m to 1260 m above msl. The routes followed in these surveys have been depicted in Fig. 1.

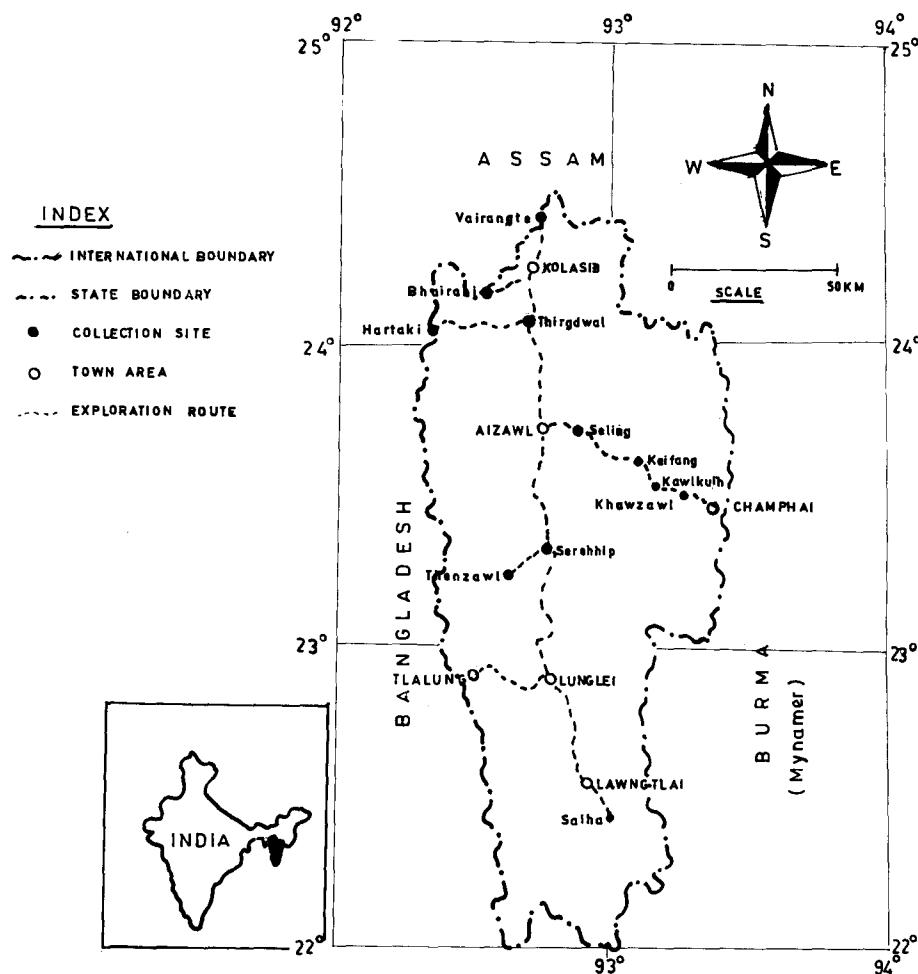


Fig. 1. Route map for collection of rice germplasm from Mizoram State

### DISTRIBUTION AND DIVERSITY PATTERN

Rice cultivation is generally taken up in Mizoram on *jhum* lands but wetland rice culture is also common in valley lands. A large number of varieties (90-95) are grown in the state. These have been introduced from Burma, Bangladesh (Chittagong hills), Manipur and Assam (Surma Valley) at different occasions in the past. However, these have lost their original identity over the time and now may rightly be called as landraces. A list of rice landraces of southern Mizoram is given in Table 1. All the available landraces

**Table 1 : Some paddy landraces of southern Mizoram with their characteristic features**

| Local Name       | Crop duration (days) | Potential grain yield (q/ha) | Cultural Practice       | Salient varietal characters                                                                    |
|------------------|----------------------|------------------------------|-------------------------|------------------------------------------------------------------------------------------------|
| Madino           | 160-170              | 20.0-30.0                    | <i>Jhum</i>             | Small slender grains                                                                           |
| Laka Kyly        | 100-110              | 15.0-20.0                    | <i>Jhum</i>             | Long bold sticky grains                                                                        |
| Liachaw          | 170-180              | 30.0-38.0                    | <i>Jhum</i>             | Small slender grains                                                                           |
| Kaodi            | 90-105               | 17.5-22.5                    | <i>Jhum</i>             | Medium long slender grains introduced from Burma (Arakan)                                      |
| Moresah          | 110-115              | 15.0-20.0                    | <i>Jhum</i> and Wetland | Bold grains variety                                                                            |
| Ngawni Mawpa     | 180-185              | 30.0-40.0                    | <i>Jhum</i>             | Long slender grains                                                                            |
| Sasai            | 110-115              | 17.5-22.5                    | <i>Jhum</i>             | Small slender grains                                                                           |
| Sakha Kyly       | 160-165              | 15.0-22.5                    | <i>Jhum</i>             | Bold grains                                                                                    |
| Laka             | 115-120              | 17.5-22.5                    | <i>Jhum</i>             | Grains small slender                                                                           |
| Hekha Kyly Saipe | 140-150              | 15.0-20.0                    | <i>Jhum</i>             | Sticky                                                                                         |
| Aksina           | 135-145              | 25.0-30.0                    | <i>Jhum</i>             | Grain breakage, more susceptible to blast and good yielder in <i>jhums</i> and low altitudes   |
| Zosah            | 110-120              | 20.0-22.5                    | <i>Jhum</i>             | Small slender grains and a good variety for ratooning and photo-thermo insensitive             |
| Taho             | 135-145              | 25.0-30.0                    | <i>Jhum</i>             | Small slender grains                                                                           |
| Kasaba           | 135-145              | 20.0-25.0                    | <i>Jhum</i>             | Small slender grains variety is good for <i>jhum</i> cultivation in low as well as high hills. |
| Zosa             | 130-145              | 20.0-25.0                    | <i>Jhum</i>             | Medium long slender grains                                                                     |
| Rapha Kyly       | 130-145              | 23.0-25.0                    | <i>Jhum</i> and Lowland | Long bold sticky rice                                                                          |
| Kypu             | 130-140              | 20.0-25.0                    | <i>Jhum</i>             | Long slender grains                                                                            |
| Liaraw           | 180-185              | 30.0-35.0                    | <i>Jhum</i>             | Small slender grains                                                                           |
| Angka            | 130-135              | 20.0-25.0                    | <i>Jhum</i>             | Medium long slender grains introduced from Burma                                               |
| Mochisah         | 130-135              | 18.0-22.5                    | <i>Jhum</i>             | long slender grains                                                                            |
| Mipu Kyly        | 180-185              | 25.0-30.0                    | <i>Jhum</i>             | Bold grain                                                                                     |
| Pawnbuh          | 125-130              | 30.0-35.0                    | <i>Jhum</i>             | Tall                                                                                           |

of Mizoram may be classified into two major groups - upland (*jhum*) varieties and lowland or wetland varieties. These could be further divided into following subgroups :

### **I. Upland (*jhum*) varieties**

- (i) **Early (90-110 days) :** Buhmiltha, Taibial, Zongam, Khazang, Buhban
- (ii) **Medium (110-140 days) and Late (140-185 days) :** Taibar, Mawngbuh, Zaithai, Buhsezuk, Buhbial, Buhdite, Mydani, Mybring, Farel, Vaibuh, Phulbuh, Luangbuh, Fazai, Liankhuma, Burma buhban, Ui thobuh, Maimi, Chiaru, Leva, Kaikuangbuh, Beti, Badia, Dilung, Kengpui, Zaithai, Hawnghen, Taibawr, Ralleng, Buhpui (Red), Tahoe, Hmaohmisapa, Zosa, Kypu, Liaraw, Angka, Mochisahr, Aksina, Laka, Saipo, Sakha Kyly, Sasai, Ngawni mapaw, Kaodi, Liachai, Laka Kyly, Madino, Maubuh, Chhirthlukpui, Maibasa, Pawnbuh.
- (iii) **Sticky (used as flour or for fermentation)**
  - (a) **Early :** Kawlawang
  - (b) **Medium and Late :** Buhbanben, Ziankhuma, Fazu, Zakeuva (best quality), Tawisanga, Dumte, Buhsanghar Kyly Doehque, Vikakyly, Mipukyly, Matukeuleu, Tialpui (scented), Lianran (red), Taisanghar (red and scented grain), Konglang
- (iv) **Cold tolerant and lodging resistant :** Buhtawi, Kasaba
- (v) **Scented and fine quality :** Tai (very early), Farate (early), Bawngbuh (early), Mawngbuh, Zongam (long slender grains), Phanrai
- (vi) **Drought resistant :** Hmawrhawng
- (vii) **Ratooning :** Zosah (early)

### **II. Wetland (low land) varieties**

- (i) **Early :** Tai.
- (ii) **Medium and late :** Vuitawi, Phaipui Buhban, Tialte, Taifang Sawl, Vuitawia, Mawngsen (Leilet buh), Lalruma.
- (iii) **Scented and fine quality :** Tai Kawlawang (Late), Moresah.
- (iv) **Sticky :**
  - (a) **Early :**
  - (b) **Late :** Maipuom, Rapha Kyly (good in upland also)
- (v) **Ratooning :** Tai (bold grain, 4 months' duration).

It was interesting to observe the cultural practices of rice in Mizoram which may have relevance to understand the changes in evolutionary pattern of rice germplasm in the context of their cultural characteristics. *Jhum* or shifting cultivation is predominant. A *jhum* cycle of 6 to 8 years is followed.

The paddy is grown on about 71,000 hectares per family which is the highest in north-eastern region (Upadhyaya, 1986). The *jhum* clearing and burning is completed before February and March. Field preparation and sowing start in April. The Mizo farmers do all the field work themselves and no draft animals are employed for agricultural work. All the cultural operations performed by using few implements like axe (*Hreipui*), *dao* (*Chem*), small and big spade (*Tuthlolawh te* and *pui*) and a sickle (*Fafah*). The holes are dug without using a definite scale but depending on the tillering capacity of a variety and 8-10 seeds are placed in each. These may be thinned out (3-4 or 5-6 seedlings) later. In general, the harvestable paddy yields are about ten quintals per hectare. The reasons for this low yield could be due to little irrigation facilities, damage by pests, wild animals (elephants, wild pigs) and post harvest losses. The loss of *jhum* lands varies from 5 per cent to 15 per cent or even more and 50 per cent of the total area remains under forest cover. In good years, however, a yield of 30-35 quintals/ha of paddy is not uncommon.

The varieties under cultivation in the southern Mizoram are unique in many aspects and their detailed features are presented in Table 1. They showed variation in maturity from 90 to 185 days, the yield potential ranged for high altitudes, wetlands and uplands, and ratooning etc. They also possessed a moderate degree of resistance to leaf roller, brown plant hopper and root knot nematodes which are serious yield barriers in the region.

To conclude, all the germplasm of rice in Mizoram have been found to possess many valuable genes for various abiotic and biotic stresses, high yield potential under favourable conditions but moderate yields even under adverse conditions.

#### ACKNOWLEDGEMENTS

Authors are thankful to the Director, National Bureau of Plant Genetic Resources, New Delhi; Director of Agriculture, Government of Mizoram and the officials of Directorate for rendering necessary help in the explorations.

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## ADAPTABILITY IN FRENCH BEAN (*PHASEOLUS VULGARIS* L.)\*

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Forty two varieties of french bean, studied for their phenotypic stability in five environments (i.e., 3 *Kharif* and 2 spring seasons), indicated presence of significant genotype-environment interactions for all the eleven characters including seed yield. Most of the genotype-environment interactions were attributed to linear component except in case of plant height, number of leaves, number of seeds, 100-seed weight, days to flower and days to maturity in which both linear and non-linear components were significant. Keeping in view all the three parameters of adaptability, EC 44624, EC 109975, PLB14-1, EC 43893, and PLB-256 proved to be the best adaptables and can be utilised in breeding as parents for yield stability in french bean.

**Key words :** Frenchbean, adaptability, joint regression, G×E interaction, genetic stability

The information on stability aspects in Frenchbean (*Phaseolus vulgaris* L) is insufficient in India. It is imperative to identify stable and adaptable genotypes of Frenchbean over a number of environments for various yield and yield contributing attributes. The information on the stable yield contributing characters would provide selection criteria which would help the breeders in tailoring new high yielding cultivars for a wider range of environments. The present studies were carried out to identify stable varieties for breeder's use.

### MATERIALS AND METHODS

Forty-two varieties of Frenchbean originating from different geographical regions of the world were tested in five environments i.e. three *kharif* (July-October) and two spring (February - April) seasons in a randomised complete block design with four replications at Shimla. Each accession was

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\*Part of Ph.D Thesis of the first author submitted to Kumaon University, Nainital (U. P.)

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sown in 2.25 m long rows and spaced 50cm apart. Seeds were dibbled 15 cm apart in the rows. Five randomly selected plants in each single row plot were marked for taking observations on 11 characters, viz., days to flower, plant height (cm), number of leaves, number of branches, number of clusters, number of pods, pod length (cm), days to maturity, number of seeds per pod, 100-seed weight (g) and yield per plant (g). The mean values were computed for each character, using five seasons data. The stability analysis was carried out following the model proposed by Eberhart and Russel (1966).

## RESULTS AND DISCUSSION

Joint regression analysis for eleven characters studied is presented in Table 1. The variance due to genotypes was significant for all the traits suggesting presence of variation among genotypes. The variance due to genotype-environment interactions were also significant for all the traits. All the parameters of adaptability, viz., mean (m), coefficient of regression (bi) and deviation from regression ( $S^2d$ ) estimated for yield are presented in Table 2. Differences were found among 42 Frenchbean varieties in respect of deviation from regression. The genotypes EC 44624, EC 109975 and PLB 14-1 had mean values for seed yield above the grand mean, low  $S^2d$  and were thus rated the most stable genotypes.

Out of 42 genotypes, EC 18600, EC 26399, EC 43893 and EC 44758 were found to be high yielding. They showed response to better environment. EC 43893 also showed sufficiently high adaptability to unpredictable environmental conditions due to non-significant  $S^2d$  values. Over five environments EC 18600 gave maximum yield but was found to be most unstable genotype.

The stability parameters for components of yield and fitness revealed that most stable and high yielding variety PLB14-1 had higher mean value than the grand mean for plant height, number of branches, number of clusters, number of pods, pod length, 100 seed weight and days to maturity. EC 18611 (B) was found to be most stable genotype for days maturity and number of leaves. PLB14-1 and EC 43900 were observed to be most stable for characters number of clusters and number of pods. These character have significant correlation with seed yield. EC 109977, EC 93621 and PLB14-1 were observed to be most stable for pod length and genotype EC 109975 and EC 77005 for number of seeds. Genotypes EC 44790 and EC 94469 showed the highest consistency and stability for 100-seed weight under changing environments.

Table 1 : Pooled analysis of variance for stability for 11 characters in french bean

| Source                           | df  | Plant height | Number of leaves/plant | Number of branches/plant | Number of clusters/plant | Number of pods/plant | Pod length | Number of seeds/plant | 100-seed weight | Days to flower | Days to mature | Seed yield/plant |
|----------------------------------|-----|--------------|------------------------|--------------------------|--------------------------|----------------------|------------|-----------------------|-----------------|----------------|----------------|------------------|
| Genotypes                        | 41  | 1943.37**    | 289.96**               | 0.37                     | 21.50**                  | 71.66**              | 15.35**    | 2087.44**             | 441.92**        | 165.26**       | 249.68**       | 72.46**          |
| Environment                      | 4   | 2662.97**    | 178.23**               | 9.20**                   | 163.23**                 | 268.17**             | 28.63**    | 6885.39**             | 357.32**        | 6722.42**      | 3345.55**      | 352.38**         |
| Genotype x Environment           | 164 | 286.36**     | 44.98**                | 0.15**                   | 9.96**                   | 19.20**              | 3.01**     | 497.78**              | 21.54**         | 1912**         | 48.84**        | 26.09**          |
| Heterogeneity between regression | 41  | 525.52**     | 64.23**                | 0.14                     | 21.96**                  | 47.70**              | 1.77**     | 1428.31**             | 30.55**         | 28.92**        | 108.90**       | 39.74**          |
| Remainder                        | 123 | 206.64       | 38.57                  | 0.16                     | 5.95                     | 9.70                 | 3.43       | 187.61                | 18.54           | 15.86          | 28.86          | 21.54            |
| Pooled Error                     | 630 | 23.15        | 7.19                   | 0.13                     | 7.50                     | 12.00                | 9.75       | 80.48                 | 5.50            | 5.09           | 24.35          | 24.26            |

\* = P<sub>0.05</sub>, \*\* = P<sub>0.01</sub>

**Table 2 : Means and estimates of stability parameters for yields of 42 varieties of french bean**

| Variety      | Mean  | $b_i$ | $S^2_d$ | Variety   | Mean  | $b_i$ | $S^2_d$ |
|--------------|-------|-------|---------|-----------|-------|-------|---------|
| EC-18600     | 25.33 | 3.93  | 214.83* | EC-57260  | 9.96  | 1.15  | -5.32   |
| EC-18611     | 17.30 | 1.69  | 22.56   | EC-77005  | 17.59 | 0.73  | 23.51*  |
| EC-19038     | 11.77 | -0.19 | -2.57   | EC-93621  | 9.48  | -0.62 | -0.96   |
| EC-22365     | 9.03  | 0.03  | 0.21    | EC-93625  | 17.49 | 1.24  | 27.66*  |
| EC-24948     | 12.87 | 0.67  | -0.11   | EC-93828  | 8.93  | 0.48  | -4.44   |
| EC-26399     | 20.01 | 3.23  | 29.90*  | EC-94453  | 15.27 | 1.30  | 4.40    |
| EC-26402     | 17.97 | 0.23  | 20.96   | EC-94455  | 12.19 | 0.90  | 1.55    |
| EC-31230     | 11.29 | 0.56  | -4.14   | EC-94469  | 12.94 | 0.94  | -2.39   |
| EC-34023     | 15.96 | 3.84  | 51.87*  | EC-99540  | 13.74 | -0.55 | 96.70*  |
| EC-36664     | 11.08 | 0.01  | -5.41   | EC-99541  | 14.05 | 0.42  | -4.33   |
| EC-42960     | 13.82 | 0.83  | 21.19   | EC-100677 | 7.91  | 0.37  | 0.29    |
| EC-43893     | 19.77 | 1.43  | 11.57   | EC-100680 | 10.58 | 0.45  | 0.15    |
| EC-43896     | 12.26 | -0.02 | 2.00    | EC-108101 | 11.72 | 0.25  | -1.72   |
| EC-43900     | 17.43 | 1.33  | 10.80   | EC-109508 | 15.55 | 3.04  | -4.92   |
| EC-44624     | 17.47 | 2.75  | 3.00    | EC-109975 | 17.14 | 0.33  | 1.03    |
| EC-44747     | 18.85 | 1.99  | 84.95*  | EC-109977 | 15.97 | -0.10 | 17.27   |
| EC-44758     | 20.35 | 1.54  | 29.03*  | Premier   | 11.57 | 0.64  | -3.62   |
| EC-44760     | 8.80  | 0.46  | -5.24   | PLB10-1   | 13.43 | 0.85  | -0.78   |
| EC-44787     | 9.89  | 1.07  | -4.93   | PLB-14-1  | 16.49 | 0.82  | -3.91   |
| EC-44790     | 11.72 | 0.23  | 0.21    | PLB-256   | 14.55 | 0.14  | -2.60   |
| EC-57080     | 12.16 | 1.26  | -3.80   | PLB-440   | 15.00 | 2.31  | 11.81   |
| Mean         | 14.20 |       |         |           |       |       |         |
| Pooled error | 24.26 |       |         |           |       |       |         |

\*p = 0.05

The occurrence of differential stability for various yield and adaptability influencing traits is reported in Frenchbean as also the information on stable genotypes varies for yield alone (Crispin, 1968; Stupar, 1978; Santos and Ramalho 1990; Abreu *et al.*, 1990). These studies support the findings reported in this paper in need to select germplasm with known adaptability for yield and /or its component traits alongwith high *per se* performance for further use in breeding programmes.

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## LONG TERM CONSERVATION OF RELEASED VEGETABLE VARIETIES

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**Key words :** Vegetable varieties, long term conservation

The released varieties are expected to possess desirable combination attributes out of a wide range of diversity in the available germplasm. These also provide genetic base for further improvement by incorporating other desired attributes. The Bureau attempts to conserve the seeds of all the released varieties of vegetable crops in the National Genebank as per preferred standards and specified seed storage at  $-18^{\circ}\text{C}$  or less, in air tight containers, at a seed moisture content of  $5 \pm 1$  per cent as recommended by FAO panel of experts on Plant Exploration and Introduction (Cromarty *et al.*, 1982) for the long term conservation of orthodox seeds.

The NBPGR Genebank has all the essential facilities required for the processing and storage of seed for long term conservation. The facilities include four cold storage vaults capable of maintaining the storage temperature of  $-20^{\circ}\text{C}$  and storing about 2,00,000 accessions of germplasm and varieties. The Bureau has other ancilliary facilities such as fully equipped seed testing laboratories; a seed dryer, operating at  $15^{\circ}\text{C}$  and maintaining 15 per cent RH; and a computerised data processing unit, for an efficient management of germplasm holdings under longterm conservation. In order to maintain viability of accessions in the long term the seed moisture content must be maintained after seed drying, in hermetic containers. At the NBPGR, three layered laminated aluminium foil pouches are used for keeping the seed for long term storage of vegetable seeds. So far, only 42 released vegetable varieties were conserved in the National Gene Bank at the NBPGR (Table 1).

The technique of vegetable crops seed increase for long term conservation should aim at preserving intra-variatal variability and should avoid seed and pollen contamination from adjacent plots and varieties. Techniques of seed production/extraction for important catagoeries of vegetable crops are summarised below:

**Cole Crops :** Important crops are cabbage, cauliflower and knol khol. Seed to seed and head to seed methods are practices for seed production of these crops. All these crops are highly cross pollinated and isolation distance of 1600 m is prescribed for foundation seed and 1000 m for certified seed production. The crops are harvested when 60-70 per cent pods turn yellow to brown in colour and stacked for a few days for curing before threshing (Singh and Gill, 1993).

**Table 1 : Released varieties of vegetable crops stored for Long term conservation in the NBPGR Gene Bank upto December 31, 1992**

| Crop<br>(Botanical Name)                                         | Source                                               | Variety                                                   | IC No.                   |
|------------------------------------------------------------------|------------------------------------------------------|-----------------------------------------------------------|--------------------------|
| Spinach<br>( <i>Spinacia oleracea</i> L.)                        | IARI, Regional Station,<br>Katrai, Himachal Pradesh  | Virginia Savoy                                            | 75028                    |
| Methi<br>( <i>Trigonella foenum graecum</i> L.)                  | SKN College of Agriculture, CO1<br>Jobner, Rajasthan |                                                           | 78380                    |
| Lettuce ( <i>Lactuca sativa</i> L.)                              | IARI Regional Station<br>Katrai, Himachal Pradesh    | Chinese Yellow                                            | 76300                    |
| Long melon<br>( <i>Cucumis melo</i> L. var<br>utilissimus Dutch) | IIHR, Bangalore,<br>Karnataka                        | Arka Sheetal                                              | 76262                    |
| Muskmelon<br>( <i>Cucumis melo</i> L.)                           | IIHR, Bangalore,<br>Karnataka                        | Arka Jeet                                                 | 76259                    |
|                                                                  | ARS, Durgapura,<br>Rajasthan                         | Durgapura<br>Meetha                                       | 113138                   |
| Watermelon<br>( <i>Citrulus vulgaris</i> Schrad.)                | ARS, Durgapura,<br>Rajasthan                         | Durgapura<br>Keshar                                       | 113139                   |
|                                                                  | IARI, Regional Station,<br>Katrai, Himachal Pradesh  | Asahi Ramato                                              | 76317                    |
| Red pumpkin<br>( <i>Cucurbita moschata</i> Poir<br>Dutch.)       | IIHR Bangalore,<br>Karnataka                         | Arka Chandan                                              | 76256                    |
| Summer squash<br>( <i>Cucurbita pepo</i> L.)                     | IARI, Regional Station,<br>Katrai Himachal Pradesh   | Australian Green<br>Pusa Alankar                          | 76308<br>76309           |
| Winter squash<br>( <i>Cucurbita maxima</i> L.)                   | IIHR, Bangalore,<br>Karnataka                        | Arka Suryamukhi                                           | 75257                    |
| Bitter gourd<br>( <i>Momordica charantia</i> L.)                 | IIHR, Bangalore,<br>Karnataka                        | ARKA Harit                                                | 75263                    |
| Cucumber<br>( <i>Cucumis sativus</i> L.)                         | IARI, Regional Station,<br>Katrai, Himachal Pradesh  | Pusa Sanyog<br>Japanese Long<br>Green                     | 76296<br>76297           |
| Brinjal<br>( <i>Solanum melongena</i> L.)                        | IARI, Regional Station,<br>Katrai, Himachal Pradesh  | Pusa Purple Long<br>Pusa Purple<br>Cluster<br>Pusa Anupam | 76286<br>76287<br>118806 |

(Continued on page 81)

(Continued from page 80)

| Crop<br>(Botanical Name)                                             | Source                                               | Variety                                 | IC No.         |
|----------------------------------------------------------------------|------------------------------------------------------|-----------------------------------------|----------------|
|                                                                      | TNAU, VRS, Palur,<br>Tamil Nadu                      | PLR 1                                   | 113889         |
| Okra<br>( <i>Abelmoschus esculentus</i> L.<br>Monech)                | IARI, Regional Station<br>Katrain, Himachal Pradesh  | Pusa Makhmali<br>Perkin's Long<br>Green | 76282<br>76283 |
| Sweet pepper<br>( <i>Capsicum annuum</i> L.)                         | IARI, Regional Station,<br>Katrain, Himachal Pradesh | California<br>Wonder 1<br>Yolo Wonder   | 76290<br>76291 |
| Hot pepper<br>( <i>Capsicum frutescens</i> L.)                       | RRS, Lam,<br>Andhra Pradesh                          | Sindhur                                 | 73158          |
|                                                                      | GAU, Anand, Gujarat                                  | Jwala                                   | 77004          |
| Tomato<br>( <i>Lycopersicon<br/>esculentum</i> Mill.)                | IARI, Regional Station,<br>Katrain, Himachal Pradesh | Roma                                    | 76310          |
|                                                                      |                                                      | Rest of All                             | 76311          |
|                                                                      |                                                      | Marglobe                                | 76312          |
|                                                                      |                                                      | Sious                                   | 76313          |
|                                                                      | GAU, Anand, Gujarat.                                 | S-120                                   | 76997          |
|                                                                      | TNAU, Regional Station,<br>Paiyur, Tamil Nadu        | Paiyur 1                                | 13891          |
| Cabbage<br>( <i>Brassica oleracea</i> L. var.<br><i>capitata</i> L.) | IARI, Regional Station,<br>Katrain, Himachal Pradesh | Golden Acre                             | 76238          |
|                                                                      |                                                      | Pusa Drumhead                           | 76289          |
| Knol khol<br>( <i>B. oleracea</i> L. var.<br><i>gongyloides</i> L.)  | IARI, Regional Station,<br>Katrain, Himachal Pradesh | White Vienna                            | 76318          |
| Cauliflower<br>( <i>B. oleracea</i> , var. <i>botrytis</i> L.)       | IARI, Regional Station,<br>Katrain, Himachal Pradesh | Pusa Snow Ball-1                        | 76293          |
| Garden beet<br>( <i>Beta vulgaris</i> L.)                            | IARI, Regional Station,<br>Katrain, Himachal Pradesh | Detroit Dark Red                        | 76285          |
|                                                                      |                                                      | Crimson Global                          | 76284          |
| Turnip<br>( <i>Brassica rapa</i> L.)                                 | IARI, Regional Station,<br>Katrain, Himachal Pradesh | Pusa Chandrima                          | 76314          |
|                                                                      |                                                      | Purple Top White<br>Globe               | 76316          |
| Radish<br>( <i>Raphanus sativus</i> L.)                              | IARI, Regional Station,<br>Katrain, Himachal Pradesh | Pusa Himani                             | 76305          |
|                                                                      |                                                      | Japanese White                          | 76306          |

**Root crops :** Carrot, radish and turnips are the main crops in this category. Isolation distance of 800m and 1000m are recommended for certified and foundation seed plots in these crops (Anon. 1988).

**Onion** : Bulb-to-seed or seed-to-seed method may be practiced. All the umbels do not mature at the same time. Therefore, the harvesting of umbels may be done in two to three pickings. The umbels are ready for pickings when about 20 per cent black seed becomes visible.

**Okra** : The outcrossing in okra varies from 0-60 per cent depending upon the variety. For large plot seed multiplication, isolation distance of 400m and 200m is recommended for foundation and certified seeds, respectively.

**Leguminous vegetables** : Garden pea, french bean, cluster bean, winged bean, field bean and broad beans are important in India. Fully ripened pods should be harvested, cured, threshed and cleaned for seed purpose. Seeds may be properly graded to remove shrivelled and immature seeds before sending them for long-term conservation.

**Tomato** : This is predominantly a self-pollinated crop but outcrossing does take place to a negligible extent. Isolation distance of 50 and 25 m is recommended for foundation and certified seed, respectively. Seed can be extracted manually using acid or fermentation methods or mechanically using axil - flow vegetable seed extracting machine (Singh & Gill, 1993).

**Brinjal and chillies** : Isolation distance of 200 and 100m for brinjal and 400 and 200m for chillies for foundation and certified seeds, respectively is recommended. The fruits should be allowed to mature beyond the edible stage before harvesting for seed. Mature brinjal fruits are cut and crushed and the seed is extracted by washing and sieving. The seed should be dried soon after extraction else they may start germinating. Chilli fruits are picked at red ripe stage.

**Cucurbits** : Cucumber, squashes, gourds, pumpkin, watermelon and muskmelon are the important vegetables in this category. The isolation distance required for all these crops is 1000m for foundation and 500 m for certified seed plots. Muskmelon fruit is ready for seed harvest with change in rind colour from green to yellow/cream. At maturity, the fruit gets easily detached from the vine. A dull sound while thumping the fruit of watermelon is also indicator of maturity. Fruits of other cucurbitous vegetables are also indicator of maturity. Fruits of other cucurbitous vegetables are ready for seed extraction when they are ripened beyond the edible stage. Ripened fruits of most of these vegetables change colour and skin of these become either soft (better gourd) or hard. Seed may be extracted by hand and washed or by fermenting the fruits for 24-48 hrs. The seed of these vegetables can also be extracted with axil - flow vegetable seed extracting machine.

**Leafy vegetables** : **Palak, methi, coriander, lettuce and spinach** are important in India. The seed crop is harvested when the majority of the fruit balls in case of palak and pods in case of methi have changed colour. After

harvesting, stalks are piled and cured for 3-4 days and then threshed gently to remove seed and cleaned.

The fully ripe fruits, not infested by insect-pests, identified from disease free plants, should be harvested. The appropriate seed extraction procedure may be followed to collect the seed from fruits before their decomposition and rotting starts. The seed of vegetable crops which form pods or siliqua, should be collected when the seed have attained physiological maturity and are free from any insect or disease attack. Adequate number of fruits from different plants should be harvested to represent the intravarietal genetic variability, specially in cross-pollinated vegetable crops. The seed and pods obtained, keeping above precautions, should be shade dried to reduce the moisture content to a reasonably low level. Dried seeds need to be stored in a cool and dry place to avoid spoilage due to pathogens and pests. The seed samples of released varieties consisting of atleast 4000 seeds of self-pollinated and 8000 seeds of cross pollinated vegetable crops from the larger seed lots, to represent the variability within the variety, may be sent to NBPGR with the minimum delay after the harvest. Immature, shrivelled and undersized seeds must be discarded and healthy and untreated seed material should be packed preferably in moisture proof pouches or in cloth bags and wrapped in polythene bags to avoid seed quality losses during transit. The seed packets should be neatly and correctly labled and addressed to the Head, Division of Germplasm Conservation, NBPGR, New Delhi - 110 012.

To facilitate retrieval and future utilization of varietal seed accessions stored in the National Genebank, the Passport (Origin, parentage, pedigree etc.), characterisation (distinguishing features for indentification) and evaluation data on desirable attributes such as adaptability to biotic and abiotic stresses, resistance to diseases, pests and stress etc. must be provided alongwith seed. Further, the year of release, zone for which released, actual or estimated area covered, market and consumers preference should also be desirably included.

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## ADAPTABILITY IN FRENCH BEAN (*PHASEOLUS VULGARIS* L.)\*

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Forty two varieties of french bean, studied for their phenotypic stability in five environments (i.e., 3 *Kharif* and 2 spring seasons), indicated presence of significant genotype-environment interactions for all the eleven characters including seed yield. Most of the genotype-environment interactions were attributed to linear component except in case of plant height, number of leaves, number of seeds, 100-seed weight, days to flower and days to maturity in which both linear and non-linear components were significant. Keeping in view all the three parameters of adaptability, EC 44624, EC 109975, PLB14-1, EC 43893, and PLB-256 proved to be the best adaptables and can be utilised in breeding as parents for yield stability in french bean.

**Key words :** Frenchbean, adaptability, joint regression, G×E interaction, genetic stability

The information on stability aspects in Frenchbean (*Phaseolus vulgaris* L) is insufficient in India. It is imperative to identify stable and adaptable genotypes of Frenchbean over a number of environments for various yield and yield contributing attributes. The information on the stable yield contributing characters would provide selection criteria which would help the breeders in tailoring new high yielding cultivars for a wider range of environments. The present studies were carried out to identify stable varieties for breeder's use.

### MATERIALS AND METHODS

Forty-two varieties of Frenchbean originating from different geographical regions of the world were tested in five environments i.e. three *kharif* (July-October) and two spring (February - April) seasons in a randomised complete block design with four replications at Shimla. Each accession was

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\*Part of Ph.D Thesis of the first author submitted to Kumaon University, Nainital (U. P.)

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sown in 2.25 m long rows and spaced 50cm apart. Seeds were dibbled 15 cm apart in the rows. Five randomly selected plants in each single row plot were marked for taking observations on 11 characters, viz., days to flower, plant height (cm), number of leaves, number of branches, number of clusters, number of pods, pod length (cm), days to maturity, number of seeds per pod, 100-seed weight (g) and yield per plant (g). The mean values were computed for each character, using five seasons data. The stability analysis was carried out following the model proposed by Eberhart and Russel (1966).

## RESULTS AND DISCUSSION

Joint regression analysis for eleven characters studied is presented in Table 1. The variance due to genotypes was significant for all the traits suggesting presence of variation among genotypes. The variance due to genotype-environment interactions were also significant for all the traits. All the parameters of adaptability, viz., mean (m), coefficient of regression (bi) and deviation from regression ( $S^2d$ ) estimated for yield are presented in Table 2. Differences were found among 42 Frenchbean varieties in respect of deviation from regression. The genotypes EC 44624, EC 109975 and PLB 14-1 had mean values for seed yield above the grand mean, low  $S^2d$  and were thus rated the most stable genotypes.

Out of 42 genotypes, EC 18600, EC 26399, EC 43893 and EC 44758 were found to be high yielding. They showed response to better environment. EC 43893 also showed sufficiently high adaptability to unpredictable environmental conditions due to non-significant  $S^2d$  values. Over five environments EC 18600 gave maximum yield but was found to be most unstable genotype.

The stability parameters for components of yield and fitness revealed that most stable and high yielding variety PLB14-1 had higher mean value than the grand mean for plant height, number of branches, number of clusters, number of pods, pod length, 100 seed weight and days to maturity. EC 18611 (B) was found to be most stable genotype for days maturity and number of leaves. PLB14-1 and EC 43900 were observed to be most stable for characters number of clusters and number of pods. These character have significant correlation with seed yield. EC 109977, EC 93621 and PLB14-1 were observed to be most stable for pod length and genotype EC 109975 and EC 77005 for number of seeds. Genotypes EC 44790 and EC 94469 showed the highest consistency and stability for 100-seed weight under changing environments.

Table 1 : Pooled analysis of variance for stability for 11 characters in french bean

| Source                           | df  | Plant height | Number of leaves/plant | Number of branches/plant | Number of clusters/plant | Number of pods/plant | Pod length | Number of seeds/plant | 100-seed weight | Days to flower | Days to mature | Seed yield/plant |
|----------------------------------|-----|--------------|------------------------|--------------------------|--------------------------|----------------------|------------|-----------------------|-----------------|----------------|----------------|------------------|
| Genotypes                        | 41  | 1943.37**    | 289.96**               | 0.37                     | 21.50**                  | 71.66**              | 15.35**    | 2087.44**             | 441.92**        | 165.26**       | 249.68**       | 72.46**          |
| Environment                      | 4   | 2662.97**    | 178.23**               | 9.20**                   | 163.23**                 | 268.17**             | 28.63**    | 6885.39**             | 357.32**        | 6722.42**      | 3345.55**      | 352.38**         |
| Genotype x Environment           | 164 | 286.36**     | 44.98**                | 0.15**                   | 9.96**                   | 19.20**              | 3.01**     | 497.78**              | 21.54**         | 1912**         | 48.84**        | 26.09**          |
| Heterogeneity between regression | 41  | 525.52**     | 64.23**                | 0.14                     | 21.96**                  | 47.70**              | 1.77**     | 1428.31**             | 30.55**         | 28.92**        | 108.90**       | 39.74**          |
| Remainder                        | 123 | 206.64       | 38.57                  | 0.16                     | 5.95                     | 9.70                 | 3.43       | 187.61                | 18.54           | 15.86          | 28.86          | 21.54            |
| Pooled Error                     | 630 | 23.15        | 7.19                   | 0.13                     | 7.50                     | 12.00                | 9.75       | 80.48                 | 5.50            | 5.09           | 24.35          | 24.26            |

\* = P<sub>0.05</sub>, \*\* = P<sub>0.01</sub>

**Table 2 : Means and estimates of stability parameters for yields of 42 varieties of french bean**

| Variety      | Mean  | $b_i$ | $S^2_d$ | Variety   | Mean  | $b_i$ | $S^2_d$ |
|--------------|-------|-------|---------|-----------|-------|-------|---------|
| EC-18600     | 25.33 | 3.93  | 214.83* | EC-57260  | 9.96  | 1.15  | -5.32   |
| EC-18611     | 17.30 | 1.69  | 22.56   | EC-77005  | 17.59 | 0.73  | 23.51*  |
| EC-19038     | 11.77 | -0.19 | -2.57   | EC-93621  | 9.48  | -0.62 | -0.96   |
| EC-22365     | 9.03  | 0.03  | 0.21    | EC-93625  | 17.49 | 1.24  | 27.66*  |
| EC-24948     | 12.87 | 0.67  | -0.11   | EC-93828  | 8.93  | 0.48  | -4.44   |
| EC-26399     | 20.01 | 3.23  | 29.90*  | EC-94453  | 15.27 | 1.30  | 4.40    |
| EC-26402     | 17.97 | 0.23  | 20.96   | EC-94455  | 12.19 | 0.90  | 1.55    |
| EC-31230     | 11.29 | 0.56  | -4.14   | EC-94469  | 12.94 | 0.94  | -2.39   |
| EC-34023     | 15.96 | 3.84  | 51.87*  | EC-99540  | 13.74 | -0.55 | 96.70*  |
| EC-36664     | 11.08 | 0.01  | -5.41   | EC-99541  | 14.05 | 0.42  | -4.33   |
| EC-42960     | 13.82 | 0.83  | 21.19   | EC-100677 | 7.91  | 0.37  | 0.29    |
| EC-43893     | 19.77 | 1.43  | 11.57   | EC-100680 | 10.58 | 0.45  | 0.15    |
| EC-43896     | 12.26 | -0.02 | 2.00    | EC-108101 | 11.72 | 0.25  | -1.72   |
| EC-43900     | 17.43 | 1.33  | 10.80   | EC-109508 | 15.55 | 3.04  | -4.92   |
| EC-44624     | 17.47 | 2.75  | 3.00    | EC-109975 | 17.14 | 0.33  | 1.03    |
| EC-44747     | 18.85 | 1.99  | 84.95*  | EC-109977 | 15.97 | -0.10 | 17.27   |
| EC-44758     | 20.35 | 1.54  | 29.03*  | Premier   | 11.57 | 0.64  | -3.62   |
| EC-44760     | 8.80  | 0.46  | -5.24   | PLB10-1   | 13.43 | 0.85  | -0.78   |
| EC-44787     | 9.89  | 1.07  | -4.93   | PLB-14-1  | 16.49 | 0.82  | -3.91   |
| EC-44790     | 11.72 | 0.23  | 0.21    | PLB-256   | 14.55 | 0.14  | -2.60   |
| EC-57080     | 12.16 | 1.26  | -3.80   | PLB-440   | 15.00 | 2.31  | 11.81   |
| Mean         | 14.20 |       |         |           |       |       |         |
| Pooled error | 24.26 |       |         |           |       |       |         |

\*p = 0.05

The occurrence of differential stability for various yield and adaptability influencing traits is reported in Frenchbean as also the information on stable genotypes varies for yield alone (Crispin, 1968; Stupar, 1978; Santos and Ramalho 1990; Abreu *et al.*, 1990). These studies support the findings reported in this paper in need to select germplasm with known adaptability for yield and /or its component traits alongwith high *per se* performance for further use in breeding programmes.

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## LONG TERM CONSERVATION OF RELEASED VEGETABLE VARIETIES

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**Key words :** Vegetable varieties, long term conservation

The released varieties are expected to possess desirable combination attributes out of a wide range of diversity in the available germplasm. These also provide genetic base for further improvement by incorporating other desired attributes. The Bureau attempts to conserve the seeds of all the released varieties of vegetable crops in the National Genebank as per preferred standards and specified seed storage at  $-18^{\circ}\text{C}$  or less, in air tight containers, at a seed moisture content of  $5 \pm 1$  per cent as recommended by FAO panel of experts on Plant Exploration and Introduction (Cromarty *et al.*, 1982) for the long term conservation of orthodox seeds.

The NBPGR Genebank has all the essential facilities required for the processing and storage of seed for long term conservation. The facilities include four cold storage vaults capable of maintaining the storage temperature of  $-20^{\circ}\text{C}$  and storing about 2,00,000 accessions of germplasm and varieties. The Bureau has other ancilliary facilities such as fully equipped seed testing laboratories; a seed dryer, operating at  $15^{\circ}\text{C}$  and maintaining 15 per cent RH; and a computerised data processing unit, for an efficient management of germplasm holdings under longterm conservation. In order to maintain viability of accessions in the long term the seed moisture content must be maintained after seed drying, in hermetic containers. At the NBPGR, three layered laminated aluminium foil pouches are used for keeping the seed for long term storage of vegetable seeds. So far, only 42 released vegetable varieties were conserved in the National Gene Bank at the NBPGR (Table 1).

The technique of vegetable crops seed increase for long term conservation should aim at preserving intra-varietal variability and should avoid seed and pollen contamination from adjacent plots and varieties. Techniques of seed production/extraction for important catagoeries of vegetable crops are summarised below:

**Cole Crops :** Important crops are cabbage, cauliflower and knol khol. Seed to seed and head to seed methods are practices for seed production of these crops. All these crops are highly cross pollinated and isolation distance of 1600 m is prescribed for foundation seed and 1000 m for certified seed production. The crops are harvested when 60-70 per cent pods turn yellow to brown in colour and stacked for a few days for curing before threshing (Singh and Gill, 1993).

**Table 1 : Released varieties of vegetable crops stored for Long term conservation in the NBPGR Gene Bank upto December 31, 1992**

| Crop<br>(Botanical Name)                                         | Source                                               | Variety                                                   | IC No.                   |
|------------------------------------------------------------------|------------------------------------------------------|-----------------------------------------------------------|--------------------------|
| Spinach<br>( <i>Spinacia oleracea</i> L.)                        | IARI, Regional Station,<br>Katrai, Himachal Pradesh  | Virginia Savoy                                            | 75028                    |
| Methi<br>( <i>Trigonella foenum graecum</i> L.)                  | SKN College of Agriculture, CO1<br>Jobner, Rajasthan |                                                           | 78380                    |
| Lettuce ( <i>Lactuca sativa</i> L.)                              | IARI Regional Station<br>Katrai, Himachal Pradesh    | Chinese Yellow                                            | 76300                    |
| Long melon<br>( <i>Cucumis melo</i> L. var<br>utilissimus Dutch) | IIHR, Bangalore,<br>Karnataka                        | Arka Sheetal                                              | 76262                    |
| Muskmelon<br>( <i>Cucumis melo</i> L.)                           | IIHR, Bangalore,<br>Karnataka                        | Arka Jeet                                                 | 76259                    |
|                                                                  | ARS, Durgapura,<br>Rajasthan                         | Durgapura<br>Meetha                                       | 113138                   |
| Watermelon<br>( <i>Citrulus vulgaris</i> Schrad.)                | ARS, Durgapura,<br>Rajasthan                         | Durgapura<br>Keshar                                       | 113139                   |
|                                                                  | IARI, Regional Station,<br>Katrai, Himachal Pradesh  | Asahi Ramato                                              | 76317                    |
| Red pumpkin<br>( <i>Cucurbita moschata</i> Poir<br>Dutch.)       | IIHR Bangalore,<br>Karnataka                         | Arka Chandan                                              | 76256                    |
| Summer squash<br>( <i>Cucurbita pepo</i> L.)                     | IARI, Regional Station,<br>Katrai Himachal Pradesh   | Australian Green<br>Pusa Alankar                          | 76308<br>76309           |
| Winter squash<br>( <i>Cucurbita maxima</i> L.)                   | IIHR, Bangalore,<br>Karnataka                        | Arka Suryamukhi                                           | 75257                    |
| Bitter gourd<br>( <i>Momordica charantia</i> L.)                 | IIHR, Bangalore,<br>Karnataka                        | ARKA Harit                                                | 75263                    |
| Cucumber<br>( <i>Cucumis sativus</i> L.)                         | IARI, Regional Station,<br>Katrai, Himachal Pradesh  | Pusa Sanyog<br>Japanese Long<br>Green                     | 76296<br>76297           |
| Brinjal<br>( <i>Solanum melongena</i> L.)                        | IARI, Regional Station,<br>Katrai, Himachal Pradesh  | Pusa Purple Long<br>Pusa Purple<br>Cluster<br>Pusa Anupam | 76286<br>76287<br>118806 |

(Continued on page 81)

(Continued from page 80)

| Crop<br>(Botanical Name)                                             | Source                                               | Variety                                 | IC No.         |
|----------------------------------------------------------------------|------------------------------------------------------|-----------------------------------------|----------------|
|                                                                      | TNAU, VRS, Palur,<br>Tamil Nadu                      | PLR 1                                   | 113889         |
| Okra<br>( <i>Abelmoschus esculentus</i> L.<br>Monech)                | IARI, Regional Station<br>Katrain, Himachal Pradesh  | Pusa Makhmali<br>Perkin's Long<br>Green | 76282<br>76283 |
| Sweet pepper<br>( <i>Capsicum annuum</i> L.)                         | IARI, Regional Station,<br>Katrain, Himachal Pradesh | California<br>Wonder 1<br>Yolo Wonder   | 76290<br>76291 |
| Hot pepper<br>( <i>Capsicum frutescens</i> L.)                       | RRS, Lam,<br>Andhra Pradesh                          | Sindhur                                 | 73158          |
|                                                                      | GAU, Anand, Gujarat                                  | Jwala                                   | 77004          |
| Tomato<br>( <i>Lycopersicon<br/>esculentum</i> Mill.)                | IARI, Regional Station,<br>Katrain, Himachal Pradesh | Roma                                    | 76310          |
|                                                                      |                                                      | Rest of All                             | 76311          |
|                                                                      |                                                      | Marglobe                                | 76312          |
|                                                                      |                                                      | Sious                                   | 76313          |
|                                                                      | GAU, Anand, Gujarat.                                 | S-120                                   | 76997          |
|                                                                      | TNAU, Regional Station,<br>Paiyur, Tamil Nadu        | Paiyur 1                                | 13891          |
| Cabbage<br>( <i>Brassica oleracea</i> L. var.<br><i>capitata</i> L.) | IARI, Regional Station,<br>Katrain, Himachal Pradesh | Golden Acre                             | 76238          |
|                                                                      |                                                      | Pusa Drumhead                           | 76289          |
| Knol khol<br>( <i>B. oleracea</i> L. var.<br><i>gongyloides</i> L.)  | IARI, Regional Station,<br>Katrain, Himachal Pradesh | White Vienna                            | 76318          |
| Cauliflower<br>( <i>B. oleracea</i> , var. <i>botrytis</i> L.)       | IARI, Regional Station,<br>Katrain, Himachal Pradesh | Pusa Snow Ball-1                        | 76293          |
| Garden beet<br>( <i>Beta vulgaris</i> L.)                            | IARI, Regional Station,<br>Katrain, Himachal Pradesh | Detroit Dark Red                        | 76285          |
|                                                                      |                                                      | Crimson Global                          | 76284          |
| Turnip<br>( <i>Brassica rapa</i> L.)                                 | IARI, Regional Station,<br>Katrain, Himachal Pradesh | Pusa Chandrima                          | 76314          |
|                                                                      |                                                      | Purple Top White<br>Globe               | 76316          |
| Radish<br>( <i>Raphanus sativus</i> L.)                              | IARI, Regional Station,<br>Katrain, Himachal Pradesh | Pusa Himani                             | 76305          |
|                                                                      |                                                      | Japanese White                          | 76306          |

**Root crops :** Carrot, radish and turnips are the main crops in this category. Isolation distance of 800m and 1000m are recommended for certified and foundation seed plots in these crops (Anon. 1988).

**Onion** : Bulb-to-seed or seed-to-seed method may be practiced. All the umbels do not mature at the same time. Therefore, the harvesting of umbels may be done in two to three pickings. The umbels are ready for pickings when about 20 per cent black seed becomes visible.

**Okra** : The outcrossing in okra varies from 0-60 per cent depending upon the variety. For large plot seed multiplication, isolation distance of 400m and 200m is recommended for foundation and certified seeds, respectively.

**Leguminous vegetables** : Garden pea, french bean, cluster bean, winged bean, field bean and broad beans are important in India. Fully ripened pods should be harvested, cured, threshed and cleaned for seed purpose. Seeds may be properly graded to remove shrivelled and immature seeds before sending them for long-term conservation.

**Tomato** : This is predominantly a self-pollinated crop but outcrossing does take place to a negligible extent. Isolation distance of 50 and 25 m is recommended for foundation and certified seed, respectively. Seed can be extracted manually using acid or fermentation methods or mechanically using axil - flow vegetable seed extracting machine (Singh & Gill, 1993).

**Brinjal and chillies** : Isolation distance of 200 and 100m for brinjal and 400 and 200m for chillies for foundation and certified seeds, respectively is recommended. The fruits should be allowed to mature beyond the edible stage before harvesting for seed. Mature brinjal fruits are cut and crushed and the seed is extracted by washing and sieving. The seed should be dried soon after extraction else they may start germinating. Chilli fruits are picked at red ripe stage.

**Cucurbits** : Cucumber, squashes, gourds, pumpkin, watermelon and muskmelon are the important vegetables in this category. The isolation distance required for all these crops is 1000m for foundation and 500 m for certified seed plots. Muskmelon fruit is ready for seed harvest with change in rind colour from green to yellow/cream. At maturity, the fruit gets easily detached from the vine. A dull sound while thumping the fruit of watermelon is also indicator of maturity. Fruits of other cucurbitous vegetables are also indicator of maturity. Fruits of other cucurbitous vegetables are ready for seed extraction when they are ripened beyond the edible stage. Ripened fruits of most of these vegetables change colour and skin of these become either soft (better gourd) or hard. Seed may be extracted by hand and washed or by fermenting the fruits for 24-48 hrs. The seed of these vegetables can also be extracted with axil - flow vegetable seed extracting machine.

**Leafy vegetables** : **Palak, methi, coriander, lettuce and spinach** are important in India. The seed crop is harvested when the majority of the fruit balls in case of palak and pods in case of methi have changed colour. After

harvesting, stalks are piled and cured for 3-4 days and then threshed gently to remove seed and cleaned.

The fully ripe fruits, not infested by insect-pests, identified from disease free plants, should be harvested. The appropriate seed extraction procedure may be followed to collect the seed from fruits before their decomposition and rotting starts. The seed of vegetable crops which form pods or siliqua, should be collected when the seed have attained physiological maturity and are free from any insect or disease attack. Adequate number of fruits from different plants should be harvested to represent the intravarietal genetic variability, specially in cross-pollinated vegetable crops. The seed and pods obtained, keeping above precautions, should be shade dried to reduce the moisture content to a reasonably low level. Dried seeds need to be stored in a cool and dry place to avoid spoilage due to pathogens and pests. The seed samples of released varieties consisting of atleast 4000 seeds of self-pollinated and 8000 seeds of cross pollinated vegetable crops from the larger seed lots, to represent the variability within the variety, may be sent to NBPGR with the minimum delay after the harvest. Immature, shrivelled and undersized seeds must be discarded and healthy and untreated seed material should be packed preferably in moisture proof pouches or in cloth bags and wrapped in polythene bags to avoid seed quality losses during transit. The seed packets should be neatly and correctly labled and addressed to the Head, Division of Germplasm Conservation, NBPGR, New Delhi - 110 012.

To facilitate retrieval and future utilization of varietal seed accessions stored in the National Genebank, the Passport (Origin, parentage, pedigree etc.), characterisation (distinguishing features for indentification) and evaluation data on desirable attributes such as adaptability to biotic and abiotic stresses, resistance to diseases, pests and stress etc. must be provided alongwith seed. Further, the year of release, zone for which released, actual or estimated area covered, market and consumers preference should also be desirably included.

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## IDENTIFICATION OF SOURCES OF RESISTANCE TO FOLIAR BLIGHTS (*HELMINTHOSPORIUM SATIVUM* AND *ALTERNARIA TRITICINA*) IN WHEAT GERMPLASM

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**Key words :** Wheat germplasm, foliar blights, sources of resistance

Foliar blights of wheat caused mainly by *Helminthosporium sativum* and *Alternaria triticina* have become important in reducing wheat yields in this region but so far they have received very little attention of the pathologists and the breeders. None of the wheat varieties grown has adequate resistance to these pathogens and yield losses ranging between 7.5 to 23.3 per cent are caused in different varieties of wheat cultivated in this region (Singh *et al.*, 1991). It is, therefore, essential to identify resistant sources in wheat germplasm for utilization in breeding disease resistant varieties.

2749 accessions of wheat germplasm comprising 2194 lines of bread wheat (*Triticum aestivum*), 329 lines of durum wheat (*T. durum*) and 198 lines of triticale (*X. tritico-secale*) were screened under natural infection in the field at Punjab Agricultural University, Regional Research Station, Gurdaspur from 1986-87 to 1989-90 crop seasons. Each line was sown in a 1 m row length and the row to row spacing was kept at 25 cms. The disease severity usually is very high under natural field conditions at Gurdaspur, particularly when there are late rains at heading stage which facilitates screening of germplasm.

The wheat lines which consistently gave resistant reaction (0-3 score) on a rating scale of 0-9 (Saari and Prescott, 1975) under natural infection in the field. Inoculum of *H. sativum* and *A. triticina* was multiplied separately on autoclaved sorghum seeds in 250 ml conical erlenmeyer flasks at 25°C for 2-3 weeks. The conidial suspension of these pathogens prepared in water (10-20 conidia/microscopic field) were mixed together and used for spray-inoculations

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in the field to create a severe epiphytotic conditions. The data on disease severity (% leaf area infected) on flag leaf and flag leaf<sup>-1</sup> (i.e. the leaf immediately below flag leaf) were recorded and the lines showing upto 10 per cent leaf area infected were marked as resistant. The reaction of these lines to black point, grain shrivelling, yellow and brown rusts (artificial infection) and *Fusarium* head scab caused by *F. moniliforme*, *F. subglutinans* under natural infection was also studied. The data on disease incidence and severity of *Fusarium* head scab was recorded on 0-5 scale in a double digit system wherein the first digit indicated the per cent infected heads and the second digit indicates the per cent spike area infected. Thus, per cent infected heads 0 = free infection; 1 = 0.1 - 10 per cent infected heads; 2 = 10.1 - 25 per cent infected heads, 3 = 25.1 - 50 per cent infected heads : 4 = 50.1 - 75 per cent infected heads; 5 = 75.1 - 100 per cent infected heads and per cent spike area infected : 0 = free from infection; 1 = upto 10 per cent spike area infected 2 = upto 25 per cent spike area infected, 3 = upto 50 per cnet spike area infected; 4 = up to 75 per cnet spike area infected and 5 = 100 per cent spike area infected. The severity of yellow and brown rusts was scored according to the modified Cobb scale.

Results of screening of wheat germplasm to foliar blights are given in Table 1 and 2. Among the 2749 lines of wheat germplasm screened under natural infection from 1986-87 to 1989-90, only 77(2.8%) lines were found to be resistant. Of these 68 out of 2194(3.1%) were of bread wheat, 5(1.59%) in durum wheat and only 4(2.09%) lines in triticale which showed resistance to foliar blights. These lines were further tested under artificial infection in the field during 1990-91 and 1991-92. Only 8 lines (Acc. Nos. 8231, 8397, 8448, 8450, 8470, 8527, 8528, 8672) of bread wheat (Table 2) which showed a

**Table 1 : Number of wheat germplasm accessions resistant to foliar blights (*H. sativum* and *A. triticina*) under natural and artificial infection in the field**

| Species                  | Number of accessions screened | Number of resistant accessions (Natural infection) |         |          | Number of resistant accessions (Artificial Inoculation) |         |
|--------------------------|-------------------------------|----------------------------------------------------|---------|----------|---------------------------------------------------------|---------|
|                          |                               | 1986-87                                            | 1987-88 | 1989-90  | 1990-91                                                 | 1991-92 |
| <i>Triticum aestivum</i> | 2194                          | 549                                                | 416     | 68(3.1%) | 21                                                      | 8       |
| <i>T. durum</i>          | 329                           | 27                                                 | 22      | 5 (1.5%) | 0                                                       | -       |
| <i>X. triticosecale</i>  | 198                           | 21                                                 | 15      | 4 (2.0%) | 0                                                       | -       |
| Total accessions         | 2749                          | 598                                                | 453     | 77(2.8%) | 21                                                      | 8       |

promising level of resistance to foliar blights were finally chosen. The incidence of black point and grain shrivelling was also very low in these lines as compared to the cultivated wheats. None of the bread wheat lines was found to be free (immune) from foliar blights. Efforts are being made to trace the pedigree of these resistant lines. All the *durum* and *triticale* lines which exhibited resistance under natural field infection, became susceptible after artificial inoculation. The reactions of these lines to yellow and brown rusts and *Fusarium* head scab (FHS) are given in Table 2 which clearly show that these lines have multiple disease resistance to rusts and *Fusarium* head scab which is becoming an important problem in this area during the last 2-3 years. These lines appear to be potential sources of resistance to foliar

**Table 2 : Reaction of promising accessions of *Triticum aestivum* resistant to foliar blights caused by *H. sativum* and *A. triticina* to other diseases**

| Acc. No.                 | Area infected (%) |                         | Black point (%) |         | Shrivelled grains(%) |       | FHS (0-5 scale) | Rust severity |     |
|--------------------------|-------------------|-------------------------|-----------------|---------|----------------------|-------|-----------------|---------------|-----|
|                          | Flag leaf         | Flag <sup>-1</sup> leaf | 1990-91         | 1991-92 | 1990-91              | 91-92 | 91-92           | YR            | BR  |
| 8231                     | T                 | -                       | 0.4             | 1.1     | 1.8                  | 16.7  | 33              | 0             | 0   |
| 8399                     | T                 | -                       | 0.6             | 4.0     | 5.4                  | 1.4   | 11              | 0             | 0   |
| 8448                     | T                 | -                       | 0               | 2.8     | 2.0                  | 2.0   | 11              | 0             | 0   |
| 8450                     | T                 | -                       | 1.0             | 4.6     | 0.8                  | 4.0   | 11              | 0             | 0   |
| 8470                     | T                 | T                       | 1.2             | 1.2     | 3.6                  | 8.4   | 11              | TS            | TS  |
| 8527                     | T                 | T                       | 0.4             | 2.5     | 3.6                  | 1.6   | 11              | 0             | 0   |
| 8528                     | T                 | 10                      | 0.2             | 1.8     | 3.0                  | 0.8   | 0               | 0             | 0   |
| 8672                     | T                 | 20                      | 1.6             | 2.3     | 4.2                  | 3.8   | 11              | 0             | 0   |
| <i>Cultivated wheats</i> |                   |                         |                 |         |                      |       |                 |               |     |
| PBW 222                  | 70                | 100                     | 2.0             | 4.2     | 10.6                 | 28.0  | 44              | TS            | 60S |
| PBW 154                  | 20                | 40                      | 4.6             | 3.5     | 6.2                  | 30.0  | 32              | 20S           | 40S |
| HD 2329                  | 40                | 100                     | 1.8             | 9.0     | 7.0                  | 12.9  | 43              | 20S           | 60S |
| PBW 138                  | 30                | 100                     | 3.0             | 5.0     | 8.0                  | 29.0  | 21              | 10S           | 60S |
| PBW 34                   | 40                | 60                      | 5.6             | 4.0     | 5.0                  | 7.2   | 33              | 0             | 0   |

T = Traces; TS = Traces susceptible.

FHS = *Fusarium* head scab

Yr = yellow rust

Br = Brown rust

blight pathogens and can be utilized for improving resistance to foliar blights in breadweaht. However, the results clearly indicate that the level of resistance

to foliar blights (*H. sativum* and *A. triticina*) is very low in wheat and there is a need to search for resistance in related species of wheat such as *Aegilops* and wild *Triticum* species for enhancing genetic protection in wheat to foliar blights.

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## ANNOUNCEMENTS

### THE SECOND INTERNATIONAL CROP SCIENCE CONGRESS

17-23 November, 1996

NEW DELHI - 110 001, INDIA

(Sponsored by the National Academy of Agricultural Sciences and the  
Indian Agricultural Research Institute, New Delhi)

- **CONGRESS MISSION**

1. Presentation and discussion of recent research results.
2. Integration and application of knowledge from Crop Science to the following issues as well as adoption of an inter-disciplinary approach involving other areas of agriculture :
  - intensive agriculture with sustainability, integrated pest-management, resources management and environmental conservation, post-GATT implications of agriculture on such issues as genetic resources, biodiversity, intellectual property rights.
3. Proposals for future thrusts in research and development.
4. Development of written proceedings of the Congress.

- **PROGRAMME ORGANIZATION**

The Congress programme will be organized in the form of plenary sessions, symposia, voluntary poster papers and professional tours. It will be aimed at projecting the activities of crop scientists from all regions of the world. It will provide a forum for interaction with a view to integrate knowledge from crop science and ancillary research areas to solve global and regional problems and issues. In addition, there would be entertainment, meal functions, recreational and agricultural tours so as to acquaint the participants with Indian culture and history.

- **CONGRESS INFORMATION**

To obtain information about the Congress, please write to : Dr Suresh K. Sinha, Secretary General, Second International Crop Science Congress, IARI, Pusa, New Dehi - 110 012, INDIA with the following details :

Name :  
Address :  
City/State/Zip :  
Country :  
Telephone :  
Fax :

## THE SECOND AGRICULTURAL SCIENCE CONGRESS

(19-21 January, 1995)

(Sponsored by : National Academy of Agricultural Sciences,  
IARI Campus, New Delhi - 110 012, INDIA)

### • BACKGROUND

The National Academy of Agricultural Sciences (NAAS) was founded in 1990 to promote, among other things, ecologically sustainable agriculture and to recognise and support excellence in scientific research in agriculture including animal husbandary, fishery, forestry, environment, agro-industry and allied sciences. One of the major activities of the Academy is the organisation of Agricultural Science Congress once in two years to provide a forum for agricultural scientists to effectively express their views on major policy issues relating to agricultural research, education and extension for the benefit of decision makers at various levels. The first Agricultural Science Congress, held at IARI, New Delhi, in November, 1922, was inaugurated by the Hon'ble Prime Minister of India. The proceedings of the Congress have since been published

### • VENUE

Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad - 500 030 (Andhra Pradesh), INDIA

### • PROGRAMME

The Congress will commence on the morning of 19th January, 1995 with registration of participants and inaugural function. The following three symposia will be organised during the Congress.

- i) National water policy (Dr. N.S. Randhawa, Convenor)
- ii) Vector biology covering research and development aspects of the vectors of diseases of both farm animals and plants (Dr. T.N. Ananthakrishnan, Convenor)
- iii) Integrated on-farm and off-farm employment (Dr. M.S. Swaminathan, Convenor).

The concluding session will be held on the 21st January, 1995. The detailed day-to-day programme will be sent later.

### • CONGRESS INFORMATION

To obtain information about the congress, please write to:

Dr M.V. Rao,  
Chairman, Organising Committee  
2nd Agricultural Science Congress, and Vice Chancellor,  
Andhra Pradesh Agricultural University,  
Rajendranagar, Hyderabad-500 030, INDIA  
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Telephone: 245035 - Office, 319101 - Residence  
Fax: 040-245035

## BOOK REVIEWS

### BIODIVERSITY AND WHEAT IMPROVEMENT

(Edited by Dr A. B. Damania; published by John Wiley & Sons, Baffins Lane, Chichester, West Sussex PO 19 1UD, United Kingdom; ISBN 0 471 94137 9 ; ©ICARDA, 1993; xix + 434 p)

At present, the scientific, governmental and donor communities, as well as the general public, are demanding more effective management of the earth's limited biodiversity. A critical need within the overall framework of such management is the development of strategies and the implementation of actions that integrate plant genetic resources conservation with food security. This can be achieved by developing explicit bonds between sustainable agricultural development and the conservation of natural resources. In the past several thousand years, the farmers in many parts of the world have unwillingly created a wealth of wheat forms, domesticated from their wild ancestors. The reduction of the diversity in crop germplasm now facing the world has consequences for humankind.

This book embodies exhaustive information based on papers presented in the workshop on the "Evaluation and Utilisation of biodiversity in wild relatives and primitive forms for wheat improvement" held at International Center for Agricultural Research in the Dry Areas (ICARDA) jointly by University of Tuscia, Italy. The workshop was attended by over 65 scientists from 26 countries and international organizations including those in the West Asia and North Africa (WANA) region. The publication compliments the state of research carried out and findings made in evaluating and utilizing non-conventional wheat germplasm to identify areas of further research.

The book is divided into eight parts. In the first part, papers on molecular cytogenetics, genomic relationships and germplasm evaluation using modern techniques, are presented. The second part deals with some taxonomic classification problems in the Triticeae. The third part discusses practical problems in transferring genes from alien germplasm to cultivated wheat. Genetic resources of wild and older forms of wheat have been used more successfully so far to confer disease resistance on cultivated wheat. Some of these aspects are described in part four. Part five stresses on heat, cold and drought tolerance. The papers in part six discuss experiments aiming at deciphering the germplasm variability. The advantages of the electrophoretic technique in studying these variability has been conclusively demonstrated by several authors. Part seven discusses the advantages and disadvantages of biodiversity preserved under *in situ* conservation and the utilization of germplasm for wheat improvement. Part eight presents status of the largest wheat collections in the world; and progress made in national programmes on the studies on distribution of biodiversity and its evaluation at ecologically diverse sites.

It is hoped that this book will prove useful to researchers on the subjects biodiversity as well as wheat an important crop to meet the growing demands for increased food production.

Umesh Srivastava  
NBPGR, New Delhi

## ROSA SPECIES

(Authors: Dr. D.S. Rathore and Umesh C. Srivastava; published by the National Bureau of Plant Genetic Resources, Regional Station, Phagli, Shimla 171 004, India; 1992; © NBPGR, New Delhi; xii + 113 p, 20 plates)

Over 2500 years ago, Sappho, a poetess christened the rose as the queen of flowers. This befitting tribute has not changed during long period of history, and this flower continues to be on the throne. Gertrude Stein aptly echoed "A rose is a rose is a rose is a rose" meaning thereby that rose is unique without comparison. How old is rose? It is certainly much older than man. Fossil remains of the rose, estimated by the experts to be more than thirty million years old, have been found. Rose flower has come to symbolise nature's beauty and freshness which is reflected in its immense variation in form, colour, fragrance and size. Besides its unique ornamental value, rose has its own importance in medicine and trade. This outstanding plant also offers great scope to breeders for genetic manipulation to evolve ever new combinations that continue to thrill the rose admirers.

Although global awareness of genetic resources activities of crop plants have been recognised world over, it has been increasingly apparent that there is an information gap relating to genetic resources of ornamental plants. Like any other crop improvement programme, continued success of rose breeding depends primarily upon the extent of genetic variability available for recombination of desired traits. The past impressive achievements in developing a vast array of endearing new roses notwithstanding, only a limited number of *Rosa* species have been exploited so far, though there is an urgent need for varietal improvement with respect to adaptation/tolerance to biotic and abiotic stress environments. Wild roses are a great reservoir of genetic variation awaiting utilisation for amelioration of cultivated forms. Several species of *Rosa* grow naturally in India, mostly in the Himalayan ranges. Out of more than 5000 rose varieties known so far, only a handful of them are reported to possess fragrance. The present endeavour to systematically characterise and document germplasm of 42 *Rosa* species (being maintained at NBPGR, Regional Station, Shimla), in the form of this publication, is the first step to take up genetic resources work on ornamental plants on a systematic basis, with a view to promoting their utilization.

The book is divided into eight parts. First part introduces the subject highlighting the importance of *Rosa* species, origin, domestication and diversity, including evidences from palaeobotanical angle. Taxonomy of the species has been discussed in considerable details in the second part. The third part describes details of diversity of *Rosa* species available in India. Sixteen species are found growing wild in different phytogeographical zones of India. A brief account of cultivated roses has been given in the fourth part. As far as garden roses of the world are concerned, only eight species have played an important role. Part five and six contain information on conservation and utilization of *Rosa* species. Descriptors and descriptor states have been elucidated in part even. Part eight deals with characterization and evaluation. The data contain information on characterisation of 42 *Rosa* species on 109 characters (descriptors) under different headings, viz., Accession and collection data, site data, plant data, leaf and flower characteristic, fruits (hips) characteristics, chemical characteristics and incidence to diseases/pests etc. Sufficient information is available for utilisation.

This publication has been brought out very timely and it will inspire researchers, amateurs, students and the public alike to make proper use of the rose materials in order to improve rose further for the happiness of all concerned.

Bhag Mal  
NBPGR, New Delhi

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