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# LEGAL REQUIREMENTS FOR FULFILLING OBLIGATIONS UNDER THE CONVENTION ON BIOLOGICAL DIVERSITY IN INDIA*

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The implementation of the Convention on Biological Diversity, which came into force in 1993, requires a multi-pronged strategy. The paper outlines the legal requirements, and suggests the elements that could form part of specific legal proposals for the proposed Biodiversity (Conservation) Act, an umbrella Act.

**Key words :** Convention, biological diversity, legal requirements

India is one of the 12 identified centres of origin of cultivated plants and of mega-biological diversity and has two of the 18 identified 'hotspots' - the Eastern Himalaya and the Western Ghats. Nearly 45,000 plant species and 81,000 animal species have been reported so far based on surveys undertaken by the Botanical and Zoological Surveys of India (BSI and ZSI). There is a significant percentage of endemic, rare and threatened species. The marine habitat comprising about 75,000 kms of coastline, and extending 200 nautical miles off-shore, is expected to harbour very rich resources of marine species of both economical and ecological value. According to world biogeographic classification (Udvardy, 1975), India represents two major realms, three biomes and 12 biogeographic regions. Recently, the Wildlife Institute of India (WII) has proposed a modified classification dividing the country into 10 bioecographic regions; Trans-Himalayan, Himalayan, Indian Desert, Semi-Arid, Western Ghats, Deccan Peninsula, Gangetic Plains, North-East, Islands and Coasts (GOI, 1994).

India is represented by the rich germplasm of plants of agri-horticultural, medicinal and other industrial values. The entire range of genetic diversity of buffalo in the world is also represented by eight breeds found in India. Breeds of cattle number 26, sheep 40, goat 20, camel 8, horse 6 and donkey 2. There

*The views expressed in this paper are the author's and not necessarily that of the Government of India

are 18 types of poultry. Yak, Mithun, Geese and Ducks have also been domesticated (GOI, 1994). This wide range of diversity in domesticated plants and animals has evolved largely due to diverse cultural practices adopted by the people of the country.

## MAJOR FACETS OF THE CONVENTION

The adoption of the international Convention on Biological Diversity (CBD) was an important and historic milestone at the United Nations Conference on Environment and Development (UNCED), in Brazil in 1992. After the necessary ratification, the CBD has come into force from 29th December, 1993. Its objectives are the conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the utilisation of genetic resources (Sanchez and Juma, 1994).

The CBD recognises the intrinsic value of biological diversity; the sovereign rights of States over their biological resources; the fundamental requirement of *in-situ* conservation of ecosystems and habitats; the supporting role of *ex-situ* measures; the vital role of local communities and women in conservation and sustainable use of biological diversity; the desirability of equitably sharing the benefits arising from the use of traditional knowledge, skills, innovations and practices; the importance of, and need to, promote regional and global cooperation for conservation; and the requirement of substantial investments to conserve biological diversity.

Enunciated in 42 articles, the CBD establishes a framework for conservation, access to genetic resources, transfer of technology, scientific and technical cooperation, information exchange, the generation of scientific and financial resources through new and additional funding from an identified financial mechanism. This is likely to make the Convention an extremely important instrument for the conservation of biological diversity not only for its own sake but also because of its potential benefits for human beings. From the point of view of India and other developing countries, the CBD appears advantageous for setting up a financial mechanism for supporting conservation measures and other activities such as access to genetic resources, technology transfer and capacity-building, which would bring many benefits in the field of agriculture, forestry, fisheries, pharmaceuticals and industrial applications. (UNEP, 1992).

Since the CBD is now an internationally binding treaty, to which India is a signatory, the provisions of the Convention will have to be appropriately implemented in letter and spirit. Therefore, various management and scientific approaches need to be developed. These approaches will have to be adequately supported by a comprehensive legal regime with the primary objective of providing a framework for the conservation of biological diversity, sustainable

use of its components and equitable sharing of benefits arising from such utilisation.

## NEED FOR BROAD-BASED LEGISLATION FOR IMPLEMENTING THE CONVENTION

The country's biological diversity is threatened due to many reasons: fragmentation of habitats, deforestation, over-exploitation of the genetic resources, rapid changes in the hydrological regime and land use patterns, soil degradation, air and water pollution, the adverse impact of development projects and increase in the population. As a result, a significant number of animal species (including 81 species of mammals, 47 birds, 15 reptiles, three amphibians) and 1500 plant species are considered vulnerable and endangered. About 20 species are categorised as 'possibly extinct', as these have not been sighted during the last 6-10 decades (GOI, 1994). Poaching and illegal trade in wildlife products have also adversely affected biological diversity.

The CBD has very wide scope with reference to the various legal issues concerning biological diversity. India also has numerous laws which deal with preservation of the specific components of biological diversity. At the request of the Ministry of Environment and Forests (MOEF), which is the nodal agency for implementing the Convention, Kothari and Singh (1992) analysed the central Acts and highlighted significant gaps. The priority elements requiring legal support are as follows :

- Survey, identification, characterisation and monitoring;
- *Ex-situ* and *in-situ* conservation measures;
- Sustainable use;
- Access to genetic resources including Intellectual Property Rights (IPRs);
- Access to and transfer of technology including IPRs;
- Biotechnology and biosafety;
- Safeguarding community rights including their knowledge, skills, innovations and practices.

## SPECIFIC LEGAL REQUIREMENTS

Based on a detailed analysis of the various Articles of the Convention, nearly 50 action points have been identified (Chauhan, 1993). Action points which require legal support are discussed below.

### Survey, identification, characterisation and monitoring

The convention (Art. 7) recommends identification and monitoring of ecosystems, habitats and species (as per the CBD Annexure I) and also

mechanisms for monitoring the activities directly associated for both loss and enhancement of biological diversity (UNEP, 1992). At present, India has no legal provisions stipulating the authenticated identification of wild and domestic species of plants, animals and micro-organisms. Therefore, it is important to have specific legal provisions for a uniform accepted nomenclature, and to empower the BSI and ZSI for wild species and the three Bureaus of Plant, Animal and Fish Genetic Resources for domesticated species to issue legally validated certificates for correct identification. This could be further supported by maintaining a National Register for an authenticated record of Indian biological resources. In addition, provisions are required to evolve guidelines for continuous evaluation of the status of biological diversity at ecosystem, species and genetic levels. These may vary from ecosystem-to-ecosystem and species-to-species. Specific procedures for Environmental Impact Assessment (EIA) of changes affecting nature, the dynamics and functioning of habitats are important elements. One of the biggest challenges for legal experts is to develop guidelines for environmentally sound and sustainable use of land and marine resources.

### Conservation measures

India has established a wide network of protected areas (PAs) covering more than 4.5 per cent of the total geographical area; in addition there are 7 biosphere reserves, 16 wetlands, 15 mangroves and 4 coral reef areas. However, the existing Central Acts only govern certain components - wildlife, forests, water and air pollution. Therefore, more specific legal provisions are needed to focus particularly on threatened, rare and endemic species and agro-biodiversity rich areas; and to safeguard against the possible risk of introducing exotic and alien species which may adversely affect natural ecosystems. Besides, the mechanism for establishing and enforcing liability for activities causing loss of habitats, or of the components of biological diversity needs to be evolved and made mandatory.

### Sustainable use

There are about 24 Central Acts on the use and extraction of certain natural resources (Kothari and Singh, 1992). These legal instruments do provide some regulatory mechanisms for wild biological diversity but domesticated diversity is not adequately addressed. The specific legal provisions for sustainable use of biological resources must cover protection of customary use, remedial action for enhancement, a mechanism to involve panchayats and other representative local bodies for conservation, mechanisms for liability and compensation, and adequate legal penalties for the activities responsible for the loss of biological diversity.

## Table 1. Central Legal Instruments Relevant to Biological Diversity*

1. **Agricultural and Processed Food Products Export Development Authority Act, 1985/1986**

   -Promotion and regulation of export of agricultural products specified in schedules - includes medicinal plants

2. **Agricultural Produce (Grading and Marking) Act, 1937**

   - Fixing grade designations to indicate quality of any specified agricultural produce (3a, b)

   -Prohibition or restriction on trade in wrongly marked/graded produce (3g)

   -Extension of such provisions to any other article (incl. non- agricultural articles) [6]

3. **Cardamom Act, 1965**

   -Provisions as in Rubber Act (see below); includes seeds.

   -Provision for prohibiting/restricting export/import of cardamom (21). Applicable to *Elettaria cardamomum* Maton, but extendable to any other plant notified by Cardamom Board [3].

4. **Coconut Development Board Act, 1979**

   -As in Rubber Act, Tea Act, Cardamom Act, etc.

5. **Customs Act, 1962**

   -Regulation of import-export specificially for :

   a) The protection of human, animal or plant life or health (11 (t)]

   b) The conservation of exhaustible natural resources [11(m)]

   -Regulation of transportation and storage of notified items [11 (j, k, l, m)].

6. **Destructive Insects and Pests Act, 1914**

   -Prohibition or regulation of import of any "articles" which may cause infection to any plant [3(1)]

   -Prohibition or regulation or movement, between states within India, of articles likely to cause infection to any plant [4A]

   Note: 'articles' includes insects and plants

7. **Environment (Protection) Act, 1986**

   -General measures to protect environment [3(i)]

   -Restriction of industrial and other processes/activities in specified areas [3(2)(v)]

   (Read with Rule 5 of Environment (Protection) Rules, 1986)

   -Prevention and control of hazardous substances, including their manufacture, use, release and movement [3(2), 7,8]

8. **Fisheries Act, 1897**

   -Prohibition on use of explosives for fishing [4(1)]

   -Prohibition on use of poisons for fishing [5]

   -Regulation on fishing in private waters, with consent of owners/right holders [6(2) & (3)]

   -Prohibition of all fishing in specified waters for maximum 2 years [6(4)]

9. **Forest Act, 1927**
   -Setting up and managing reserved forests [Chapter II]
   -Setting up and managing village forests [Chapter III]
   -Setting up and managing protected forests [Chapter IV]
   -Protection on non-government forests and lands [Chapter V]
   -Control of movement of forest produce [Chapter VII]
   -Control of grazing/trespass by cattle in forest land [Chapter X]
10. **Forest (Conservation) Act, 1980**
   -Prohibiting or regulating non-forest use of forest lands [2]
11. **Import and Export (Control) Act, 1947**
   -Prohibition or restriction on imports and exports of specified items [3].
   -Regulations on transportation of specified items [4e]
12. **Marine Products Export Development Authority, 1972**
   -Establishment of an Authority for developing and controlling marine products [4, 9(1)]
   -Developing and regulating off-shore and deep-sea fishing; taking measures for conservation; fixing standards for export; regulating exports [9(2a, c, f)]
   -Prohibition/restriction on export and import of marine products [20(1)]
13. **Maritime Zones of India (Regulation of Fishing by foreign vessels) Act, 1980**
   -Regulation of fishing in India's EEZ by people using foreign vessels [3]
   -Permits only to be granted within definition of public interest, and for scientific research, experiments, etc. [5(3), 8]
14. **National Dairy Development Board Act, 1987**
   -Establishment of a Board which promotes dairy development and other agriculture based industries [4, 16(1a)]
   -Financing and facilitating animal husbandry, agriculture, high yielding cattle (including import of semen), import-export of milch animals and bulls and general enhancement of cattle wealth [16(1)]
15. **National Oilseeds and Vegetable Oils Development Board, 1983**
   -As in Rubber Act, etc. special focus on providing farmers, especially seeds, and certified seeds of high quality, and for improved methods of cultivation.
16. **New Seed Development Policy, 1988**
17. **Prevention of Cruelty to Animals Act, 1960**
   -Restrictions on cruel treatment of animals, including use, transportation, and trade [Chapter III, and Rules under Secton 38].
   -Restrictions on use of animals for purposes of experimentation and performances [Chapter IV & V].
18. **Rubber (Production and Marketing) Act. 1947**
   -Establishment of Indian Rubber Board, with function of developing/encouraging improved rubber cultivation and marketing, advising or import/export [B(1) & (2)]
   -Restrictions on right of rubber planters - licence required to plant or replant where to plant, etc. [17]
   Note: Applicable to 4 species of rubber initially, more if Board so notifies [Definitions]

19. **Seeds Act, 1966**

-Regulation on quality of seeds of notified food crops, cotton and fodder, to be sold for agricultural purposes [5,6]

-Restriction on export/import of notified seeds [12]

-Exemption to persons selling/delivering, on own premises, seeds grown by them [24]

20. **Spices Board Act, 1986**

-As in Rubber Act, etc., for cardamom; for other spices, restricted to export-import development and regulation.

21. **Tea Act, 1935**

-As in Rubber Act, etc. includes restrictions on export of tea seeds [17]. Applicable to one species, *Camellia sinensis*, presumably to all the its varieties.

22. **Territorial Waters, Continental Shelf, Exclusive Economic Zone and other Maritime Zones Act, 1976**

-Establishment of sovereign rights over waters and seabed within the continental shelf and exclusive economic zone (200 nautical miles from nearest appropriate point on Indian territory) [3(1), 5(1), 6(2), 7(4)]

-Sovereign right to explore, exploit, conserve and manage resources of continental shelf and EEZ [6(3), 7(4)]

-Notification of any area within this zone for purposes of protection of resources and conservation of marine environment [6(5), 7(6)]

23. **Tobacco Board Act, 1975**

-As in Rubber Act, Tea Act, Cardamom Act, etc.

24. **Wildlife (Protection) Act, 1972 and Wildlife (Protection) Amendment Act, 1991**

-Restriction or prohibition on hunting of animals [Chapter III]- Protection of specified plants [Chapter IIIA]

-Setting up and managing sanctuaries and national parks [Chapter IV]

-Setting up of zoo authority, control of zoos, and captive breeding [Chapter IVA]

-Control of trade and commerce in wild animals, animal articles and trophies [Chapter V & Chapter VA]

*Based on Kothari and Singh (1992)

## Access to genetic resources including IPRs

The provisions relating to access to genetic resources need to be specially focused on developing model agreements regulating access through 'Prior Informed Consent'; equitable sharing of benefits on 'Mutually Agreed Terms'; measures for local communities to protect their rights relating to knowledge, skills, innovations, practices etc.; the transfer of genetic resources as per the provisions of the CBD. Also important are legal measures to cover the repatriation of germplasm (given away prior to the Convention) from international collections, and a mechanism for regional cooperation in relation to the genetic resources commonly found in this region. The present Patent

Act needs to be refined so that the Intellectual Property Regime relating to living forms becomes compatible with the patent laws prevalent in the world. This is necessary in the light of TRIPS provisions under GATT (1993) which has been ratified by India.

### Access to and transfer of technology

Regarding access to and transfer of technology, including biotechnology, there is need to develop a *sui-generis* system to circumscribe IPR related issues. The provisions must take into account the modalities/regulations for providing access to and transfer of technologies in return for genetic resources; modalities for providing options for international cooperation on patents and other IPRs; and provisions or conditionalities for joint ventures/programmes to develop technologies which have IPR implications. This will protect the interest of scientists/technologists involved in managing and conserving India's biological diversity and environmental quality. For the purpose of speedy access and transfer of technologies, a 'Clearing House Mechanism' needs to be established. Precautionary measures are also required to ensure that these technologies are not used for purposes other than conservation and sustainable use of biological diversity.

### Biotechnology and biosafety

The release of living modified or genetically engineered organisms/life forms into the environment may pose several problems including deleterious ecological consequences. At present under the Environment (Protection) Act, Rules on Biosafety (notified in 1989) and the revised guidelines (1990) govern the risk assessment and biosafety of hazardous micro-organisms/genetically modified organisms or cells. These provisions are inadequate in many respects such as :

- — modalities/protocols for access to and transfer of biotechnology, sharing results and benefits on 'Mutually Agreed Terms';
- — procedures for 'Advanced Informed Agreements' for safe transfer of living modified organisms;
- — procedures for both risk assessment and management, including disaster management. These may also include compensation and liability in case there is any harm to human health and lives, ecosystems or bio-geographic regions.

### Framework

The elements described in the foregoing paragraphs could form the basis for developing operational clauses in an 'Umbrella' Act on the Conservation

of Biological Diversity. It has been suggested that it would be difficult for a single agency to implement such a broad based legal instrument. Therefore, existing governmental machinery needs to be augmented, rather than establishing a new national authority. For administrative purposes, MOEF could continue to be the nodal point, supported by a 'Standing Committee' to oversee the implementation of the proposed Act. In addition, the proposed Committee could also look after the scientific, technical, cultural, anthropological and other aspects of conservation and sustainable use of biological diversity; continuously review and refine the shortcomings encountered in implementation of the Act and advise the Government from time to time in this regard. Besides, there is a need to establish a 'Community Gene Fund' for providing adequate financial support for effective implementation of the proposed Act (Kothari, 1994).

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# DISTRIBUTION OF MORPHOLOGICAL DIVERSITY AMONG GERMPLASM LINES OF *PANICUM MAXIMUM* JACQ.

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One hundred forty one germplasm lines of *Panicum maximum* collected from South and North-Eastern Hill region of India were evaluated for yield and six morphological traits. Variability was studied in terms of range, frequency distribution and coefficient of variation (CV). The pattern of frequency distribution varied from asymmetrical unimodal for plant height to unimodal symmetrical type for length of the panicle. However, amodal trend was observed in case of leaf length. With respect to coefficient of variability, it varied from 9.45% for leaf sheath to 48.65% for fresh weight. Range of variation was of the highest order in case of plant height (97.5 to 230.0 cm) followed by leaf length (16.4 to 77.3 cm) and panicle length (19 to 53.5 cm). The extent of variability present in the genetic material under study indicates the possibility of its utilization in the breeding programmes.

## INTRODUCTION

*Panicum maximum* was introduced in India in the last decade of eighteenth century. Initially *P.maximum* var. Makuni was introduced from Australia which is still grown in a large area. Subsequently a number of varieties such as Hamil, Rivers dale and Gatton panic were developed and came into cultivation. As such, the variation within these lines was quite less except a few varieties recently developed at Ludhiana (India) which characteristically possess soft pubescent leaves and lemmas and mostly belong to the annual type.

Broad genetic base is an important aspect for any breeding programme. Breeding the tropical forage grasses, in many cases, has its own limitation because of its apomictic and tetraploid nature. This problem is also faced with while breeding *P. maximum*. Occurrence of sexual plants have also been reported earlier (Savidan *et al.* 1989). In nature, it can be presumed that some natural crossing might have occurred between sexual and apomictic plants which could have yielded in a large number of transgressive segregants. Hence, with this presumption in mind, it was planned to collect the germplasm from those areas wherein the crop was introduced long back, and evaluate them at one place so as to document the available natural diversity.

## MATERIALS AND METHODS

The collection of *P. maximum* germplasm was made from Bangalore and Dharwad in South India and Gangtok, Shillong, Imphal and Agartala in North-Eastern Hill (NEH) region of the country. Collection was made from natural grasslands, road sides and forest areas. The details of climatic conditions at the collection site are as follows :

**Gangtok (Sikkim) :**

Height 1200 to 1800 m above msl, temperate climate, 4000 to 5000 mm annual rainfall spread over April to October.

**Shillong (Meghalaya) :**

Collection/sites Shillong 1350 m msl and Barapani 900 m msl. Topography of the areas has altitudinal variations at short distances, the place receives heavy rainfall throughout the year.

**Imphal (Manipur) :**

Height 750 m msl. Topography is table land. Black clay soil is very fertile. 2500 to 3500 mm annual rainfall.

**Agartala (Tripura) :**

Place is adjacent to Bangladesh border and is at sea level. The topography is quite undulating. Rains are received from February to July.

**Dharwar and Bangalore (Karnataka) :**

South Indian plains at sea level, moderate rainfall from June to September.

A total of 141 germplasm lines were grown in two replication of single row of eight tussocks at a distance of 1m between rows and 75 cm between tussocks. Observations were recorded for plant height (cm), stem diameter (mm), leaf length (cm), leaf sheath length (cm), leaf width (cm), panicle length (cm) and fresh weight of eight tussocks (kg).

## RESULTS AND DISCUSSION

Frequency distribution analysis and coefficient of variation of the data for six morphological traits and yield revealed considerable variation for almost all the characters under study.

The plant height ranged from 97.5 to 230cm although majority of lines attained a height between 157 to 217 cm. Frequency distribution showed nearly unimodal asymmetrical trend. Coefficient of variation (CV) was 12.45%. Most of the lines which crossed 2 m height were close to Makuni, Hamil and Gatton varieties with glabrous leaf and lemma and the lines which attained

height below 1.5 m were characteristically leafy with pubescent surface. Germplasm lines combining the two characters were also noticed and was attributed to the natural crossing which might have occurred during the course of domestication.

Variability for stem diameter ranged from 2.1 to 11.45 mm with a mean value of 5.61 mm. Frequency distribution showed nearly amodal nature as highest number of lines fell in first few groups with decreasing number in higher classes of stem diameter. Coefficient of variation was recorded 21.78%. Most of the lines with thick stem showed tendency towards perenniality and coarse leaf with, probably, less nutritive value because of high fibre content. Survival and adaptation of such lines under shade full vegetation cover is expected to be better than annual types. Symmetrical unimodal frequency distribution was observed for leaf length and the clustering of lines was around the mid value 44.17 cm. Perennial types, in general, possessed long leaves as compared to short leaves in annual types. Medium leaf length common with most of the lines were considered to be probable natural cross between the two types *viz.*, annual and Perennial types, CV was of the order of 13.48%.

Leaf sheath length did not show much variation and most of the lines possessed leaf sheath between 10.7 to 19.0 cm with mean value 16.17 cm and CV 9.45%. Frequency distribution showed asymmetrical unimodal trend. In general, long leaf sheath and small leaves were noticed in the plants with hairy leaf and leaf sheath and which belonged to the annual types.

Leaf width was observed to be quite variable among different lines. Mostly, the perennial lines resembling cultivar Gatton, Hamil and Makuni possessed glabarous broad leaves whereas pubsecent narrow leaves were common with annual types. Intermediate plants with glabrous-narrow leaves were also seen. A few germplasm lines possessed erect types of leaves and flowered only for a short period once in a year in contrast to majority of the lines with flowering tendency after each cut and regeneration. Leaf width varied from 0.9 to 2.60 cm with a mean value of 1.73 cm and 11.7% CV.

Length of the panicle showed nearly asymmetrical unimodal distribution and average panicle length was 36.65 cm. Some of the lines possessed as short panicle as 19.0 cm in contrast to lines with as long as 53.5 cm panicle. Sparse distribution of spikelets over the panicles have been considered as a primary indication for the possibility of plants being self incompatible but sexual in nature (Noirot, 1989). Hence, this character is important for identification of marking such lines.

Biomass is probably, the most important character while evaluating certain species for its forage value. In the present study, yield was observed as eight tussocks fresh weight of above ground biomass. A comparative study showed

that variation for yield was quite high and this varied 0.57 kg to as high as 12 kg, although in frequency distribution most of the lines clustered on lower group (0.57 kg to 8.0 kg). Most of the lines yielding high biomass possessed long hard flowering tiller and long coarse leaves. Hence, it becomes imperative to evaluate these lines in cumulative terms of biomass yield, nutrition and digestibility.

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# GENETIC DIVERSITY AGAINST SHEATH ROT DISEASE IN RICE (*ORYZA SATIVA* L.)

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Seventy six lines of diverse origin in rice were evaluated for sheath rot disease. Fifteen genotypes were found to be resistant having no disease incidence. These resistant lines were mostly late and all types in nature. However, one early maturing and dwarf genotype (Shakti 1) could be identified as a source of resistance to sheath rot. These genotypes can be exploited in rice breeding programme.

**Key Words :** *Acrocylindrium oryzae, Sarocladium oryzae*, rice, sheath rot, germplasm

The sheath rot disease of rice caused by *Sarocladium oryzae* (Swada) W. Gams and D. Hawksw (*Acrocylindrium oryzae*, Swada) has become a serious problem in rice production for Asian countries. In India, generally dwarf and semi dwarf rice varieties are severely affected during kharif season (Raina and Singh, 1981). With the increased area under cultivation of dwarf and semi-dwarf cultivars, the disease has assumed serious problem causing upto 57% loss (Mohan and Subramaniyam, 1979).

None of the high yielding variety have been found to be resistant so far. The present investigation aims to know the reaction and nature of rice genotypes to sheath rot disease.

## MATERIALS AND METHODS

Seventy six lines of diverse sources including improved cultivars of rice were grown in randomized block design with two replications at experimental farm of Central Rice Research Institute, Cuttack. Each entry was allotted in a single row plot of 3m length with spacing of 15 × 15cm between row to row and plant to plant, respectively. The artificial inoculation of the disease was done after 20 and 30 days of transplanting, respectively as per the method suggested by Estrada *et al.* (1978).

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For measuring the disease intensity, ten randomly sampled plants from each line were tagged. Observations were recorded on individual plant at booting stage. The present disease intensity was calculated using the following formula

$$\% \text{ Disease intensity} = \frac{\text{Number of affected tillers}}{\text{Total number of tillers}} \times 100$$

The rating of disease was done as per Standard Evaluation System (SES) for rice developed at IRRI (1980). The genotypes were classified in different reaction group as resistant (no incidence), moderately resistant (1% tillers are affected), tolerant (1 to 5 per cent tillers are affected), moderately susceptible (6 to 25 per cent tillers are affected), susceptible as (26-50 per cent tillers are affected) and highly susceptible (more than 50% tillers are affected).

## RESULTS AND DISCUSSION

On the basis of disease reaction, all the seventy six genotypes were classified into various groups (Table 1). Fifteen genotypes were recorded to be resistant because they showed no incidence of disease at all. On the other hand, twelve genotypes exhibited upto five per cent affected tillers and considered as tolerant. A total number of 23 genotypes including improved cultivars have shown moderate susceptibility. Regarding susceptible genotypes 16 genotypes found to be susceptible to this disease because of higher incidence of disease i.e., upto 50%, while remaining ten genotypes, showed almost all the tillers affected and considered to be highly susceptible.

**Table 1. Performance of seventy six lines against sheath rot disease in rice**

| % of affected tillers | Disease Reaction | No. of genotypes |
|---|---|---|
| No incidence | Resistant | 15 |
| Less than 1 | Moderately resistant | 0 |
| 1-5 | Tolerant | 12 |
| 6-25 | Moderately susceptible | 23 |
| 26-50 | Susceptible | 16 |
| 51 and above | Highly susceptible | 10 |

Dwarf plant types are considered to be most favourable genotypes for yield. In general, if we consider plant stature and duration simultaneously in relation to disease resistance; fifteen resistant lines can be further classified into several groups (Table 2). Among them, Shakti 1 was the only early maturing and dwarf statured genotype which showed resistant reaction. This genotype could be successfully exploited in breeding programmes.

A persual of data presented in Table 2 demonstrate that most of the resistant genotypes were tall and late maturing types. This suggested that plant stature is somehow related to disease reaction as also reported by Amin (1976) where it has been emphasized that resistance can be successfully

**Table 2. Classification of sheath rot resistant genotypes based on plant height and maturity duration in rice.**

| Criteria | Genotypes |
|---|---|
| Tall and early | T-141, BJ1 |
| Tall and medium | CR 1014 |
| Tall and late | ASD-2, Manoharsali, Tetep, PTB-18, Raminad Str-3, CO4, GEB 24, ADT-10 |
| Semi dwarf and early | CO22, Pankhani |
| Semi dwarf and medium | RP 2071-20-21. |
| Dwarf and early | Shakti 1 |

transferred to dwarf lines. However, present study demonstrated that even tall genotypes can be used in resistance breeding programme following appropriate mating designs. Two genotypes of tall and early (T141, BJ1) and a tall and medium maturity (CR1014) can be directly introduced for general cultivation or may be used in breeding programme. Earlier it had been assumed that none of the dwarf cultivar was resistant to this disease. After continuous evaluation over two years, the present study has identified one line of dwarf and early maturing type (Shakti 1) to be resistant. This line can directly be recommended for rice growers and/or it can be considered as dwarf source to this disease in varietal development programmes. Therefore, present study clearly demonstrates the availability of sources of resistance against sheath rot in tall as well as in dwarf genetic backgrounds in rice germplasm.

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# *ALLIUM* BIODIVERSITY AND ITS TRADITIONAL PROPHYLACTIC SIGNIFICANCE IN INDIAN SUB-CONTINENT

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*Allium*, a well known vast genus, constitutes not only man's palatables but also signifies its ethnomedicinal potential worldwide in the traditional effective therapy against various ailments. This genus has been the subject of taxonomic renovation among the Botanists for a long and consequently it has to traverse its positional distance from Liliaceae to Alliaceae. Some species of the genus are originated outside the Vavilovian centres but most of these are confined to temperate world. Three new species viz., *A. caesium* Shrenk, A. *fasciculatum* Rendle and *A. prattii* Wight are being reported in addition to the previous reviews on *Alliums* in Hindustani Centre of biodiversity. The present review deals with taxonomic status, distribution, domestication, diversity of different *Allium* species in Indian sub-continent and their affinities and medicinal significance in Indian traditional medicine system.

**Key words :** *Allium* species, biodiversity, ethnomedicinal potential

The best known diagonostic characteristics of *Allium*, in general, are their smell and taste. The *Alliums* mainly have underground bulbous structure and are low growing annuals, biennials and perennials. Important vegetative parts of these plants are leaves and rhizome, more specifically bulbs. The leaves emerge from the underground portion of stem and also sometimes have sheathing bases, thus are known as pseudo-stems. Except single spathe which encloses the young inflorescence, no leaf is found on the flower stalk. Flowers are arranged in an umbel-like inflorescence. Each flower consists of six perianths arranged in two whorls of three each. Flower colour ranges from white, rose, violet, blue to yellow and hence these coloured *Alliums* are also grown for their ornamental value and showy appearance (Davies, 1992).

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## TAXONOMIC STATUS OF *ALLIUMS*

Henelt (1990) reviewed the taxonomic status of *Alliums* considering the earlier descriptive details by Jones and Mann (1963), and the revised contextual taxonomic state of *Alliums* is - Monocotyledones, Liliiflorae (super order), Asparagales, Alliaceae, Alliae (tribe) and genus *Allium*. He further divided the genus into five subgenera and within subgenus level, different sections have been categorized; single or several species may comprise an individual section such as *A. cepa* and *A. fistulosum* have been grouped under *Cepa* section of *Rhizirideum* subgenus while *A. ampeloprasum* and *A. sativum* were placed under *Allium* section of subgenus *Allium*. Earlier, the genus *Allium* was classified under the family Liliaceae and was followed for a long; later on it was placed under the family Amarylidaceae, by some phytologists, but it was given a separate position in the family Alliaceae by Purseglove (1972).

## DISTRIBUTION OF *ALLIUMS* IN THE WORLD

Approximately one thousand wild species of *Allium* have been noticed throughout the world, distributed in different megacentres of biological diversity particularly in the northern temperate regions (Buijsen, 1990). Vavilov (1931) initially revised it from seven to eight but at a later stage, he recognized ten gene centres. Based on the fact that some species still originating outside the Vavilov's recommended centres, Zhukovsky (1965) compounded a view with 12 megacentres of origin throughout the world stretching vast areas of land. He himself further made some modifications of megacentres boundaries (still the precision of exact boundary limitations is not complete), however, Zhukovsky (1965, 1970) propounded 12 megacentres widely based on the Vavilov's earlier diversity distribution studies. Prominent centres of diversity of *Alliums* are East-Asian Centre (Chinese-Japanese region), Hindustani Centre (Indian Sub-continent), South-West Asian Centre (Central Asian Region), Near-East Centre, Mediterranean Centre, European- Siberian Centre (Fig. 1). Thus, it is believed that most of the *Alliums* cultivated in South-East Asian region are the introduced variants either from Chinese-Japanese region or from Central Asian region. The probability of its introduction also from European region can not be ruled out (Buijsen, 1990).

*Alliums* are distributed widely throughout the temperate, warm temperate and in some zones of northern hemisphere. In Eurasia, the species diversity ranges from Turkey eastwards to the mountains of Central Asia through northern Iran, Afghanistan, Tajikstan, the Tien Shan mountains of Kirgiziya and North-East China, also the mountains of Mongolia and southern Siberia. Depending upon ecological and general climatic variation, different important species are cultivated and domesticated in different regions of the world. The first domestication of *A. cepa* is considered to be in the mountaineous region

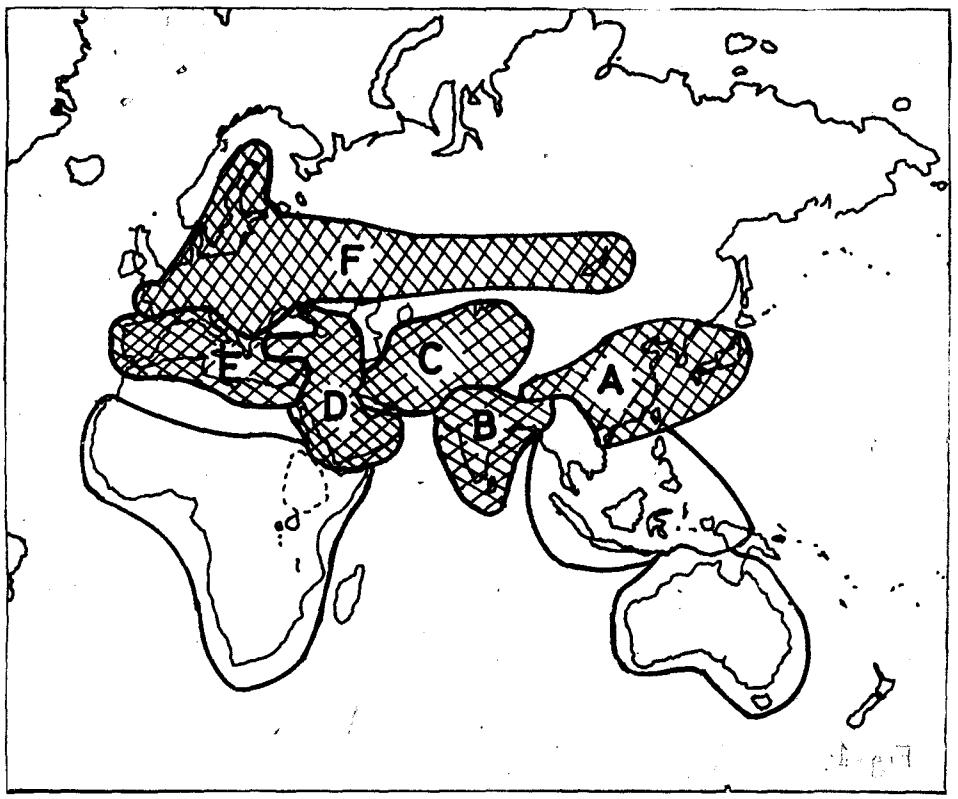


**Fig. 1. Allium biodiversity distribution in prominent world megacentres of origin of phytodiversity. A — Chinese-Japanese Region, B — Hindustani Region, C — Central Asian Region, D — Near Eastern Region, E — Mediterranean Region, F — European-Siberian Region**

of Turkmenia, Uzbekistan, Tajikstan, North Iran, Afghanistan and Western Himalayan region. More than 600 *Allium* species have been reported from temperate zone; wild species are concentrated in northern hemisphere in different centres of diversity.

## *ALLIUMS* IN INDIA

Though 40 species (Wlth. India, 1985) were reported in India, the distribution of wild species still need proper elucidation. Most of the *Alliums* in India are distributed in temperate and alpine zones of Himalaya (Kachroo, 1977). In Hindustani centre (Indian sub-continent), only *A. ampeloprasum* has been quoted to be present by Zeven and de Wet (1982) and reported by Koul

and Gojil (1970) from Kashmir. However, Hooker (1894) described four *Allium* species, *A. ascalonicum, A. ampeloprasum, A. cepa* and *A. sativum* most common in use and cultivation. Both the reports by Hooker (1894) and Zeven and de Wet (1982) were quite incomplete probably due to lack of adequate exploratory studies on *Allium* biodiversity in India and that is why the possibility of inclusion of other naturally occurring wild species in Indian gene centre was absent in their previous citations. A more comprehensive information in this regard has been provided by Chandel and Pandey (1992) and they have enlisted 27 wild species of *Alliums* in India distributed in different temperate regions of the country. In the present review, three more species have been added to the previous information on *Allium* biodiversity in Indian gene centre. These are *A. caesium*, Shrenk, *A. fasciculatum* Rendle and *A. prattii* Wright which have overlapping distribution in Indian Himalayas adjoining western Nepal and Tibet. Out of these 30 species, only four or five species are cultivated and used as different recipes in food, vegetables, condiments, pickling, salad, medicine and also decorated ornamentally in gardens. Most of the species in wild state are found in the domain of Himalayan region (Fig. 2a, 2b, 2c and 3).

Description of the new additions

(i) *A caesium* Schrenk : It is common to Lahaul area in Himachal Pradesh and has its marked distinction by its dark blue flowers. Flowering stem is comparatively longer than the leaves which are 1-2 mm broad; inflorescence umbel 3-4 cm.

(ii) *A. fasciculatum* Rendle : The scented herb, comprising white or pale-green flowers with umbel inflorescence is found in borderland area of Indian Himalaya adjoining western Nepal and Tibet.

(iii) *A. prattii* Wright: The plants have pink coloured flowers, narrow elliptic paired leaves and many flowered umbel inflorescence. Flowering stems are longer than the leaves, fibrous sheath surrounds the base of the stem

**Affinities within some notable *Alliums***

*Alliums cepa* being cultivated for a long, is related to *A. pskemense* and *A. vavilovi* which grew wild in central Asia especially northwest India, Afghanistan, Uzbekistan and west Tien Shan (Vavilov, 1949). Other related wild species is *A. oschaninii* (syn. *A. cepa* var. *sylvestris*) from Pamirs, Alai and Tien Shan. Wendelbo (1971) and Mc Collum (1974) suggested that these species are wild relatives of *A. cepa*. Secondary centre of origin of *A. cepa* is considered to be the mediterranean region but said to be originated in Persia. Romans introduced onion into western and northern Europe around 300 A.D.

*A. sativum* has been considered to be a native of China. Some workers consider *A. longicuspis* as the wild parental stock of garlic. *A. sativum* is thought

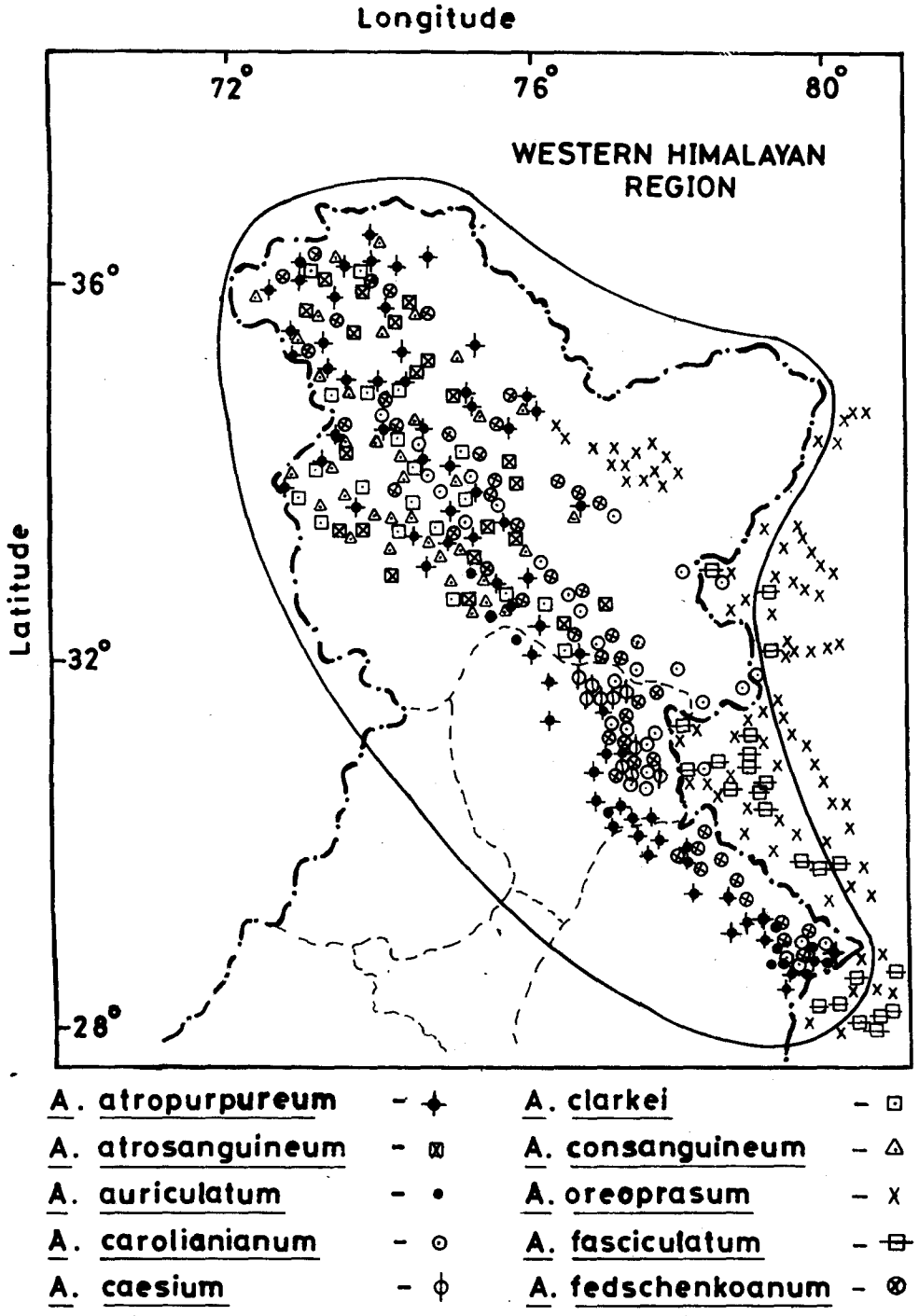


Fig. 2a. Occurence of *Allium* biodiversity in Western Himalayan region in Indian gene centre

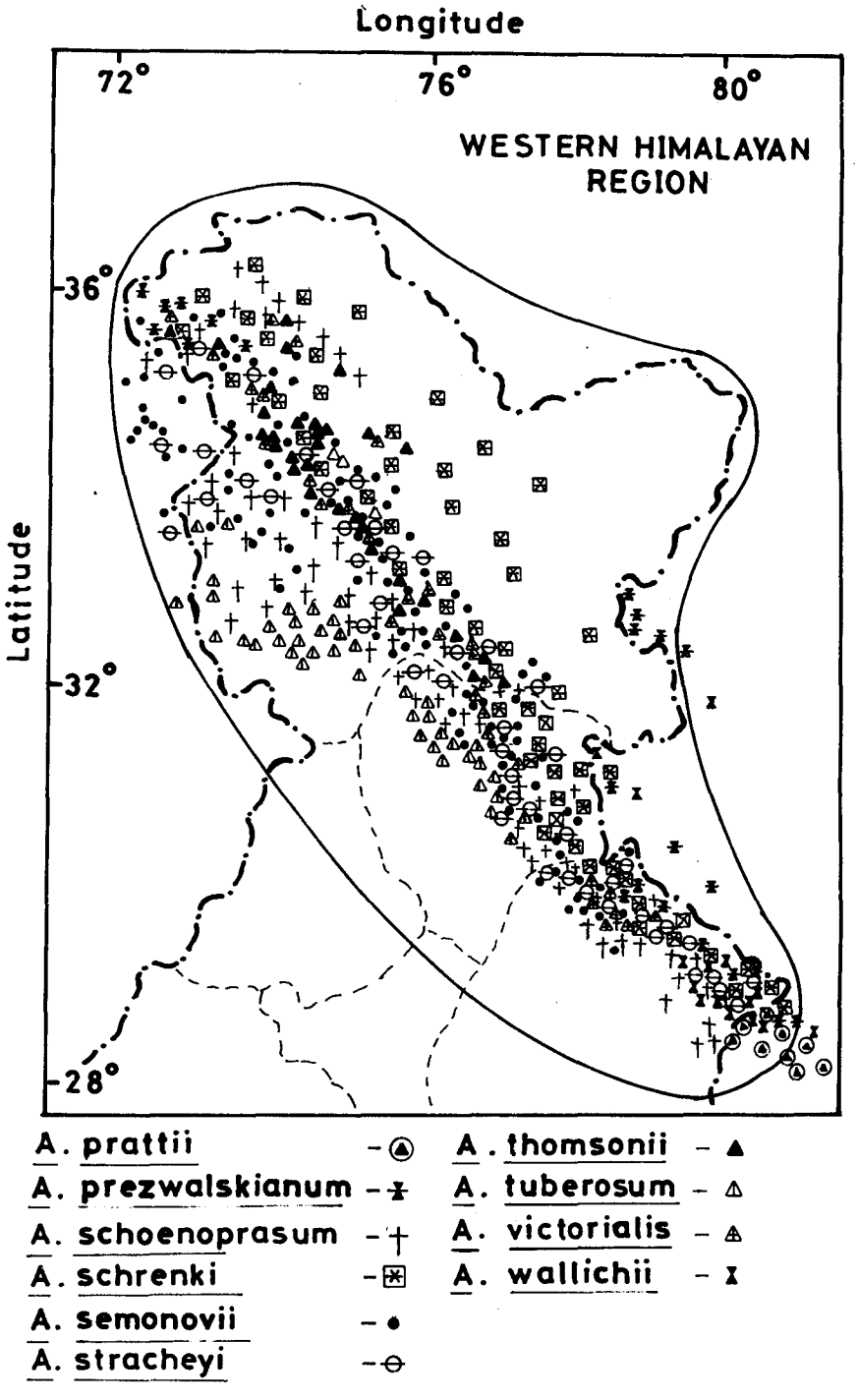


Fig. 2b. Western Himalayan region continued

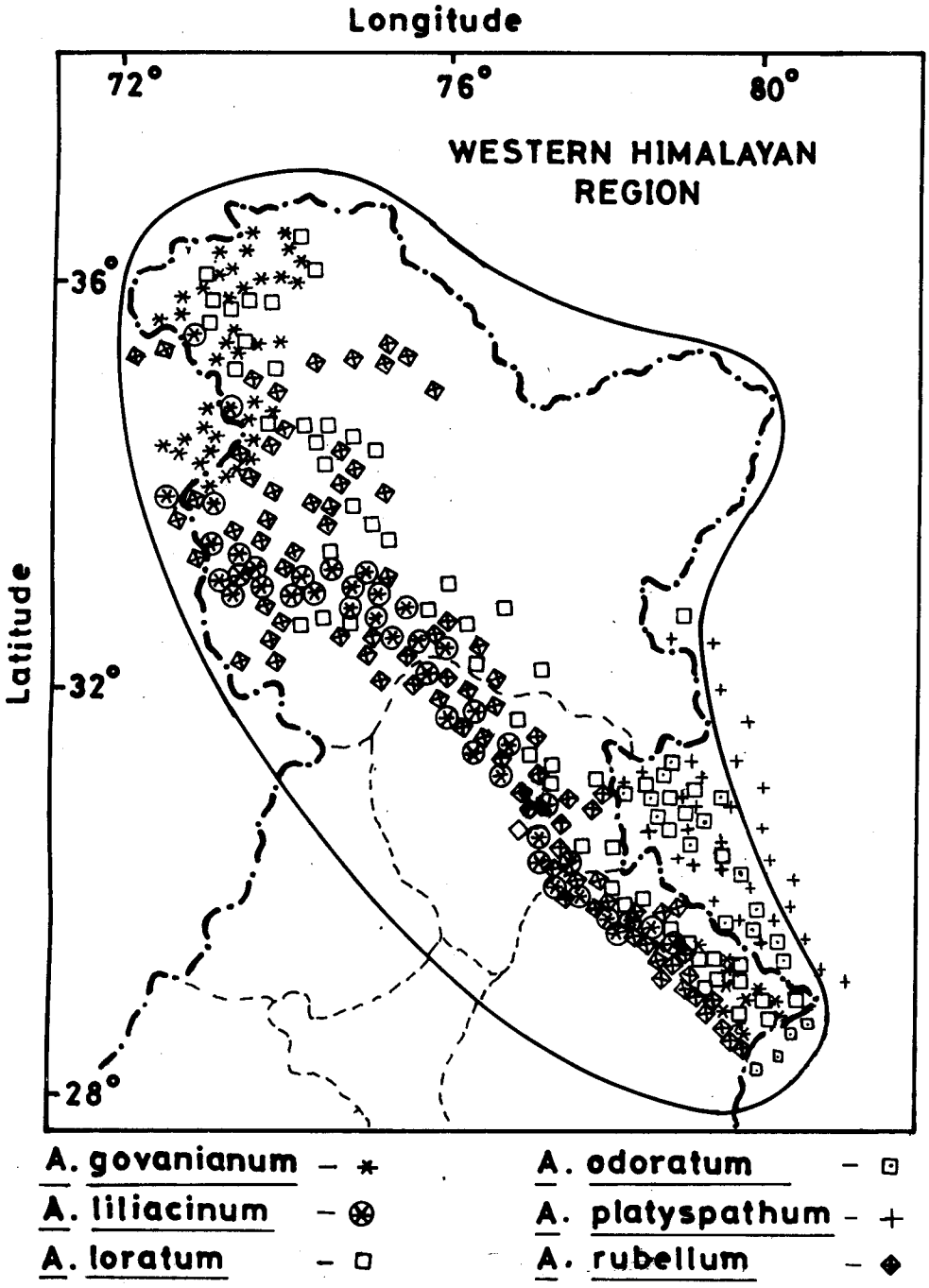


Fig. 2c. Western Himalayan region continued

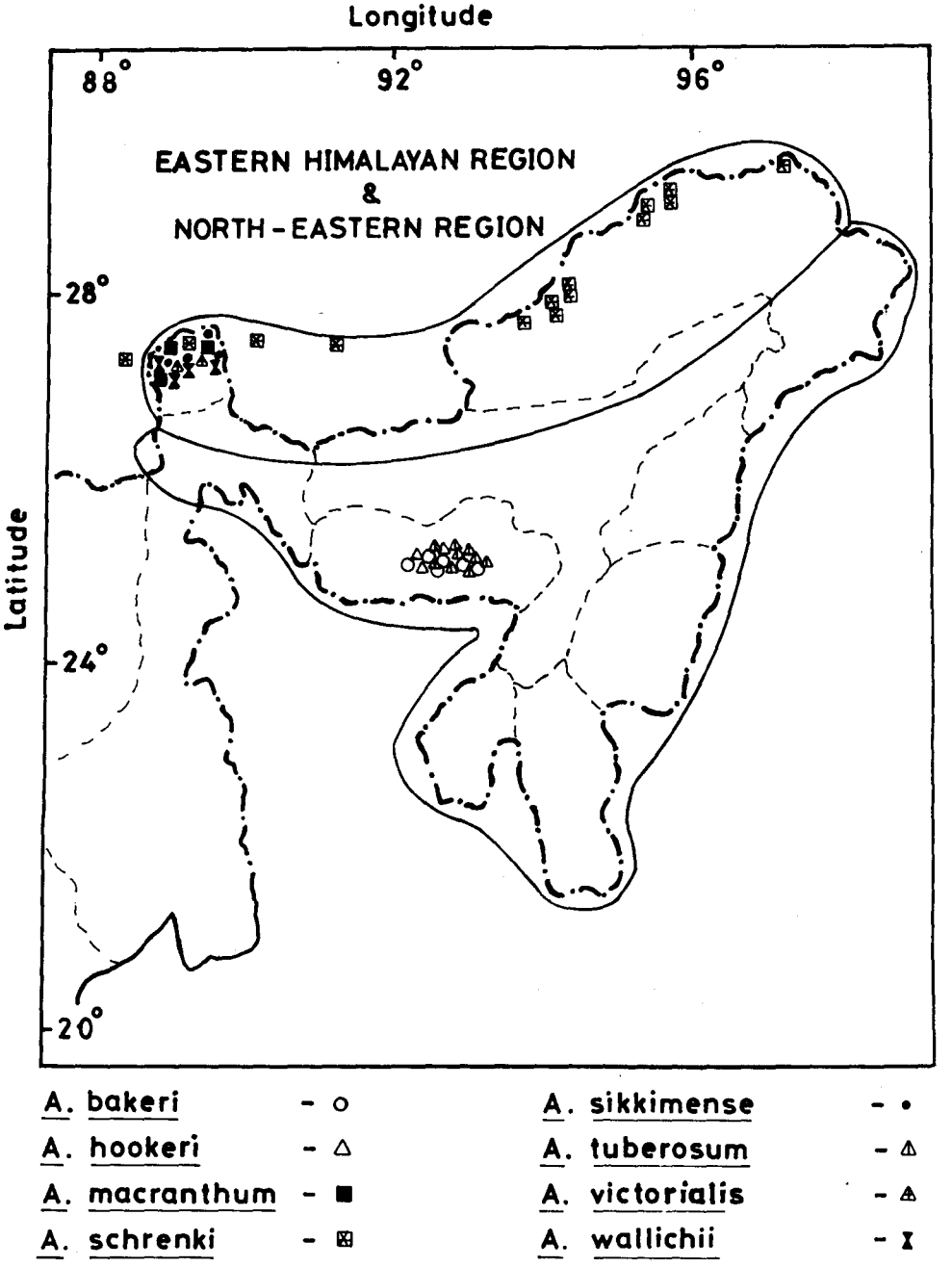


Fig. 3. Occurence of *Allium* biodiversity in Eastern Himalayan region in Indian gene centre

to be originated in Central Asia, while the secondary centre have been recognised in the Mediterranean region. The wild and cultivated forms of *A. ampeloprasum* (levent garlic) are highly variable and it is considered related to *A. sativum, A porrum, A. kurrat* and *A. scorodoprasum.* Levent garlic is an ancient crop mentioned in the Bible and most probably domesticated in the Mediterranean region. *A. porrum* (leek) is a cultivated form *A. ampeloprasum.* Few nomenclaturists consider both these species as one and synonyms. Because of a close relation of *A. kurrat* to *A. ampeloprasum,* it has been mistakenly included as a variety (var. *kurrat*) either of *A. ampeloprasum* or *A. porrum. A. kurrat* is known from the times of Pharaohs and grown mainly in Arabia and Egypt. The centre of origin of *A. ascalonicum* (Shallot) has been probably recognized in West Asia. The earlier history indicates that the crop is related to *A. cepa*. The presence of *A. macleani* stretches in the areas from Iran to Afghanistan. According to Tutin (1976), the species *A. scorodoprasum* (giant garlic) comprised four subspecies viz., *A. scorodoprasum rotundum, A. scorodoprasum waldsteinii, A. scorodoprasum jajlae* and *A. scorodoprasum scorodoprasum,* probably the later sub-species was derived from sub-species *rotundum.* At present *A. tuberosum* (syn. *A. odoratum*) has been reported wild from East Mongolia to Japan, Philippines and through Thailand to Northern India; the primary centre of origin is unknown. It is thought to have been originated in China. Its tetraploid may derive from an amphiploidization of hybrid of two diploid species or autotetraploidization of a diploid species. Egyptian onion or tree onion (*A. proliferum*) was previously described as a variety of onion as *A. cepa* var. *proliferum* and *A. fistulosum* but later, on the basis of a comprehensive C-banding study, it was declared as a true hybrid of both of these species (Fiskenjo, 1975; Vosa, 1976). *A. fistulosum* (Welsh onion, stone leek, spring onion) probably originated in north-west China has been recognized to show a close affinity with *A. altaicum* from North Mongolia while the former is reported to be first cultivated in North China. And *A. microbulbum* is said to be a hybrid of *A. fistulosum* and *A. altaicum.* Cultivation of Welsh onion dates back to 200 BC in China and reached to Japan around 500 AD, now it is spread throughout the South-East Asia. *A. chinense* is native to central and eastern China and mainly cultivated in China and Japan. Because of a very polymorphous nature of *A. schoenoprasum,* its intra-generic relationship with other species is not well documented.

Most of the species have been introduced from Near-East, Central Asia and East Asia, usually the basic haploid state of x = 8 have been reported in most of the *Alliums.* But an interesting state of haploidy have been noticed in the subgenus *Amerallium* comprising around 27 species. The species in this group have the basic chromosome number x = 7 not as like others x = 8, also these species have some anatomical differences such as the position of vessels and lacticifers in the leaves (Hanelt, 1995). These mediterranean group

of *Alliums* are distributed well in America, temperate areas of west and central Europe and extending to Himalayas and south-west China.

## GLOBAL ECONOMIC STATUS OF ALLIUMS

Alliums have their historical occupation in the feeding habit and out of a vast *Allium* variants, only few species could obtain their place in the man's history of plant domestication and cultivation. Onion had very old cultivation practice and still capturing an excellent market in the world next to cabbage and tomatoes, thus, it has third position in terms of global production (FAO, 1991), with 2 million tonnes annual International trade amounting 400 million US dollar. In India, onion production is reported to be around 3,59,0000 tonnes. In comparison to onion, shallot is less important economically. These are only produced in small scale in home gardens. Their importance are mainly confined to the humid tropical areas because of disease and pest resistance to grow in a particular environment (Currah and Proctor, 1990). According to Eurostat (1990), these are mainly produced in France covering 2500 ha area under cultivation giving 39000 tonnes of production. Especially in the developed countries. *A. sativum* is second widely consumed *Allium*. The world production of garlic is about 2.9 million tonnes. Californian climate is the most suitable for garlic cultivation and production that yields highest quality of garlic. The most suitable chain of climate is mild winter with little rain followed by dry summer (FAO, 1991). India is considered fourth out of 10 leading countries for garlic production. India's production is 217000 m tonnes with 60000 ha in comparison to world's garlic production of 2962000 m tonnes with 421000 ha area. European Economic Community (EEC) member countries preferably produce leeks, an important European *Allium* crop, producing about 7 million tonnes per year that is rating 25 per cent of onion production. Of the member countries, France is the highest producer of leeks (Eurostat, 1990). Kurrat which is closely related to leek, is grown for fresh leaves in east mediterranean region, more precisely in Egypt (Meer and Hanelt, 1990). Japanese bunching onion and Chinese chives are crops of commercial importance in East Asia, notably Japan, Korea and China. Annual production of Japanese bunching onion in Japan is about 600000 tonnes almost half of the country's onion production and the cost of bulb onion is half to that of bunching onion. South Korea produces about 430000 tonnes of Japanese bunching onion annually (Rabinowitch and Brewster, 1990 a, b). Chinese chives are preferably grown as garden plant and flavouring herb and, particularly domesticated in Denmark, New Zealand and Germany. The production of chinese chives is comparatively less, amounting only 66000 tonnes.

**Flavour biochemistry of Alliums**

In general, the compounds present in *Alliums* are mainly sulphur containing biomolecules which impart a peculiar remarkable smell and pungency. Possible detailed studies on the nature of flavour and other biochemical properties have been investigated in the last decade by few workers (Block, 1985; Fenwick and Hanley, 1985 a, b; Lancaster and Boland, 1990). As the sulphur is a well known mineral ingredient in the sapidity of *Allium* tissues, it remains bound with non-protein amino acids which further constitute the precursor of volatile compounds. Though precursors have no smell and non-volatile amino acids with a basic skeleton-S-Alk (en) yl cysteine sulphoxides

Cysteine sulphoxide group

R may be $CH_3$ (methyl), $CH_3$-$CH_2$-$CH_2$ (propyl), $CH_3$-CH≡CH (1-propenyl) and $CH_2$= CH-CH (2-propenyl). S-alk (en)yl-L-Cysteine sulphoxide lyase (enzyme alliinase) controls the reactions of flavour precursors on damaging fresh tissues yielding sulphenic acids (R-S-OH), ammonia and pyruvic acid (Block, 1985) in the presence of pyridoxal phosphate. Onwards, the highly reactive sulphenic acid undergoes further reactions and the resultant composition gives a volatile and pungent smelling products. These reactions depend upon and varies with species and other environmental conditions. Because of this reason, the boiled onion never imparts proper flavour, boiling treatment destroys the enzyme. In the case of garlic, allinase catalyze the formation of allicin which provides a peculiar garlic smell.

**Chemical composition in Alliums**

Besides different volatile flavour constituents in different *Allium*, in general, carbohydrates make up about 5-12 per cent, and much of the dry matter is stored particularly in the form of fructans (a long chain polymer of frutose) in the vacuoles (Hendry, 1993), 1-2 percent protein and 0.2 per cent fat. Besides other amino acids, proteins in *Allium* have glutamic acid (a basic amino acid of nitrogen source) as one of the main constituent. Flavonols, anthraquinones, saponins, sterols, prostaglandins are also found in *Allium* (Fenwick and Hanley 1985 a, 1990 a, b). In onions, iron, vitamin A, B and C are also present. Mono, di- and tri- sulphides and sulphinates contribute essentially to the lachrymatory factor in some of the species of *Allium* (Block, 1985). *Allium* also contain salicylic acid, albumin, mucilage and other organic sulphides. Depending upon the species variation, the constituents are variable so, their fragrance, flavour and taste also varies.

**Prophylactic significance of some well known *Alliums***

The number of Alliums studied for their ethnomedicinal potential is very less, almost negligible when we view their vast diversity in the world. Hence, the efforts have been made to those *Allium* species which have folklore and traditional medicinal efficacies.

(i) ***Allium cepa*** (Vernacular name : Sanskrit - Nripakanda, Palandu, Raktakanda, Durgandha, Hindi - Piyaz, English - Onion)

In ayurvedic school of medicinal description, *A. cepa* has sweet, smooth, heavy and oily characteristics and is a good ethnomedicine to relieve wind disorders (Vāāt vikār). On different body systems, its actions are briefly summarized as follows.

*Nervous system* — It is useful in many nervous disorders such as rheumatism and its associated secondary problems and aches. Mixed with mustard oil in equal parts, it is beneficial against rheumatic pains.

*Digestive system* — It is used to cure dyspepsia, constipation, piles, jaundice and prolapsus ani. Raw onion gives an unpleasant odour to breath but it has an antiseptic effect to entire alimentary canal.

*Blood vascular system* — Heart weakness can be alleviated by a regular limited use of *A. cepa;* also, it cures other inflammatory diseases of the system.

*Respiratory system* — It's usage corrects phlegm disorders such cough, coryza and expelling sputum when the state of phlegm in the body is disturbed severely due to imbalanced metabolism. its continuous use for a limited period brings the effect of expectorant.

*Urinary system* — Because of its diuretic property, it is useful in the treatment of strangury.

*Reproductive system* — In man, its usage removes weakness of sperm and semen, thus wards off impotence; in woman, it corrects dysmenorrhoea.

*Skin* — In pruritis and other infectious diseases, its massage is useful to get relief from itching.

**Side effects and remedy**

It may be unsuitable to brain and its functioning and cause adverse effects if consumed in excess. To ward off its side effects, pomegranate should be used that has been found to mitigate the dysfunction due to excessive intake. Normally, the dose is 10-30 ml bulb extract or 1-3 g seed powder.

**General medicinal actions and uses**

Onion is considered very important medicinally by local people, healers, Vaidyas, Hakims who stemmed up a local health traditions and now have

attained a broad recogniation, in fever, dropsy, catarrh and chronic bronchitis-Onion bulbs are useful against colic and scurvy when mixed with common salt. To mitigate heat sensation, it is used as poultice to boils, bruises and wounds. Bulb juice is used against convulsions, headache, epileptic and hysterial fits: It is sniffed in epistaxis, applied its extract mixed with honey to eyes in dimness of vision also, given as an antidote to tobacco poisoning in rural areas. In phthisis, onions are eaten to mitigate the disorder. When used mixed with ginger, it is useful in sore throat; when cooked with vineger, it is beneficial against jaundice, splenic enlargement and dyspepsia. Local medicinemen advise a remarkable effect against malarial fever if eaten two times a day with black pepper. Onions are considered good for growth of children when eaten with jaggery. Decoction of onions has been considered much effective against the cases of strangury and extreme heaty sensation. A mixed preparation made of roasted onions, cumin, sugarcandy, cow's ghee (milk fat), is an effective demulcent in the treatment of piles. In ear pain, lukewarm extract is used as a drop.

(ii) ***Allium sativum*** (Vernacular name : Sanskrit — Rason, Rasonam, Mlechhagandha, Ugragandha, Yaveneshta, Bhutanga, Hindi — Lahsun, English — Garlic)

From the Ayurvedic standpoint, it alleviates phlegm (Kaph) disorders due to its pungent and bitter properties. Oiliness and lubricity provide this herb a curable capacity against wind (Vāāt) disorders, so it is used as a good homely treatment for the ailments due to phelgm and wind disorders (Kaph-Vāāt vikār).

*Nervous system* — It is an effective and homely nervine tonic for strengthening nervules and alleviates other related nervous disorders. In local health care, it is prominently recommended against paralytic affections and mental weakness. It also activates the nerves connecting eyes and supposed to be a good sight improver.

*Digestive system* — Because of its hot and bitter properties, it is stimulative, digestive. It corrects constipation, relieves pain; expels worms and stimulates liver. Also, the annorexia and dyspesia may be alleviated by its usage.

*Blood vascular system* — Continuous prophylaxis of *A. sativum* activates and strengthens heart functions and removes inflammatory disorders of heart. It is helpful in controlling bradycardiac and tachy-cardiac heart rhythms and keeping the normal heart beat.

*Respiratory system* — In general, it alleviates phlegm disorders and cleans the foul smell of sputum. Useful in impoverishing bronchial affections and strengthens aleveoli by killing the germs and nullifying infections thus, it is highly protective and curing against tuberculosis and chronic fever.

*Urinary system* — It regulates urine formation and maintains its regular flow because of its diuretic property.

*Reproductive system* — Due to its viscous, oily and lubercity properties, it is considered one of the best ethnomedicine for the production of healthy semen and sperms. In females, it regulates menstrual cycle and cures dysmenorrhoea and menopause.

*Skin* — Since sulphur is present in its sap, the herb is reckoned to be very useful against infectious skin and leprotic patches.

## Side effects and remedy

No side effects, till now, have been reported if used under dosage prescription intake of bulb 3-6 gms and oil 2-3 drops. However, it should be safely used by the persons with regular bile complaints and should not be taken by pregnant women. To ward off its side effects, coriander seeds (*Coriandrum sativum*) should be consumed till the effect is mitigated.

## General medicinal actions and uses

*A. sativum*, for its activating properties and prophylactic importance, is generally used against general debility. It is considered to enhance body stamina and empowers livliness and also has sweat producing and perspiratory effects. The garlic therapy cleans bowels, thus, mitigates the hidden feverish feeling in the body and maintains body temperature. It alleviates the bacterial indexes and restores the clinical state of the patients. In bile (pitta) complaints, it should be used with sugar; in phelgm (Kaphˆ) disorders, with honey and in wind (Vāāt) disorder with milk fat. During therapy, wine, acid substances and meat are favourable, all the same, excessive water intake and milk are unfavorable. Also, anger and tension should be avoided.

When the bursted cloves are rubbed on the affected skin, it produces redness followed by burning sensation. It is used locally as counter-irritant in painful affections like rheumatism, pleurisy, neuralgia and hepatitis. Its stimulancy on respiratory and digestive systems is brought out by its excretion by bronchial and intestinal mucosal membranes after its absorption. It enhances the purgative property of Senna (*Cassia lanceolata*) and **Harra** (*Terminalia chebula*), also used in combination with ginger (*Zingiber officinalis*) and variously with *Vitex negundo, Piper longum* for different ailments like typhoid, pneumonia , pulmonary phthisis and tubercular affections. In *Unani* system of medicine, *A. sativum* is used also to improve memory, colic, internal ulcers of the lungs and paralytic affections.

*A sativum* is also used as resolvent in wound cleaning tinctures. It corrects deafness, pain and purulent discharge in ear. Chakradatta, an Indian medicine

man of traditional Ayurvedic school of medicine, recommended the decoction of *A. sativum* prepared in milk, as very useful against hysteria, flatulence, sciatica and heart diseases.

Some Indian medicaments are Rason Vati, Rason Pinda, Rasonstak, Lahsunadya Ghrita, Rason Sura, Garlic Oil, Lasona, Garlic pearls, Garlic Liniment, Compound Decoction and Powder, while some popular exotic medicaments are Extractum Allii Sativi Liquidrum, Syrupus Allii Sativi, Tincture Allii Sativi.

Most of the species of *Allium* have been scared from detailed therapeutical and clinical trials in both the old and new worlds for their medicinal efficacy in local health traditions. The reason for this pharmacognosical neglect may probably be the centuries old usage of mainly two species i.e., *A cepa* and *A. sativum* as a part of man's food. As the time passed, man started domestication and cultivation of few more species viz., *A. ampeloprasum, A. ascalonicum, A. macleani, A. leptophyllum, A. schoenoprasum* species for making an ingredient of his food but still the medicinal potential regarding these species is not pertinent in the literature.

*A. ampeloprasum* (syn. *A. porrum*), sweet leek is mainly cultivated in Kashmir. The bulbs of the plant are used to hasten the suppuration of boils. The alcoholic extract of *A. ascalonicum* (Shallot) bulb is considered as an anticoagulant and causes liquification of coagulated blood and lowers the level of serum-cholesterol in blood. Locally, the bulbs are used for its aphrodisiac property and used in the treatment of ear-ache. The bulbs of *A. schoenoprasum* are considered to possess cardiac depressive constituents (CDRI, 1971). *A. leptophyllum* (Himalayan onion) bulbs have been considered to possess sudorific property. *A. macleani* is considered as demulcent and given to alleviate general debility, nervous exhaustion and seminal weakness. Other cultivated species such as *A. fistulosum* and *A. victorialis* constitute man's food either as carminative or for making palatable diets.

**Possible future biotechnological advances in *Allium* research**

Because Alliums possess human food value and ethnomedicinal significance, first, the whole *Allium* biodiversity present in the world should systematically be categorized and updated on the basis of present stringent taxonomical measures and then these species should be mapped using different physiological and molecular techniques such as isozymes, RFLP and RAPD. Thus, the refined information obtained will not only provide a broad concept on *Allium's* synteny but also will be useful to engineer different crops which are pathologically or physiologically sensitive to present changing global environment. These measures may also lead to secure diversity of the genus for future sustainable use.

It is axiomatic that one can not assess and understand the potency and significance of germplasm and its genetic utility in the field. In 1948, Harlan collected a wheat PI 178383 from remote parts of Eastern Turkey. This strain of wheat was having almost disqualifying attributes like tallness, thinness, stemmed, excessive lodging, susceptible to leaf rust, lacking winter hardiness, difficult to vernalize and poor baking quality in comparision to normal routinely used wheat, thus, anyone hardly paid any attention to it. But after a period of time, this miserable PI 178383 proved to be resistant enough to four races of stripe rust, thirty five races of common bunt, ten races of dwarf bunt and very good tolerance to flag smut and snow mould (Harlan, 1975). Then, this accession of wheat was used in all wheat breeding programmes which saved millions of dollars. So, wild, scared weed forms and ancestral plant diversity related to present day crops more specifically *Alliums* in the present context must be given proper attention which may prove a good genepool for future.

## ACKNOWLEDGEMENTS

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# DIVERSITY DISTRIBUTION AND ETHNOMEDICINAL RELEVANCE OF *PSORALEA CORYLIFOLIA* L. IN TRADITIONAL HEALTH CARE IN INDIA

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*Psoraleas*, distributed throughout tropical and sub-tropical regions of the world, represent more than one hundred species. In India, *P. corylifolia* L. is widely distributed from Rajasthan to Bengal and from Punjab to down south Indian states. In indigenous system of medicine, this plant is highly recommended against leprotic syndromes, apart from this medicinal siginficance, the herb is also useful in alleviating other disorders of the body systems. Besides, its antibiotic and insecticidal potential, it may serve a good drug source against AIDS. Biotechnological advances have also been briefly discussed.

**Key words :** Diversity, distribution, ethnomedicinal relevance, *Psoralea corylifolia*

*P. corylifolia* L. (Purple fleabane), popularly known as *Babchi*, was earlier classified as a papilionaceous plant but later has been placed under the family Fabaceae. By mode of life form and habit, these plants are herbs, undershrubs and shrubs around 1-5 feet high, punctate with pellucid glands. Roundish heart shaped 1-3 inches long leaves have slightly inciso-dentate margins and are mucronate at the apex. Usually 1 to 30 flowers, composed of nearly sessile calyx and yellow corolla, bloom on the floral axis in racemes in winter and form small glabrous pods containing black indehiscent seeds in early summer. The plant besides its medicinal relevance, is a good source of nitrogen as feed to cattle and also serves as green organic manure.

## Diversity distribution

*Psoralea*, comparatively a large genus has its wide distribution in tropical and sub-tropical parts of India and different centres of diversity in the world.

*In Indian gene centre* - Mainly four species of the genus have been reported to occur in India, out of these, one species is exotic i.e. *P. pinnata*, a South African shrub found around Ootcamund in south India. *P. corylifolia*, covering

its occurrence in most of the parts of the country, is abundant as a weed in Assam, Bengal, Bombay, Deccan, Rajasthan and Uttar Pradesh (Fig. 1) though reported to be rare in Orissa (Saxena and Brahmam, 1983). *P. plicata* has been reported to be distributed in the states of Punjab and Delhi. From Rajputana

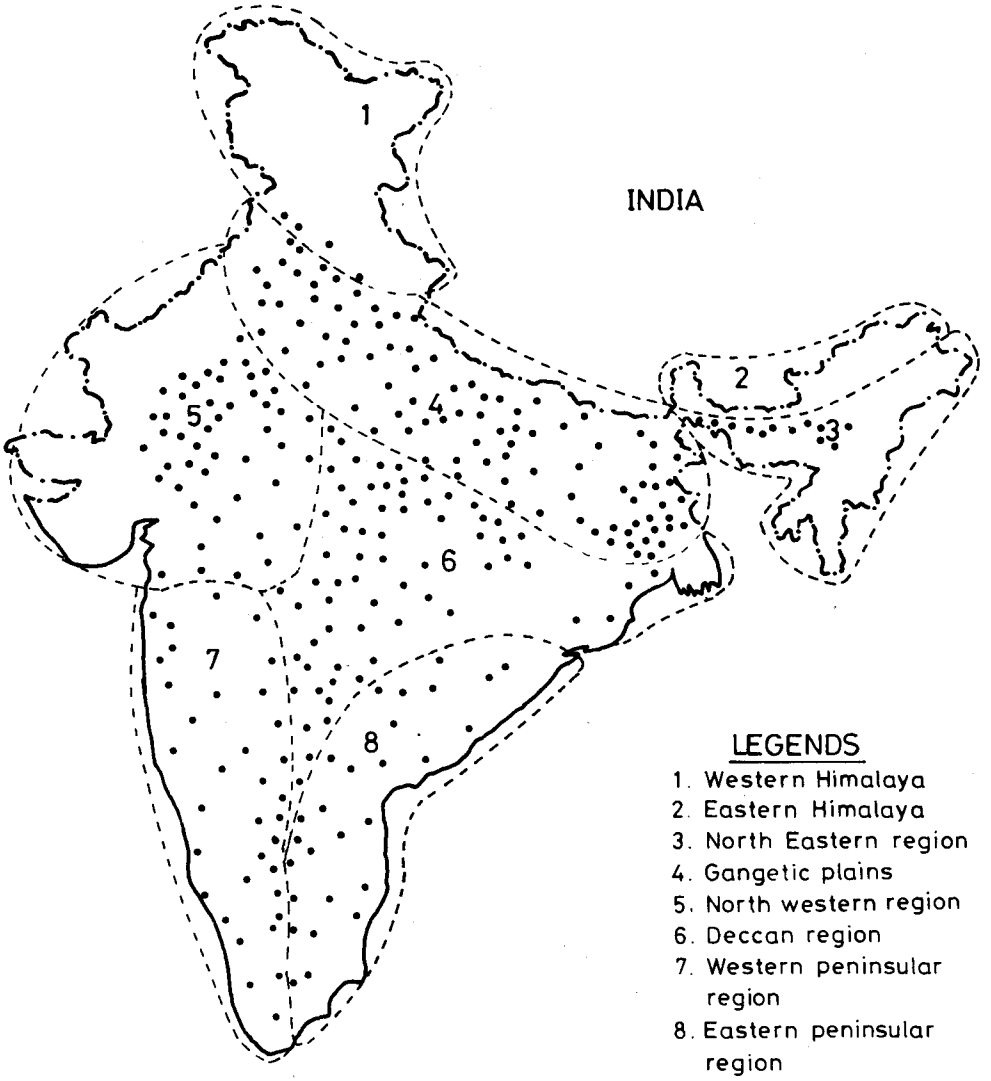


**Fig. 1. Diversity, distribution of *P. corylifolia* in India**

in 1918, *P. odorata* has been reported, however, few workers consider it as a synonym to *P. plicata* while others treat it as a seperate species. On the basis of collection records in various herbaria, literature and field survey, Pandey *et al.* (1983) reported *P. odorata* to be rare in Rajasthan.

*In the world* - Approximately 100 species of *Psoralea* have been stated to be distributed (Hooker, 1973) in both old and new world, however, Santapau and Henry (1984) reported about 130 species. Out of these, some species are *P. canescens, P. cinerea, P. corylifolia, P. glandulosa, P. holosericea, P. lachnostachys, P. leucantha, P. macrostachya, P. martini, P. obtusifolia, P. onobrychis, P. plicata, P. plumosa, P. postulata, P. sensu* and *P. stipulata*. Apart from these, Fig. 2(a and b) shows distribution of some other prominent species in various global megacentres comprising continental and sub-continental occurrence of the genus.

## Secondary metabolites in *Psoralea*

The plant is endowed with effective biochemicals resulting from secondary metabolic pathways. Roots and seeds possess chalcones, flavones isoflavones, furocoumarins and other derivatives. Chief active principle of the seed is a straw-coloured, optically inactive essential oil, however, fixed oil, resin and trace of a substance of alkaloidal nature are also present. The alkaloid identified has been named as vernonine. Rangari and Agarwal (1994) carried out extensive quality control studies on *P. corylifolia* probably towards its refined herbal drug formulation.

Of many secondary derivatives, psoralen and bakuchiol are comparatively more important. Degradation studies by Banerji (1989) revealed that leucine, valine and iso-valeric acid contribute in the synthesis of bakuchiol for its phenyl propane and terpenic part. Cinnamic acid, P-coumaric acid, umbelliferone and marmecin are stated to form molecular backbone in the psoralen synthesis. The prenylation of umbelliferone leading to marmecin in *P. corylifolia* was reported by Innocenti *et al.* (1977).

## Therapeutic potential

Almost whole herb is medicinally useful in indigenous system of medicine, seeds are very useful against various diseases and recommended as analgesic anthelmintic, antibacterial, antifungal, anti-inflammatory, aphrodisiac, diuretic, febrifuge, laxative and stomachic. Local healers, vaidyas and ayurvedic physicians prescribe it against leucodermic affections and psoriasis. Both oral ingestion and paste or ointment are being prescribed understanding the condition of ailment. Normally 1-3 *masas* or 5-20 grains comprise one dose but in the treatment of worm expulsion, the dose is 4-6 *masas*. The drug is so effective against leprotic syndromes that it has been reckoned as *Kushtnashini*

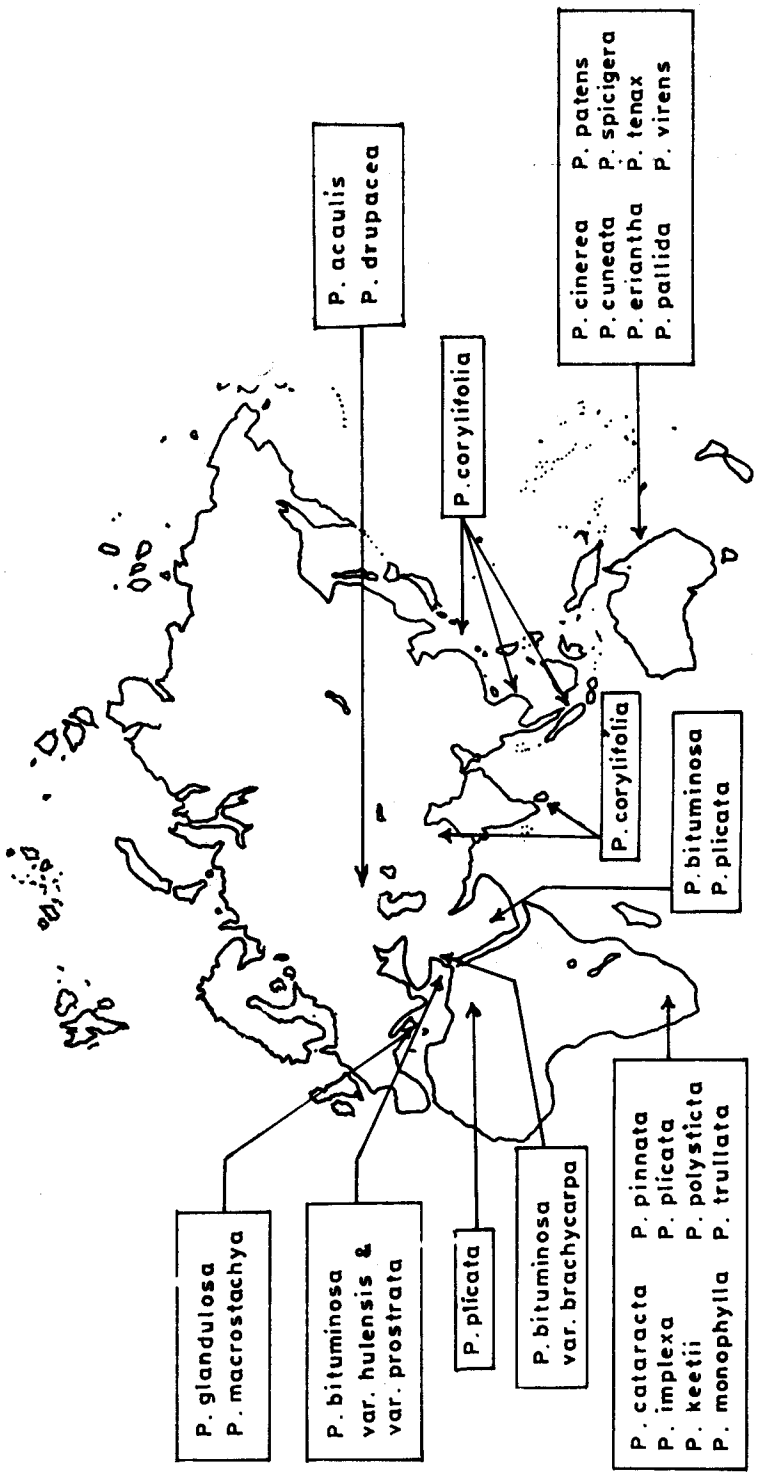


Fig. 2a. Global occurrence of some prominent species of *Psoralea* in Old world

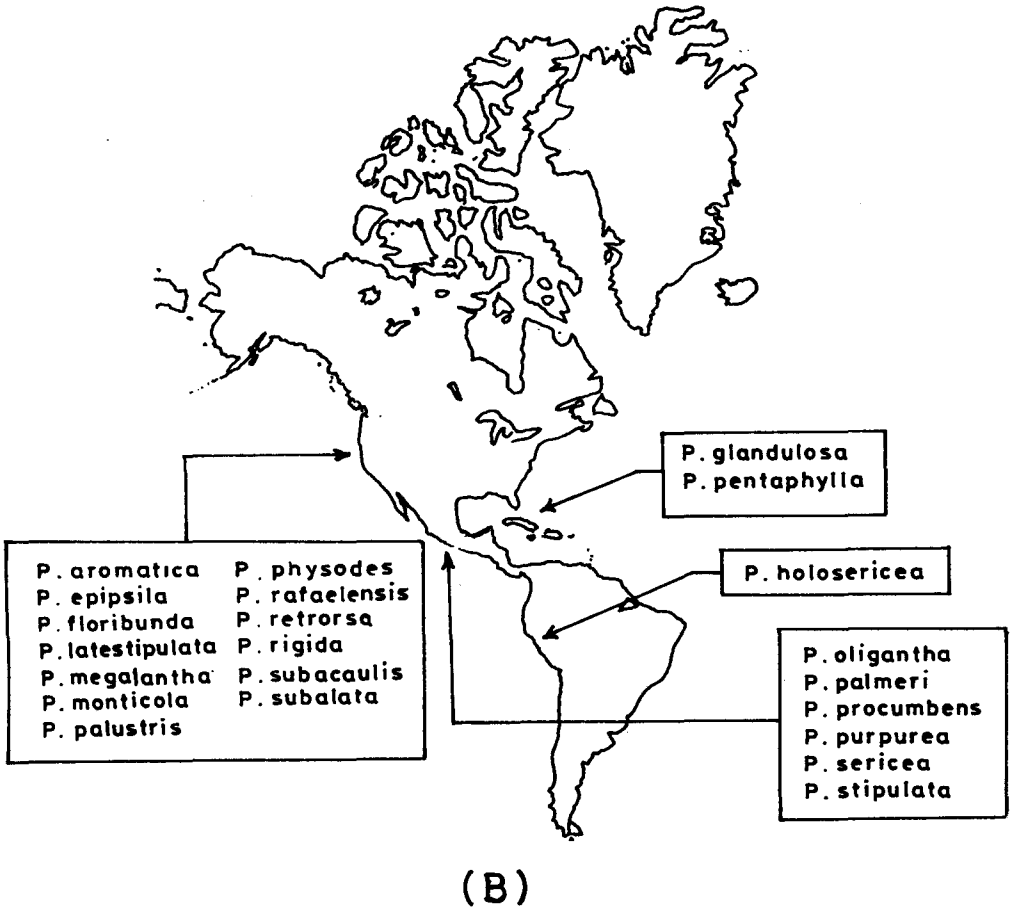


**Fig. 2b. Global occurrence of some prominent species of *Psoralea* in New world**

(Leprosy destroyer). Roots are useful in the caries of teeth while leaves are given in diarrhoeal cases. In scorpion sting, the herb is used orally as well as externally. Against *staphylococcal* infections, it has also proved its effectiveness.

According to Ayurveda the characteristic of pungency promises a good remedy to phlegm disorders (Kaph vikar) and plethora, also good for heart troubles urino-gential problems, scabies and elephantiasis. The plant is also used against the debility of the nervous system. Due to its alleviating properties in the disorders of digestive system like dyspepsia, constipation and liver disfunctioning, it is also known as Vakuchi (wind humour alleviator). Since it has stimulating property, thus, improves and maintains cardiac rhythmicity and swelling in the heart. In respiratory disorders like cough and asthma, its therapy is effectively used. It is one of the ingredients in the oil prepared for massage to alleviate physical sexual weakness. Besides these prophylactic

qualities, Unani system of medicine considered the seeds good for blood diseases, to improve appetite and as an aphrodisiac.

In U.S.A., *Psoraleas* have been recognised in therapy due to stimulating and nervine properties. In Sri Lanka, the seeds are ground with water and the preparation thus obtained is poured in both the nostrils to treat snake-bite, powdered seeds are also given orally.

**Clinical characterization**

Devraj and Bhutani (1994) studied the role of 8-methoxypsoralen from *P. corylifolia* in the treatment of vitiligo in 50 patients, and 26 patients of psoriasis. They found that the patients with psoriasis required treatment for a maximum of three months or it may slightly prolong in severe cases. Ancient phototherapy was combined with phytotherapy by Dolphin (1994) and it was observed that the psoralens after oral ingestion accumulated in the skin tissue and when activated by sunlight caused re-pigmentation of the skin.

The psoralen (PSO), a biochemical derivative from *P. corylifolia* was found to be cytotoxic against *in vitro* cultured human muco-epidermoid carcinoma cells of MEC-1 cell line. It inhibited the growth of MEC-1 cells by 79.1% which was as strong as pigyanmycin (PYM) (Wu *et al.*, 1992), thus, the plant may prove a good source of herbal drug against carcinoma.

Wall *et al.* (1988) isolated a number of known prenylated flavonoides from *P. corylifolia* and studied antimutagenic property. They concluded that most of the isolates were toxic rather than antimutagenic, but the activity of bakuchiol, a prenylated phenolic terpene, as an antimutagen did not show any toxicity.

**Prophylaxis against leucoderma**

In the case of syphilitic origin of leucoderma, the treatment with *Psoralea* oil is not recommended. But in the leucoderma of non-syphilitic origin, the oleoresinous extract is very popular in Indian pharmacopoeia as Babchi oil or ointment. While using crude oil extract from seeds, it is advisable to standardize and adjust the strength in such a way before application that it should not cause any reaction except the redness of leucodermic patches, though manufactured oil is available in the market. This is safe prophylaxis in comparision to oral administration of powdered seed and intradermal injections of essential oil. The oil is preferably better than other skin irritant agents like mercury salicylic acid etc. because it does not produce any change in the dermal tissues of skin.

Ayurveda considered *P. corylifolia* the only effective drug that has double action on the cells of dermal layers of skin. In leucodermic condition, the

melanoblastic cells do not function well and stop to secrete pigment. The oil effectively penetrates into the lymphatic tissues that causes on increase in plasma, and further it stimulates the melanoblasts that results to form and exude the pigment which on diffusion on decolourized areas starts developing normal colour.

### *P. corylifolia* and AIDS

Secondary metabolites of the plants as tetragalloyl quinic acid, arjunolic acid, ellagic acid, β-sitosterol, gallic acid, castanospermine, calanolides, flavonoids, xanthones and polyphenolic compounds are being characterized for their anti-HIV activity. *P. corylifolia* have triggered new clinical research activities not because of its anti-leukemic properties but due to its possible therapeutic potential against the diseases of immune system such as AIDS, its bioactive principle may provide promising results (Duke, 1987). Since seeds of the plant contain essential oil, bakuchiol, resin, flavones and other derivatives, anti-HIV potential in the plant can not be ignored.

### Antibiotic and insecticidal activities

Seed extract of *P. corylifolia* possess strong antibiotic potential causing growth inhibition of different *Staphylococcus* strains as *S. albus, S. aureus and S. citreus*. The skin affection of *Streptococci* and *Paramecia* can be best treated with the essential oil derived from the seeds. Other bacterial strains even resistant to penicilline do not withstand the extract application. Chadha (1986) reported insecticidal (antifeedant) activity with in *Psoralea*. In the roots of *P. corylifolia*, Chintalwar *et al.* (1992) also found antifeedant potential.

### Agrotechnological aspects

In India, the plant is found in weed form, its cultivation at commercial scale is not probably anywhere except stated to be cultivated to some extent in Rajasthan and eastern districts of Punjab. The plant grows well on any average soil and the sowing is performed in lines at the rate of 7 kg per hectare during March-April. Good quality of seeds are produced in Rajasthan. The seeds have staggered germination thus, pose a problem in getting suitable biomass and reproductive yield. This problem can be overcome by *in vitro* strategies, all the same good quality of genetically stable, disease free plantlets may be obtained.

### Germplasm seed conservation

*Psoralea* germplasm seed exhibit orthodox nature hence the same can be conserved by drying the seed to 5% moisture, sealing in moisture impermiable

containers and storing the same in cold room modules at –20°C. Out of a total collection of 40 germplasm lines being maintained at NBPGR, 10 accessions have already been conserved for long term in the National Gene Bank.

**Biotechnological advances**

In France, the hairy root cultures of *Psoralea* were attempted by Nguyen *et al*(1992) in eight species but later concentrated their studies on *P. lachnostachys*. *Agrobacterium rhizogenes* a naturally occurring pathogenic bacterium for plants, was used for raising hairy root cultures. Transformed roots were healthy and grew rapidly in Gamborg B5 liquid medium with a doubling time of 38 hours. Psoralen and angelicin, usually found in the roots of the plants raised in soil, could not be detected in the transformed roots which indicates that these furanocoumarins are translocated from aerial parts of plants to roots. The pathways of translocation of these metabolites need to be studied in detail.

Considering the problematic seed germination resulting in the decreased plant stand and its exploitation in pharmaceutical industry, the micropropagation studies have been undertaken at National Plant Tissue Culture Facility. The *in vitro* raised *P. corylifolia* plants were successfully transplanted in the soil. The plants showed luxuriant growth in the soil conditions.

In future, modern techniques of plant biotechnology like RFLP, RAPD and gene cloning may be fruitful in identifying gene sequence for antifeedant activity of the plant and engineering insect resistant transgenics in crop improvement programmes.

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# METROGLYPH AND INDEX SCORE ANALYSIS OF SOME QUANTITATIVE TRAITS IN *BERBERIS LYCIUM* ROYLE.

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Seeds were collected from seventeen different seed sources within the state of Himachal Pradesh ranging from 900 to 2,600 m above msl. Dharampur (1), Rajgarh (3), Solan (16) and Gohar (14) were among the four top ranking seed sources for eight characters. There were six different morphological complexes recognized on the basis of dry shoot weight per seedling and seedling height. Morphological variation within group was of low magnitude. Majority of the high scoring seed stands were in groups V and VI characterized by higher seedling height and dry shoot weight

**Key words :** Metroglyph, variability, index score, divergence, seed stands

## INTRODUCTION

*Berberis* is a genus mainly of shrubs under family Berberidaceae The genus consists of 280 species distributed throughout the world (Anon 1974). *Berberis lycium* locally known as "Kashmal" is one of the promising source of berberene, a medicinal valued alkaloid. The species has multipurpose utility like fuelwood, fruits, biofence, medicinal and a palatable leaf fodder for sheep and goats during the lean period of summer and winter months. It's roots are used as a good febrifuge, carminative and gentle aperient (Anon, 1976). Roots also act as a good intestinal astringent, cure for cough, chest, throat troubles, eye sores, eye itch, piles and chronic diarrhoea. The genetic resources of this species are depleting fast in Himachal Pradesh because of unscientific exploitation of its roots. With the present pace of exploitation the species is expected to become endangered within a few years. Therefore, an attempt was made to collect the seeds from different altitudes within the state to scan the complex morphological variations for the quantitative traits, further analyze them by reducing into scores and subsequently compare the scores. Metroglyph analysis is one of the tools to analyze such complex variations and assess the

variability. The analysis has been successfully utilized in several agricultural and horticultural crops, but no such information is available on forest tree and/or shrub species. Therefore, an exercise was made to analyze the type of variation existing in this important multipurpose shrub vis-a-vis to conserve *ex-situ* for further utilization in breeding and improvement programmes.

## MATERIALS AND METHODS

The material was collected from 17 seed stands namely Dharampur, Jaunaji, Rajgarh, Kandaghat, Subathu, Sarahan, Palampur, Mandi, Kullu, Chail, Fagu, Shimla, Dharamsala, Gohar, Dalhousie, Solan and Darlaghat areas of Himachal Pradesh within an altitudinal range from 900 to 2,600 m above msl (Fig. 1). Fresh matured berries were collected, depulped and seeds extracted. These fresh seeds were sown in the nursery in three replications without giving any presowing treatment and complete germination was obtained within two months. The data on morphological traits were recorded by selecting 10 random seedlings in each replication for seedling height and other characteristics after one year growth in the nursery (Table 1). The metroglyph and index score analysis was carried out according to the method suggested by Anderson (1957). The class interval for different characters was also calculated (Table 2). The index scores were obtained by assessing numerical values on the basis of range of variability assuming an index score of 1 as lowest, 2 as medium and 3 as highest. The sum total of index score for six characters in each stand was considered as an indication of its total worth and the histograms of the index scores constructed (Fig. 2).

## RESULTS AND DISCUSSION

Mean performance of the seedlings from different seed stands (Table 1), showed that the highest seedling shoot dry weight was depicted by Dharampur (3.12 g), followed by Rajgarh (2.169 g), Solan (1.739 g), Palampur (1.66 g) and Mandi (1.64 g). The lowest shoot dry weight was observed for Darlaghat (0.63 g) followed by Dalhousie (0.68 g), Chail (0.87 g) and Sarahan (0.91 g). Seed stands of Dharampur, Rajgarh, Solan and Gohar were among the top ranking genotypes for most of the characters (Table 1).

The results of the metroglyph analysis drawn on the shoot dry weight and seedling height are represented in Fig. 2. These characters are most important from breeding point of view, therefore, they were used in plotting the glyph. The remaining six characters were represented by symbols at different positions in the glyph (Table 2).

The perusal of the scatter diagram (Fig. 2) depicted that six groups were distinguished on the basis of morphological variations. The first group consisted of four seed stands obtained from Kandaghat, Sarahan, Dalhousie and Darlaghat.

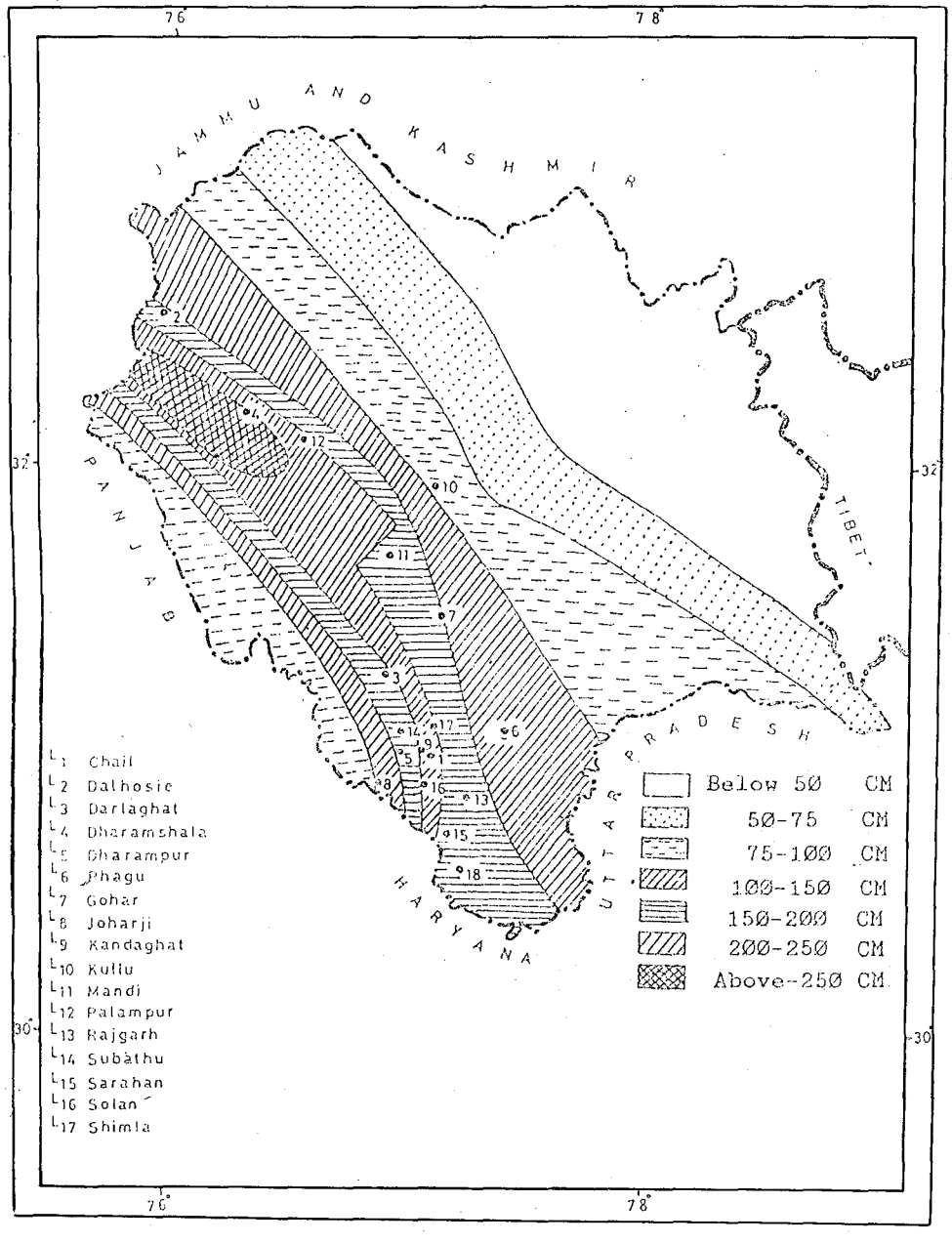


**Fig. 1. Map showing location of *Berberis lycium* provenances in Himachal Pradesh along with rainfall zones**

The stands of this group were characterized by low shoot and root dry weight, minimum seedling height and the score range (6) was uniform and low.

**Table 1. Mean values for eight characters in *Berberis lycium***

| Sr. No. | Provenances | Height (cm) | Diameter (cm) | Number of Leaves | Internodal length (cm) | Shoot fresh weight (g) | Shoot dry weight (g) | Root fresh weight (g) | Root dry weight (g) | Total score |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Dharampur | 16.50 | 0.25(3) | 26.15(3) | 1.73(3) | 6.73(3) | 3.12 | 2.17(3) | 0.99(3) | 18 |
| 2 | Jaunaji | 10.62 | 0.18(1) | 16.80(1) | 0.93(1) | 2.73(1) | 1.18 | 1.10(1) | 0.59(2) | 7 |
| 3 | Rajgarh | 15.28 | 0.20(2) | 20.56(2) | 1.64(3) | 4.85(2) | 2.16 | 1.64(2) | 0.74(2) | 13 |
| 4 | Kandaghat | 8.94 | 0.17(1) | 14.28(1) | 0.82(1) | 2.02(1) | 0.97 | 1.0691) | 0.52(1) | 6 |
| 5 | Subathu | 12.05 | 0.20(2) | 18.78(2) | 1.24(2) | 2.96(1) | 1.35 | 1.42(2) | 0.64(2) | 11 |
| 6 | Sarahan | 7.88 | 0.15(1) | 12.00(1) | 0.7291) | 1.96(1) | 0.91 | 0.87(1) | 0.40(1) | 6 |
| 7 | Palampur | 12.25 | 0.20(2) | 18.42(2) | 1.35(2) | 3.46(2) | 1.66 | 1.3192) | 0.59(2) | 12 |
| 8 | Mandi | 9.66 | 0.17(1) | 13.92(1) | 1.02(1) | 3.4192) | 1.64 | 1.06(1) | 0.49(1) | 7 |
| 9 | Kullu | 10.65 | 0.18(1) | 20.78(2) | 0.97(1) | 2.10(1) | 1.02 | 0.89(1) | 0.42(1) | 7 |
| 10 | Chail | 9.97 | 0.17(1) | 18.31(2) | 0.88(1) | 1.85(1) | 0.87 | 1.18(2) | 0.50(1) | 8 |
| 11 | Fagu | 11.49 | 0.19(2) | 17.86(2) | 1.20(2) | 3.02(1) | 1.45 | 1.20(2) | 0.56(2) | 11 |
| 12 | Shimla | 10.90 | 0.18(2) | 17.51(2) | 1.57(3) | 2.00(1) | 0.97 | 0.98(1) | 0.46(1) | 10 |
| 13 | Dharamsala | 10.00 | 0.15(1) | 16.27(1) | 0.88(1) | 2.08(1) | 0.96 | 0.99(1) | 0.46(1) | 6 |
| 14 | Gohar | 13.71 | 0.19(2) | 22.10(3) | 1.36(2) | 3.07(1) | 1.38 | 1.40(2) | 0.65(2) | 12 |
| 15 | Dalhousie | 8.24 | 0.16(1) | 12.89(1) | 0.77(1) | 1.32(1) | 0.68 | 0.71(1) | 0.36(1) | 6 |
| 16 | Solan | 14.84 | 0.19(2) | 23.01(3) | 1.37(2) | 3.73(2) | 1.73 | 1.41(2) | 0.67(2) | 13 |
| 17 | Darlaghat | 7.86 | 0.15(1) | 13.38(1) | 0.70(1) | 1.37(1) | 0.63 | 0.67(1) | 0.34(1) | 6 |

Values in parenthesis indicate index score for each character at each location

The second group consisted of single stand from Mandi. The score average was 7 which was characterized by low shoot and root dry weight and seedling height. The variation was almost at par with group one.

The third group possessed the genotypes of Jaunaji, Kullu, Chail, Shimla and Dharamsala stands, which comprised better shoot dry weight and seedling height than those of group I and II. However, the group variation ranged from 6 to 10 and the index score ranged from 9 to 13.

The fourth group comprised Subathu, Palampur and Fagu stands was characterized by medium seedling height and dry shoot and root weight. The variation in the score, within the group ranged from 11 to 12. Group five included three representative stands of Rajgarh, Gohar and Solan. It projected

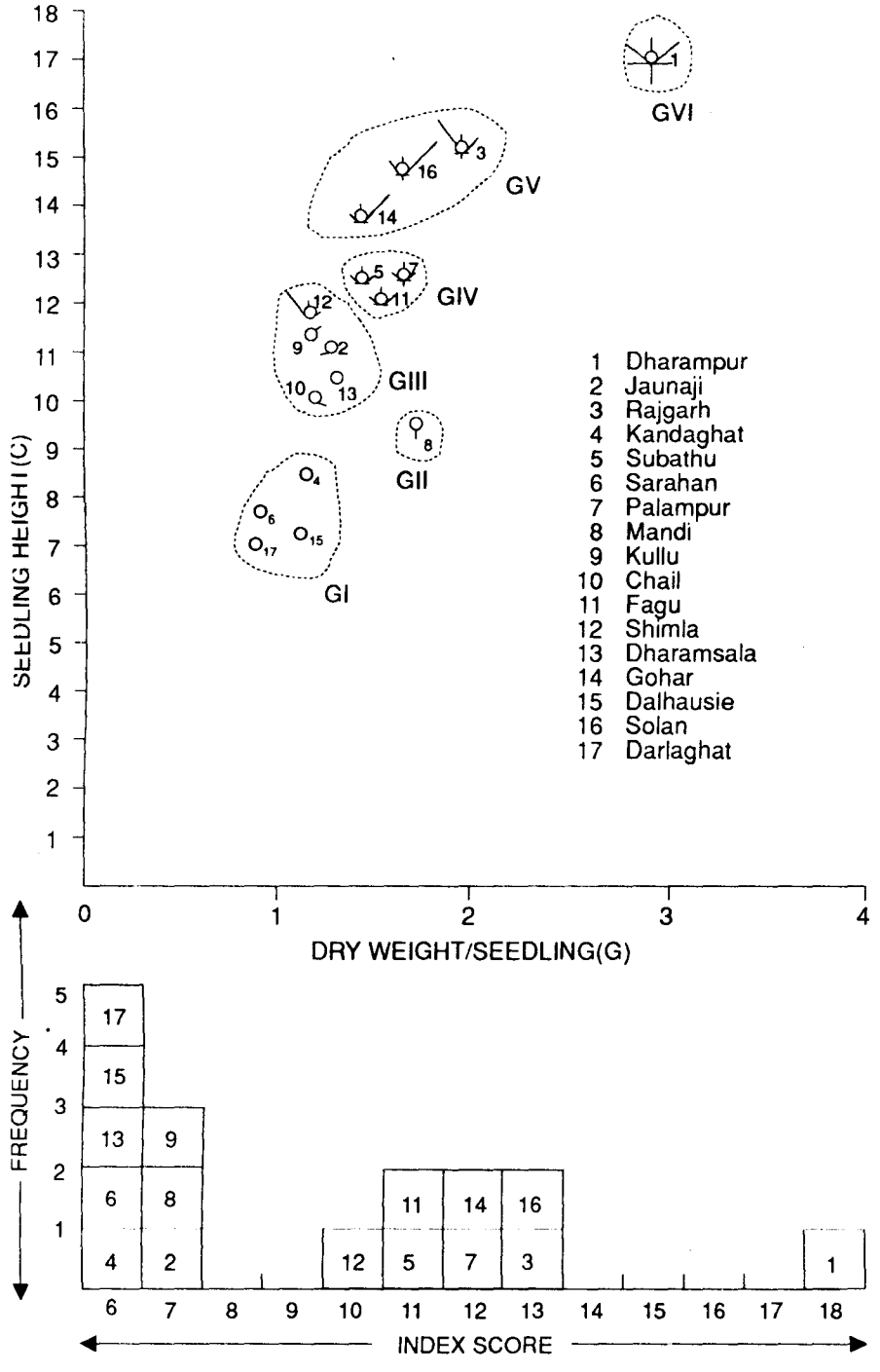


Fig. 2. Scatter diagram of metroglyph representing 17 seed stands of *Berberis lycium* Royal

medium height followed by high shoot dry weight and the index score ranged from 11 to 13 thus indicating the within group variation.

**Table 2. Class intervals, index score values and signs for six characters in seventeen stands of *Berberis lycium***

| Sr. No. | Character | Range of Means | Score-1 value less than | Sign | Score-2 value less than | Sign | Score-3 value less than | Sign |
|---|---|---|---|---|---|---|---|---|
| 1 | Diameter | 0.15 to 0.25 | ≥0.18 | 0 | 0.18 to 0.21 |  | 0.21 |  |
| 2 | Number of leaves | 12.00 to 26.15 | ≥17.00 | 0 | 17.00 to 22.00 |  | 22.00 |  |
| 3 | Internodal length | 0.70 to 1.17 | ≥1.15 | 0 | 1.15 to 1.40 |  | 1.40 |  |
| 4 | Shoot fresh weight | 1.32 to 6.73 | ≥3.12 | 0 | 3.12 to 4.92 |  | 1.40 |  |
| 5 | Root fresh weight | 0.67 to 2.17 | ≥1.17 | 0 | 1.17 to 1.67 |  | 1.67 |  |
| 6 | Root dry weight | 0.34 to 0.99 | ≥0.55 | 0 | 0.55 to 0.76 |  | 0.76 |  |

Group six depicted single genotype from Dharampur which consisted of highest index score value of 18 and was found quite divergent from all other groups. It also reflected highest mean value and index score for all the morphological traits (Table 3).

**Table 3. Group means for eight characters in *Berberis lycium***

| Group | Seedling Height (cm) | Collar Diameter (cm) | No. of Leaves | Internodal Length (cm) | Shoot Fresh Weight | Shoot Dry Weight | Root Fresh Weight | Root Dry Weight |
|---|---|---|---|---|---|---|---|---|
| G1(6) | 8.25 | 15.75 | 13.04 | 0.75 | 1.67 | 0.80 | 0.83 | 0.49 |
| G2(7) | 9.66 | 0.17 | 13.92 | 1.02 | 3.41 | 1.64 | 1.06 | 0.49 |
| G3(9) | 10.43 | 0.17 | 16.73 | 1.05 | 2.15 | 1.00 | 0.85 | 0.49 |
| G4(11) | 12.96 | 0.20 | 18.36 | 1.26 | 3.15 | 1.49 | 1.31 | 0.60 |
| G5(13) | 14.61 | 0.19 | 21.92 | 1.46 | 3.88 | 1.76 | 1.48 | 0.69 |
| G6(18) | 16.50 | 0.25 | 26.15 | 1.73 | 6.73 | 3.12 | 2.17 | 0.99 |

Values in the parenthesis indicate mean index score for the groups

The overall index scores ranged from 6 (Kandaghat, Sarahan, Dharamsala, Dalhousie and Darlaghat) to 18 (Dharampur) indicating wide range of variability between the seed stands. Five seed stands were found in the index score

range of 11 to 13. Thus it can be concluded that the range of variability observed in the present investigation was mainly due to few extreme seed stands. This suggested to generate variability through hybridization and/or mutation for wider spectrum of selection in a productive breeding programme. The study revealed that the seed stands of group IV, Vand VI were divergent and exhibited desired medium to high index scores. These genotypes may be utilized for raising shrubbery of this species while the seeds of Dharampur stand would be ideal donor for raising improved plantations of this shrub as a biofence and/or to improve the degraded and denuded sites in the state.

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# OCCURRENCE, DISTRIBUTION AND DIVERSITY OF SOFT FRUITS IN N-W AND W-HIMALAYA AND PROSPECTS OF THEIR CONSERVATION AND UTILIZATION

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Soft fruits, constituting genera of *Rubus*, *Ribes* and *Fragaria* have rich species diversity in the N-W and W- Himalaya due to the high ecological diversity. There occur 32 species and 4 varieties of *Rubus*, seven species of *Ribes* and four species of *Fragaria*. Some of these have good horticultural potential. Prospects of their commercial cultivation, conservation and utilization have been discussed.

**Key words :** Soft fruits, *Rubus*, *Ribes*, *Fragaria*, Himalaya, species diversity.

India is a country of very rich diversity in edible plants. The under-utilization or even non-utilization of the plant genetic resources in many instances not matching the ever increasing demand of food and nutrition has been causal to its placement in the group of developing countries. Soft fruits present an excellent case of non-utilization of the existing resources. The soft fruits or small fruits is a category of highly perishable fruits which include genera of *Rubus*, *Ribes* and *Fragaria*. The present paper is an attempt to throw light on the existing resources, distribution, diversity and prospects of their conservation and utilization.

## Ecological Diversity

The North Western and Western Himalaya comprises of the states of Jammu & Kashmir, Himachal Pradesh and the Uttarakhand (Uttar Pradesh). The N-W and W-Himalayan ranges have the widest flank and have colder and drier climate. The vegetation is in general drought resistant and cold loving. This part of the Himalaya is constituted of Siwaliks or outer hills,

central (Greater) Himalaya and the trans-Himalaya. Its ecological zones include; (i) warm tropical (below 800m), (ii) warm subtropical (800 to 1200m), (iii) cool temperate (1200 to 2400m), (iv) cold temperate (2400 to 3600m), and (v) arctic or arid temperate (above 3600m). This part of the Himalaya usually receives low rainfall in monsoon but gets heavy snow or rain in winters. The region has contributed a number of species of the genera of *Rubus, Ribes, Prunus, Pyrus, Sorbus, Hordeum, Avena, Cicer, Aegilops, Allium, Cucumis, Linus, Carum, Elymis, Eremorpyrum, Lepedium* and *Viburnum*. Since the climate ranges from tropical through temperate to the tundra type (near snow line), there occurs unique vegetation consisting of extensive stands of pines, deodars, beaches, birches, rhododendrons and sea buckthorn. The soils are also extremely varied. The foot hills and plain valleys have deposits of gravel and coarse sand, alluvial and red loams. On mountains the forest soils are clayey and gravely porous sandy loam rich in humus. Marshy low lying areas comprise peaty soils. The coniferous covered hill slopes have acidic podzols and oak covered areas have brown soils. Leaching of nutrients and soil erosion are the main features of soils on slopy lands. The trans-Himalaya have sandy soils, very low winter temperatures and very scanty rainfall.

**The Specific Diversity**

The north-western and western Himalaya is a suitable habitat and hence is also a rich resources of soft fruit plant species.

1. *Rubus* species : *Rubus* is the most variable and complex genus, widely and predominantly distributed in temperate and warm temperate regions of the northern hemisphere. Focke has described 429 or more species the world over, of which 57 species occur in the Indian subcontinent. The north-western and western Himalayan region contain 32 species and four varieties (taxonomic), which is about 63 per cent of total diversity (Table 1).

The distribution of *Rubus* species shows a wide altitudinal and ecological variation (Table 1). The warm tropical and subtropical climate comprised of deep valleys, low and medium hills with 500 to 2000 m altitude contain eight species and two varieties under *Rubus ellipticus* Linn. Seven species and two varieties of *R. niveus* have distribution in cool temperate mid hills with altitude ranging from 2000m to 2500m above m.s.l. The highest specific number of species (12) however occur in high hills (altitude 2500 to 3000m) with cold climate. In temperate arid climatic conditions of very high hills 3000 m above m.s.l. only five spp. have been found distributed. The two species *R. ellipticus* and *R. niveus* exhibited wide variation for foliar and fruit characteristics.

**Table 1. Distribution and diversity of *Rubus* spp. in different ecological zones of N-W and W Himalaya**

| S.No. | Ecological zone | Altitude range (m) | *Rubus* spp. diversity and distribution |
|---|---|---|---|
| 1. | Warm tropical & subtropical (valleys & low hills) | 500 to 2000 m | *Rubus ellipticus, R.paniculatus, R.almorensis, R.acuminatus, R.ellipticus, Var.hirtus, R.antennifer, R.fasciculatus, R.ellipticus var. denulata, R.noluccanus, R. fruticosus.* |
| 2. | Cool temperate (Mid hills) | 2000 to 2500 m | *R.foliosus, R.ulnifolius, R.reticulatus, R.alpestris, R.niveus var. pauciflorus, R.niveus var. membranaceous, R.hoffneistrianus, R.purpureus, R. clarkei.* |
| 3. | Cold temperate (High hills) | 2500 to 3000 m | *R.biflorus, R.nacilentus, R.pedunculosus, R.barbatus, R.lanatus, R.calycinus, R.nepalensis, R.nutans, R.flavus, R.rosaefolius, R.chambica, R. pungens.* |
| 4. | Temperate arid (cold desert) | Above 3000 m | *R.irritanus, R.niveus, R saxatilis, R.hypagyrus, R.concolor.* |

2. *Ribes* species : About 150 species of *Ribes* occur in temperate and cold regions of the world. In India eight species have been recorded, seven of these are found in the N-W and W Himalayan region (Table 2). In general

**Table 2. Distribution and diversity of *Ribes* species in the N-W and W Himalaya**

| S.No. | Name of Species | Distribution |
|---|---|---|
| 1. | *Ribes alpestre* Wallich ex Decne = *R. grossularia* auct. (non L.) Wall. | Alpine Western Himalaya (2400-3600): Chamba, Kinnaur, Lahaul & Spiti; Ladakh, Kashmir valley |
| 2. | *Ribes emodense* Decne. = *R.rubrum* auct. (non L.) H.F. & T. = *R. himalense* Decne. | Chamba, Kinnaur, Kullu, Lahaul & Spiti, Shimla(Narkanda); Gulmarg (J&K). |
| 3. | *Ribes glaciale* Wall.= *R. acuminatum* Wallich. | Chamba, Kinnaur, Kullu, Lahaul & Spiti, Shimla (Chur peak alt. 3600m) |
| 4. | *Ribes nigrum* Linn. | Lahaul & Spiti, Kinnaur, Gulmarg (J&K); Garhwal and Kumaon. |
| 5. | *Ribes orientale* Desf. | Chamba, Kinnaur, Lahaul & Spiti, Ladakh (J&K), alt. 2100 to 4400 m. |
| 6. | *Ribes takare* D.Don. | Kumaon and Garhwal (2200 to 3300 m). |
| 7. | *Ribes rubrum* Linn. | Shimla, Narkanda (Himachal Pradesh, Kumaon and Garhwal (U.P.), Kashmir, alt. 2400 to 3600 m. |

their most favourable habitat is altitudes above 200 m m.s.l. and cool climatic conditions of Kinnaur, Lahaul & Spiti, Chamba in Himachal Pradesh; Jammu & Kashmir (Ladakh, Gulmarg) and Uttarakhand (Kumaon and Garhwal) of Uttar Pradesh, the species such as *R. alpestre* and *R. orientale* are adapted to low temperature and moisture stress areas. The *R. rubrum* could grow very well in moist and dry localities whereas *R.emodense* grows only in moist situations.

3. *Fragaria* species : The species of *Fragaria* are low growing perennial herbs confined to the north temperate zone and in the high tropical regions of the western Hemisphere. Probably 20 to 25 species occur all over the world. In India five species have been recorded and four of these are found distributed in the N-W and W Himalayan region (Table 3). *Fragaria indica* Andr. grows in moist and shady situations in lower hills and valleys while *F. vesca* is well adapted to high altitudes (2700-2800 m) and dry soil conditions. *F.nubicola* Lindley ex. Lacaita. has a wide range of altitudinal variation (1800 to 3800 m) and is found distributed in Uttarakhand (Nainital, Dewali) of Uttar Pradesh. The Kali valley (2000-3600 m) is a favourable habitat for *F. daltoniana* Gay.

**Table 3. Diversity and distribution of *Fragaria* species in the N and W-Himalaya**

| S.No. | Species | Distribution |
|---|---|---|
| 1. | *Fragaria vesca* Linn. | Kinnaur (Chini alt. 2775 m), Chamba (Pangi, alt. 2800 |
| 2. | *Fragaria nubicloa* Lindley ex Lacaita | Kumaon (Nainital, Dewali, alt. 1800 to 3800 m) |
| 3. | *Fragaria daltoniana* Gay. | Uttarkhand (Kali valley, alt 2000 to 3600 m). |
| 4. | *Fragaria indica* Andr. | H.P. (Bilaspur, Kangra, Hamirpur, Shimla, Mandi); Lower hills and valleys of J&K; Uttarakhand (U.P.). |

## Adaptability Gene Complex

All the species of *Rubus*, *Ribes* and *Fragaria* show considerable variation with respect to their adaptation to different soil conditions (continuous moist rich in organic matter to dry rocky and humus poor sandy soils on hill slopes), low to high precipitation areas, low hills of high mountains, and subtropical temperatures to freezing arctic temperatures. The *Rubus* spp. can be successfully grown on a wide range of soil types. Some species like *R. niveus* have been found to grow even on alkaline soils in the United States.

### Biotic and abiotic stress

Generally no serious diseases and insect pests are observed on the naturally occurring soft fruit species. Among the *Rubus* species, *R.biflorus* Buch-ham. and *R.ellipticus* Sm. could be used as parental lines in breeding for incorporation of disease resistance. *Ribes alpestre* Wall ex Decne. is considered to have moderate resistance to white pine blister caused by *Cronartium ribicola* Fisher., and *R.glaciale* Wall. and *R. orientale* Desf. are said to be immune to white pine blister (Wealth of India).

**Table 4. Classification of *Rubus* spp. on the basis of time of flowering, fruiting and fruit colour**

| | | |
|---|---|---|
| Flowering Time | Jan-March | *R. ellipticus, R.fasciculatus, R.calycinus, R.nepalensis, R. biflorus, R.chambica, R.foliolus, R.nacilentus, R.niveus, R.paniculatus, R.ulnifolius, R.rosaefolius, R.pedunculosus.* |
| | April-June | *R.narbatus, R.acuninatus, R.reticulatus, R. hypagyrus, R.ellipticus var. hirtus, R.niveus var. pauciiflorus & var. nembranaceous, R.hoffnesisterianus.* |
| | July-Sept. | *R.irritanus, R.saxatilis, R.antennifer.* |
| Fruiting Time | April-May | *R.ellipticus, R.calycinus.* |
| | June-July | *R.rosaefolius, R.pedunculosus, R.fasciculatus, R.nepalensis.* |
| | August-Sept. | *R.biflorus, R.chambica, R.foliolus, R.irritanus, R.nacilentus, R.niveus, R.paniculatus, R.saxatilis, R.ulnifolius, R.lanatus, R.acuminatus, R.reticulatus, R.alpestris, R.concolor, R.hypagyrus.* |
| Fruit colour | Orange | *R.biflorus, R.ellipticus, R.irritanus, R.rosaefolius, R.ellipticus* var. *hitrus.* |
| | Red | *R.saxatilis, R.barbatus, R.lanatus, R.acuminatus, R.reticulatus, R.hypagyrus, R.noluccanus, R.calycinus, R.nepalensis, R.hoffneisterianus,* |
| | Pink | *R. pedunculosus, R.nutans.* |
| | Black | *R.niveus, R.paniculatus, R.ulnifolius, R.fasciculatus, R.foliolus.* |

### Attributes of horticultural value

Considerable variability exist for fruit size, shape, colour and juiciness as well as the nutritional contents (Table 4 & 6). *Rubus* species have fruits of

black, red, pink, scarlet and orange colour. The genes for improving the fruit quality could be found in *R. biflorus, R.ellipticus, R.almorensis* and *R.pedunculosus.* The fruit quality in *F. vesca* is as good as the European types. In *F. daltoniana,* fruits are large about 2.5 cm long and have attractive pink colour and were pleasantly flavoured. Similarly the fruits of the indigenous wild spp. of *Ribes* are large and palatable like cultivated European types. The flowering in *Rubus* begins in January and goes upto the end of September while the fruit maturity spreads over six months starting from April to September. The *Fragaria* spp. bear fruits from April to June. The availability of fruits in *Ribes* is mostly in September (Table 4).

**Status of Soft fruits in the Indian Horticulture**

Except strawberry (*Fragaria* cultivars) meagre efforts have been made to grow or to improve genetically either the *Rubus* or the *Ribes* species. The fruits of these are collected from their wild habitats and are consumed fresh by the hill people. Information on their nutritive value is rather scanty. Fruit processing is negligible.

**Prospects of Soft fruits**

The advanced countries such as U.S.A. have achieved good success in the build up of genetic resources, genetic improvement and fruit processing. The small or soft fruits sometimes classified as high value speciality crops have gained industrial prominence in USA. The germplasm collection at the National Clonal Germplasm Repository (NCGR) at Corvallis include *Rubus* (1229 accessions), *Ribes* (717 accessions) and *Fragaria* (976 accessions) whereas in India no efforts have been made to collect even the indigenous diversity existing in these fruit plant species.

By judicious use of the wild germplasm, appreciable work on the genetic improvement aimed at high fruit yield or better fruit quality have been done in the United States and the European countries. Till 1989 in USA there were 49 cultivars of *Rubus* (black berry), 47 cultivars of *Ribes* (currant), 42 cultivars of *Ribes* (gooseberry), 86 cultivars of *Rubus* (raspberry), and 130 cultivars of *Fragaria* (strawberry). Some of the important cultivars among them are given below:

| | |
|---|---|
| Raspberry | Black Hawk, Brandy wine, Cumberland, Bristol, Heritage, Lotham, Royalty. |
| Black berry | Black Satin, Thornless Boysenberry, Darrow, Himalaya Blackberry, Tay berry, Thornfree. |
| Currant | Alpine currant, Cherry, Consort, Red Lake, Wilder. |

| | |
|---|---|
| **Gooseberry** | Pixwell, Poorman, Welcome, Captivator, Oregon Champion. |
| **Strawberry** | All Star, Earliglow, Guardian, Red Chief, Sure Crop, Sparkle, Tristar, Ozark Beauty. |

The annual estimates for the Oregon state of USA for the earnings from the processed fruit products during 1987 were straw berries ($55 millian), black berries ($ 18 millian), rasp berries ($ 19 millian). It is also evident that a single US state (Oregon) has expanded the small fruit cultivation remarkably as is evident from the following table :

**Table 5. Statistics on area, yield/acre, production and total income of small fruits in the Oregon State of USA.**

| Commodity | Area harvested (Acres) | Yield/acre | Production (,000 units) | Total income |
|---|---|---|---|---|
| Strawberries | 7,740 | 12,600 lbs | 98,106 | 28,233$ |
| Red raspberry | 3,650 | 4,330 lbs | 15,809 | 8,027$ |
| Black raspberries | 1,700 | 2,610 lbs | 10,207 | 7,707$ |
| Other berries | 1,268 | - | - | 2,714$ |
| Total | 14,358 | - | 124,122 | 47,283$ |

The above account clearly describes as to how the soft fruit genetic resources have been exploited in the countries like USA. As pointed out earlier, the rich resources of the N-W and W Himalaya offers ample scope for growing soft fruits. The berries not only provide remunerative source for improving the economic conditions of the mountain people, but these have also high nutritional value (Table 5). The fruits of *Rubus* and *Ribes* are rich in minerals Ca, P, K, Fe and vitamins A&C. These could be grown on marginal fertility lands on hill slopes with low inputs. The fruits are either consumed fresh or could be preserved as jellies, fruit sauces, chutney, canned and frozen.

They may be used flavoring to ice cream, pudding, biscuits, toffees. Therefore the soft fruits may provide new opportunities to start cottage or small scale industries in the hills. Ideal conditions exist for the cultivation and commercial exploitation of the fruit plant species *Rubus, Ribes* and *Fragaria* in the hills. This could be possible by introduction of superior improved varieties and simultaneously initiating research on all aspects for the development of these fruit crops. The quality of Wild Himalayan black current fruits is comparable to cultivated European types.

A guide to their cultivation is that raspberries fit apple climates while black raspberries and black berries prefer subtropical (peach climate) conditions. The strawberries suit almost any soil or any temperate climate.

**Ethnobotanical/ Medicinal and Ornamental Uses**

1. *Rubus ellipticus* Linn. : Juice of young tops is given to cure tonsilitis in children. Ripe fruits are rich in minerals like K, Fe, P and Na (Singh, 1995) hence can be used to treat deficiency symptoms.

2. *Rubus fruiticosus* Linn. : Decoction of root is useful for relaxing bowels and dysentry and against whooping cough in its spasmodic stage. Infusion of leaves is beneficial to control diarrhoea and bleeding. Leaves contain lactic, succinic, malic and oxalic acids. Wild fruits contain cyanidin- monoglucoside (W.I.).

3. *R. moluccanus* Linn. : Leaves are astringent, emmengogue and abortificient. Fruits (ripe) are useful remedy for nocturnal micturition in children (Chopra, Nayar, Chopra 1986). Ripe fruits are also considered beneficial for liver ailments in children. Young shoots effectively cure pneumonia (Dutta, 1985). Paste of roots is applied on cuts for checking bleeding and to prevent swelling (Maikhuri & Gangwar, 1993).

4. *Ribes nigrum* Linn. : A decoction of leaves and top shoots is considered to be a home cure for coughs. Leaves are also said to have diuretic properties. Fruits are very rich in vitamin C K(372 mg/100g), and minerals Mg (17 mg/100g), and Ca (60mg/100g). They are also a good source of flavonoids (Kaempoferol, guercetin & myrcetin).

5. *Ribes orientale* Desf.: Fruits are said to have good purgative properties (Wealth of India).

Besides, *Rubus* and *Ribes* have value as ornamentals. The *Rubus* also serve as a good fence for preventing the entry of animals. The species, which have value as ornamental, are *R. ellipticus, R. barbatus, R. paniculatus, R. rosaefolius.*

**Research Needs**

The soft fruit (small fruit) crops except strawberry have received little attention in the Indian subcontinent where they offer good scope for exploitation. There is urgent need to undertake intensive research for developing technologies to suit different agro-ecological zones of the hills. The research thrusts must be laid on the following :

(1) Genetic improvement to evolve superior varieties to the local agro-climates.

(2) Collection, evaluation, documentation and conservation of germplasm of *Rubus*, *Ribes* and *Fragaria* species from India and abroad.

(3) Introduction of elite cultivars from the USA and European countries either for direct use or using as parental lines.

(4) Standardization of agro-techniques for the soft fruit crops.

(5) Research on pathological and entomological problems.

**Table 6. Nutritional value of soft fruits**

| Name of Berry | Edible portion (%) | Water (g) | Protein(g) | Fat(g) | Minerals(g) | Fibre (g) | Carbohydrates (g) | Ca (mg) | P(mg) | Fe (mg) | Vit.A (mg) | Thiamine (mg) | Riboflavin (mg) | Niacin (mg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Black berry (*R. fruticosus*) | 100 | 87.2 | 1.3 | 0.5 | 0.5 | 3.8 | 6.7 | 30 | 20 | 4.3 | 7.0 | - | - | 20 |
| Black currant (*Ribes nigrun*) | 98 | 18.4 | 2.7 | 0.5 | 2.2 | 1.0 | 75.2 | 130 | 110 | 8.5 | 21.0 | 0.03 | 0.14 | 0.40 |
| Rasp berry (*R. ellipticus*) | - | 84.6 | 1.0 | 2.1 | 1.8 | 0.1 | 10.6 | 40 | 110 | 2.3 | 1248 | - | - | 0.80 |
| Straw berry (*Fragaria vesca*) | 96 | 87.80 | 0.7 | 0.2 | 0.4 | 1.1 | 9.8 | 30 | 30 | 1.8 | 18 | 0.03 | 0.02 | 0.20 |

Source: Nutritive value of Indian foods, NIN, Hyderabad.

(6) To explore possibilities of their diversification to apple belts.

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# SOME MINOR FRUITS OF ROSACEAE: DISTRIBUTION, DIVERSITY AND USE IN INDIAN HIMALAYAS

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The Himalayan region is endowed with rich genetic diversity in temperate fruits. Several species of family Rosaceae are available locally. Many of them are also cultivated or found as semi-domesticated types in the areas of their distribution. In some genera like *Prunus*, *Pyrus*, *Rubus*, *Fragaria* and *Malus* a large number of wild species have not only contributed towards food but also are a rich wild gene pool for important traits. With drastic increase in the world population, there is a great need to explore newer sources of food and in this context, the diversity available in minor/lesser known fruits of the family Rosaceae, available in this region along with a brief description of chief types among them has been discussed. A check-list of species with botanical names, popular names/common names is included as Appendix. This information will be useful in screening for newer sources of food in this region both for present and future needs.

**Key words :** Rosaceae, minor fruits, *Prunus*, *Pyrus*, *Rubus*, *Fragaria*, distribution, diversity, uses

Minor fruits have their importance mainly in the areas of their occurrence. Due to diverse climatic and physiographic diversity, the Himalayan region has tremendous wealth in terms of wild fruits and less known edible plants. In the temperate region, economically more important families, yielding edible fruits from the wild and cultivated species are - the Rosaceae, Saxifragaceae, Caprifoliaceae, Cornaceae and Berberidaceae. In Rosaceae, apart from cultivated fruits, enormous diversity occurs in semi-domesticated and wild types in local pockets and such types have been selected locally by native people as part of their routine food requirements. Several examples of vitamin C rich fruits include wild apples, roses, *Crataegus*, *Cydonia*, *Rubus*, etc. Many important wild fruits such as *Prunus*, *Pyrus*, *Sorbus*, *Docynia*, *Rubus* are locally consumed. Native types in *Malus*, *Prunus*, *Pyrus*, *Rubus*, *Fragaria*, *Duchesnea* are edible as a part of their regular diet also. Consumption is usually in the ripe form of fruits, raw or in pulp form or sliced, sun dried or made into drinks and other beverages. The kernels of selected wild types such as *Prunus armeniaca* and *Prunus persica* are sweet, highly nutritious and form an important supplement in day to day food/calories requirements. As such no special attention has

been laid on specific breeding or cultivation/evaluation programmes for these types. The wild gene pool possesses important traits and may be exploited both by direct selections or breeding, besides being useful as root-stock.

## DISTRIBUTION AND DIVERSITY

A large number of rosaceous species form a part of the Himalayan flora extending from the sub-temperate to alpine zone. Of a total of 278 representative species in Rosaceae in India about 67 species belonging to 37 genera are cultivated. 211 species occur wild and many of them are valued as wild economic fruits. 28 species in 9 genera are cultivated for fruits of which 23 species are in cultivation on a major scale. Among fruit yielding genera, tribe Pomeae consists of large number of species, followed by the tribe Pruneae. Less known/wild edible rosaceous fruits are represented mainly by 16 genera (see Appendix). Of these *Prunus, Pyrus, Malus, Docynia, Eriobotrya, Rubus, Sorbus, Rosa* and *Stranvaesia* show narrow distribution restricted to Indian region from north western and north eastern region mainly. Species such as *Prunus nepaulensis, P. jenkinsii, P. rufa, P. undulata, Pyrus kumaoni, Malus baccata* var. *himalaica, M. sikkimensis, Fragaria daltoniana, Rubus ellipticus, R. lineatus, R. mollucanus, Docynia hookeriana* and *D. indica, Pyracantha crenulata, Rosa webbiana, Pourthiaea arguta* are also available in the central Himalayas and adjoining areas of Nepal, Sikkim and Bhutan. Several species such as *Prunus undulata, P. jacquemontiana, Malus baccata, Fragaria vesca, Rubus saxatilis, Photinia integrifolia, Rubus rosaefolius, Sorbus aucuparia, Rosa foetida, R. brunonii* are distributed beyond Himalayas upto south east Asia in east and Afghanistan and further westwards. Species endemic to this region include *Pyrus pashia, P. kumaoni* and *P. jacquemontiana, Eriobotrya dubia, Malus baccata* var. *himalaica, M. sikkimensis, Sorbus cuspidata, S. lanata, Rosa gigantea* and *Stranvaesia nussia*. Tremendous variability is prevalent in wild types in branching pattern, maturity of fruits, fruit bearing; shape and size, colour and quality of fruits.

## IMPORTANT MINOR FRUITS

### *Prunus* spp.

Most of the Indian species inhabit hilly and cold climate areas but some species are naturalised and found usually between altitude ranging 760-3600 m. Of the 35 species in this genus in India, about 8 are wild economic types utilised as fruits. Some of them are cultivated on small/local scale. The acidic fruits/drupes of *P. nepaulensis* and *P. jenkinsii* are edible. In *P. cornuta* the drupes are red and with thick stone, var. *cornuta* is distributed throughout the Himalayas and Tamil Nadu whereas var. *vilosa*, with small drupes, is less commonly available.

*P. cerasoides*, the Himalayan Wild Cherry, is a common tree in north western Himalayas. The drupes are 4-5 mm, ovoid, var. *majestica* possessing large drupes (12-15 mm), with a bitter pulp. *P. undulata*, with 2 mm long hypanthia (persistant in fruit) has edible drupes. The fruits are 20 × 10 m, with pointed apex, glabrous and purplish black. *P. rufa* drupes are ellipsoid, glossy, red, bitter in taste. Types are known with hypanthia and petals glabrous or hairy in lower half or at base. *P. prostrata* has drupes (8-6 mm), ellipsoid, red on ripening. Although the pulp is scanty, yet the fruits are consumed. *P. jacquemontii*, with serrated stipules and red, subglobose, fleshy drupes is edible.

Wild forms of *P. armeniaca* (wild apricot, *chuli* ) and *P. persica* (wild peaches) are also gathered and used for edible purpose in the Himalayan region in dried or raw form particularly the former species. Besides, *P. carmesina*, *P. undulata*, *P. tomentosa*, and *P. venosa* are also exploited for edible fruits.

### *Pyrus* spp.

The genus is represented by 22 species of which 6 occur in India between 700-3000 m altitude. Of the three wild/lesser known species, the most favourite is *P. pashia* which occurs wild and also as semi-domesticated/cultivated species in the western, northern and eastern region is also reported from Nilgiris. The poor quality fruits are gritty, dark brown and pyriform (20-40 mm) with white raised dots; it is used as root stock for cultivated pear. The apple shaped, hard, bitter fruits are edible when half-rotten. Other two species *P. kumaoni* and *P. jacquemontiana* (very similar to *P. pashia*) possess fruits with smooth skin. These species are related to *P. pashia*. Of all the wild edible *Pyrus* and *Prunus* species, fruits of *P.kumaoni* are the tastiest. It is frequently used as root-stock on pear.

### *Malus* spp.

Of the 35 species, 5 occur in the Himalayan region between 1650-3300 m. *M.baccata*, the Siberian Crab Apple (*Jangli Seb*) a tree found in western Himalayas, occasionally cultivated in the valleys of north-western and eastern hills is small round headed tree, with sub-globose (10-30 mm), red, scarlet, yellowish/creamish fruits. It shows wider distribution in its wild and naturalised forms in north-eastern region with variability in fruit size, branching and resistance to diseases, insects/pests, cold hardiness, etc. It is often raised as an ornamental, or used in breeding of cultivated apple. The fruits astringent before cooking or are made into preserves.

An Indian wild crab apple, *M. baccata* var. *himalaica*, the Himalayan Crab Apple, with smaller, edible fruits, distributed from north-western to central Himalayan region is used as stock for commercial apple in low rainfall areas

for imparting resistance against diseases and pests. In Lahaul areas its true apple flavoured fruits are edible. Another endemic crab apple, *M. sikkimensis*, is an apomictic species which occurs at high altitudes of central to north-eastern region. It is locally used as an edible fruit and for root stock of *M.baccata*. The fruits are more woody and much larger than former species. It is good as steamed food.

**Table 1. Nutritional values of some minor Rosaceous fruits of India***

| Species | Moisture | Protein | Fats | Minerals | Fibres | Carbohydrates | Vitamine(%) | Others |
|---|---|---|---|---|---|---|---|---|
| *Prunus armeniaca* | 19.4 | 1.6 | 0.7 | 2.8 | 2.1 | 73.4 | - | Vit A |
| *Cydonia oblonga* | 85.7 | 0.3 | 0.1 | 0.3 | 1.7 | 11.9 | 1 | - |
| *Crataegus oxyacantha* | - | - | 0.76 | - | - | 35.0 | 0.15 | - |
| *Pyrus pashia* | - | 1.8 | - | - | - | 3.3 | 0.32 | - |
| *Fragaria vesca* | 87.5 | - | 14.3 | - | - | 3.75 | - | - |
| *Rubus fruticosus* | 87.2 | 1.3 | 0.5 | 0.5 | 3.8 | 6.7 | 0.9 | Vit A Calcium, Phosphorus, Iron |
| *Rosa foetida* | - | - | - | - | - | 20 | 3.3 | - |
| *R.macrophylla* | - | - | - | - | - | - | 78.7 | |
| *R.webbiana* | | | | | | | 8.0 | |
| *Sorbus aucuparia* | - | - | - | - | - | - | 0.56 | |

*Data compiled from WIth India (1948-1972) and Gopalan *et al.*, 1987

### *Sorbus* spp.

It is represented by 100 species of which 13 are available in India with maximum concentration of diversity in north-western and eastern region. *S.aucuparia* and *S. cuspidata* are distributed in the temperate Himalayas at high altitudes. *S. aucuparia*, a small moderate sized tree from western temperate Himalayas from Kashmir to Kumaon (3500-4000 m) shows variants/forms in fruits and flowers characters. The fruits are round to globose (10 mm), bright red (sometimes white in European types) and are used for extracts, syrups, juices, brandies, marmalades, also as scarcity fruits. Candied fruits are good source of vitamins (see table). The fruit concentrates have vitamins as high as 240 mg/100 gm as compared to candied types (30-40 mg/100 gm). It is used as an ornamental species also in Indian gardens.

*S. lanata*, a moderate sized deciduous tree, is distributed between 2300-3000 m altitude in the temperate Himalayas. It yields globose, red, pyriform (10-30

mm) fruits. The leaves are used as fodder in temperate Himalayas. *S.cuspidata,* a deciduous tree at 2700-3000 m altitude yields fruits which are globose (15-20 mm), reddish-brown with spotted skin. They are much relished in eastern region in same way as that of the *S.aucuparia* and *S.lanata* in the north-western region. It is also cultivated as an ornamental species.

*Docynia* spp.

Of 6 species, two occur in India. *D. indica,* an indigenous species is also cultivated in the temperate region of eastern Himalayas. The yellow green, pyriform-ellipsoidal, pomaceous (25-50 mm) fruits are acidic and eaten raw/cooked. The fully ripe fruits have quince-like flavour. Its wild related species *D. hookeriana* occurs in Khasia region of eastern Himalayas with high variability in habit and flower colour. It is exploited for edible fruits and wood used for tool handles.

*Eriobotrya* spp.

Of 30 species, 9 occur in India. *E. angustissima* and *E. dubia* are used for wild edible fruits. These two endemic species are available from central to eastern Himalayas. *E. angustissima,* an evergreen shrub, grows gregariously on banks of streams in Khasia, Jaintia and Garo Hills in the eastern parts (1700 mm). It yields pyriform, speckled berries which turn yellow on ripening and are edible. The second species *E.dubia,* a small tree from central and eastern Himalayas (1700-2100 m), also yields edible fruits. The fruits of *E. bengalensis* are insipid and not much relished.

*Crataegus oxyacantha*

The distribution of *C. oxyacantha* extends from north-western temperate Himalayan region upto 2000-3900 m and westwards beyond Europe. The liquor extracts from scarlet coloured fruits is used in cure of the heart diseases. Several forms differing in foliage, flesh and fruit characters are available in this region. The Indian Himalayan types yield better fruits than those of the European types. Hawthorn marmalade is prepared from the fruits which is a high vitamin C source (1.5 mg/gm). The fruit flesh contains citric acid, tartaric acid and crataegus acid, pectin and fatty acids. They are made into preserves.

**Other types**

Diversity is well represented in other wild economic taxa such as *Rubus* and *Fragaria.* In *Rubus,* the Yellow Himalayan Raspberry, *R. ellipticus,* widely occurring in the Himalayas and Western Ghats yields one of the best wild fruits of India and is used in breeding for fruit size, disease and heat, drought

resistance. The fruits of *R. mollucanus* a species occurring in the eastern and peninsular region has better quality but smaller cherry sized fruits. *R. niveus* from Himalayas and peninsular region has black, sweet, juicy fruits and is consumed directly or in processed form. The species is grown commercially. *R. rosaefolius*, primarily an ornamental species is also exploited for its beautiful red/orange red, large, succulent fruits. In *Fragaria, F. vesca* and related species *F. nubicola* from temperate Himalayas; *F. nilgerrensis* from Khasi and Nilgiris also yield deliceous edible fruits.

Besides the above mentioned species, several other taxa such as *Photinia integrifolia, Potentilla anserina, Pyracantha crenulata, Pourthiaea arguta, Stranvaesia nussia, Sanguisorba minor, Duchesnea indica* are exploited for edible fruits. Hips of several species of wild roses such as *Rosa foetida, R. microphylla, R. webbiana, R. sericea, R. gigantea* and *R. foetida* and *R. webbiana* are rich source of vitamin C. *R. gigantea*, an endemic rose from Manipur is a source of commercial rose hip from the wild population. *R. sericea* and *R.microphylla* fruits are eaten raw when over-ripe and also processed into sauce.

## ETHNOBOTANICAL USES

Wild plants of economic value have played an important role in the lives of tribal people. Several local plants, perennial trees/bushes are regular part of their diet supplement. They are either collected directly from the wild or cultivated/protected as backyard cultigens by the native people which include species of *Rubus, Prunus, Sorbus, Malus, Pyrus, Rosa, Docynia hookeriana, D. indica, Eriobotrya angustissima, Fragaria* spp., *Prunus jenkinsii, P. nepaulensis, Rubus* spp., *Sorbus* spp., which commonly occur in areas surrounding local habitation particularly in the north western and eastern Himalayas.

There are several forms in which fruits of these species are consumed, viz. as raw/ripened in *Crataegus, Docynia, Duchesnea, Eriobotrya, Fragaria, Malus, Pourthiea, Prunus, Rubus, Rosa*; over-ripened/half - rotten in *Pyrus kumaoni, P.pashia, Rosa microphylla, Sorbus aucuparia, S. lanata*; processed as beverage, sauces, jams/jellies or for brewing in *Prunus armeniaca, P. cornuta, Rosa sericea, Rubus ellipticus, R. niveus, Docynia hookeriana*. Several species are also exploited to the level of commercial exploitation and are marketed from wild/semi - domesticated source, viz. *Docynia indica, Prunus nepaulensis, Rubus niveus, R. ellipticus, Rosa gigantea, R. webbiana, R. foetida* and *Malus baccata*.

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## APPENDIX

### Wild Edible Fruits of Rosaceae in India : A Check-List

**Crataegus oxyacantha* Linn. English Hawthorn

*Docynia hookeriana* Decne.; **D. indica* (Wall.) Decne. Indian Crab Apple.

*Duchesnea indica* (Andr.) Focke syn. *Fragaria indica* Andr. Indian Strawberry, *Bhiu-Kaphal, Kiphaliya.*

*Eriobotrya angustissima* Hk. ; *E. bengalensis* Hk. f.; *E. dubia* Decne.

*Fragaria nubicola* Lindl. *ex* Lacaita *syn. F. vesca* L. var. *nubicola* Lindl. Alpine Strawberry; *E. vesca* Linn. Perpetual Strawberry, Alpine Strawberry; *F.nilgerrensis* Schlecht. Nilgiri Strawberry; **F. daltoniana* Gay.

**Malus baccata* (L.) Borkh. Siberian Crab Apple; **Malus baccata* var. *himalaica* (Maxim.) Schneid. Himalayan Crab Apple; **M. sikkimensis* (Hk. f.) Koehne.

*Pourthiaea arguta* Decne.

*Photinia integrifolia* Lindl; **Prunus armeniaca* Linn. Wild Apricot, *chuli; P. carmesina* Hara syn. *P.cerasoides* var. *rubea* C. Ingram. Carmine Cherry; **P. cerasoides* D. Don *syn. P. puddum* Roxb. *ex* Brandis *non* Miq. Himalayan Wild Cherry, *Paddam, Phuya; P. cornuta* Steud. *syn. P. padus* Hk. f. *non* Linn. Himalayan Bird Cherry; **P.jacquemontii* Hk. f. *Kursang, Targui; P. jenkinsii* Hk. f.; **P. nepaulensis* (ser.) Steudel; **P persica* (L.) Batsch. *Aru,* Wild Peach; **P. prostrata* Labill.; *P. rufa* Steud. *ex* Hk. f.; *P. tomentosa* Thun, *P.venosa* Koehne. *Gadh-ara, Aria ; P. undulata* Buch.-Ham. *ex* D.Don. *Mauli, Lali, Lik-kung.*

*Pyracantha crenulata* (D. Don) Roem. *syn Crataegus crenulata* Roxb. *Ghingaru.*

*Pyrus kumaoni* Decne; **P. pashia* Buch. -Ham. *ex* D. Don. *Mehal. Mol,* Melu; *P.jacquemontiana* Decne.

*Rosa brunonii* Lindle. Himalayan Musk Rose, *Kujji, Karer.; R. gigantea* Collett. Manipur Wild Tea Rose.; **R. foetida* Herrm. Austrian Briar.; *R. macrophylla* Lindl.; *R. sericea* Lindl. *Chapala, durkunja;* **R. Webbiana* Royle.

*Rubus assamensis* Focke.;**R. barbatus* Edgew. *syn. R. nutans* Wall. exes Eddgew. *Sinjang; R. biflorus* Buch. -Ham. ex Sm. Himalayan Yellow Cherry.; **R. ellipticus* Sm. Himalayan Yellow Raspberry.; *R. fruticosus* Linn. var. *discolor syn. R. discolor* Weihe & Nees. The Blackberry or Bramble, Alish.; *R. lanatus* Wall. *Hisalu; R. leucens* Focke;**R. lineatus* Reinw.; *R. macilentus* Camb. *Anchu, Insula Rajalu.;* **R. moluccanus* Linn. The Black Cherry, *Katsoi;* **R. niveus* Thunb. syn. *R. lasiocarpus* Hook. f. Ceylon Raspberry, Mysore Raspberry, Mahabaleshwar Raspberry, *Kala hisalu, Kala anchu.; R. pedunculosus* D. Don. *syn. R. niveus* Wall. *Pila Hisalu.; R. paniculatus* Sm. *Kala hisalu.; R. rosaefolius* Sm.; *R. rugosus* Sm. *syn. R. moluccanus* Sm.; *R glandulifer Balak; R. gracilis* Roxb.; R. *nepalensis* Kuntz.; *R. pentagonus* Wall.; *R. calycinus* Wall., *R. insignis* Hk. f.; *R. panculatus* Sm.; *R. treutleri* Hk. f.

**Sorbus aucuparia* Linn. *syn. Pyrus aucuparia* Gaertn. Mountain Ash, Baltal; *S. lanata* (D. Don) S. Schauer *syn. Pyrus lanata* D. Don *Galion, Mauli, Pahi.;* **S. cuspidata* (Spech.) Hedlund *syn. Pyrus vestita* Wall. *ex* Hk. f. *Mauli,* Himalayan White Beam.

*Stranvaesia nussia* (D. Don) Decne. *Gadhmela, Garhmehal.*

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*Most popular edible species

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# COLLECTION OF RICE GERMPLASM FROM ADILABAD DISTRICT, ANDHRA PRADESH, INDIA

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In an exploration undertaken in Adilabad district of Andhra Pradesh a total of 107 accessions of rice and nine wild *Oryza* species were collected from 41 sites. A wide range of variability was observed in plant and panicle morphological characteristics. The germplasm was observed to possess tolerance to abiotic stress in addition to kernal quality. A number of landraces of rice grown in the region were sampled.

**Key Words :** Collection, landrace, rice germplasm

Andhra Pradesh has been identified as an ecological area, rich in rice germplasm with tolerance to abiotic stresses (Chang and Perez, 1975). The national priority for exploration and collection for rice is also high (Anonymous, 1980). In order to collect and conserve the prevailing endemic genetic diversity in rice, a survey was undertaken by the National Buerau of Plant Genetic Resources (NBPGR), Regional Station, Hyderabad in November, 1994 in the Adilabad district of Andhra Pradesh in collaboration with Andhra Pradesh Agricultural University (APAU), Agricultural Research Station, Maruteru.

## MATERIALS AND METHODS

### Agro-Ecology

Adilabad, the northern most district of Telangana region in Andhra Pradesh, is hilly, and bordering with Maharashtra state. It is inhabited by Savaras, Gonds and other tribals. The district is divided into 52 Mandals and half of the area is covered by forests. Ninety two per cent of the cultivated area is rainfed (Anonymous, 1990). Rice is mainly grown as a rainfed crop

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under subsistence conditions. The farmers still predominantly grow traditional varieties which have been, over a period of time, well adapted to the conditions and are resistant to moisture stress, diseases and pests and require very low inputs.

The explored area is an intermittently semi-wet and dry, an average annual rainfall between 900-1150 mm. The mean annual temperature varies between 21-37°C. The soil was mainly black clay.

### Collection Strategy

An intinerary was prepared for the collection of the rice germplasm in consultation with research institutes, Andhra Pradesh state Department of Agriculture, Hyderabad and the areas covered are given in Fig. 1. Farmer's field was taken as a unit area and random samples from the populations and biased samples of the elite material were collected (Chang, 1976, Chang *et al.* 1972, Pandravada and Reddy, 1990). Germplasm samples were also collected from threshing yards and farm stores. Each germplasm sample was given a collector number and passport information was also recorded.

## RESULTS AND DISCUSSION

A total of 107 accessions of rice germplasm were collected from 41 sampling sites. The important land races collected were, *Budivivadlu, Cherukuluchchalu, Chinnaluchchalu, Dhaniyamvadlu, Erravadlu, Garikalu, Moddugarekalu, Mukkasolalu, Nallavadlu, Palalutchalu, Pisodeelu, Polalavadlu, Regadivadlu, Tellavadlu, Vattedlu,* etc. and the characteristics are given in Table 1.

*Variability observed*

Rich variability was observed in maturity duration of rice germplasm varying from (60-150 days), penicle length, compactness; number of grain/penicle, and other seed characteristics. Most of the cultivars are grown as rainfed except few which are under semi-irrigated/irrigated conditions. As per the height, the cultivars has been classified into medium-tall and tall groups. Majority of the cultivars fall under medium-tall category. The glume colour is mainly brown, black, red and in different combinations of the above colours. The landrace, Dhaniyamvadlu (SMS-4150) possessed brown glumes with blackish-purple tips. Among the germplasm collected, 40% possessed awns. Variability in awn colour was also noticed.

Variability in grain shape and size includes very long slender, long slender, long bold, medium-long slender, medium-long bold and short bold types. The kernel colour varied from white to red. The yield potential of the germplasm varied from 2-19 quintals per acre as reported by farmers.

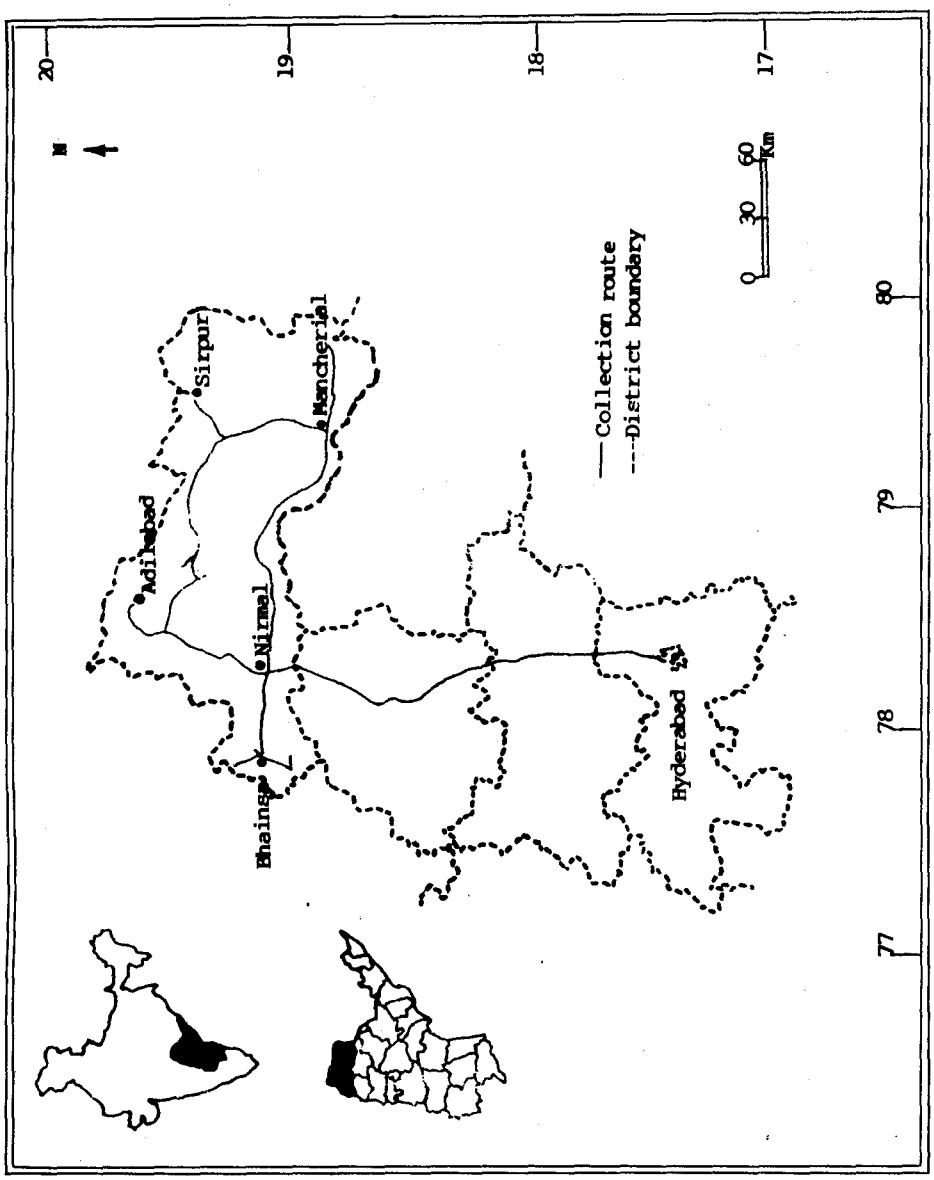


Fig. 1. Exploration route for collection of rice germplasm from Adilabad district of Andhra Pradesh.

**Table 1. Characteristics of landraces of rice collected from Adilabad district of Andhra Pradesh, India**

| Landrace | Characteristics |
|---|---|
| *ATTEDLU* | 90-110 days maturity, brown glume, short bold grains, red kernel, awned. |
| *BAKKAMASOORI* | 150 days maturity, medium slender grains, white kernel, non-scented. |
| *BASTARLU* | 135 days maturity, straw glume, fine grains, white kernel. |
| *BEETLU* | 90 days maturity, long slender grains, white kernel. |
| *BOFADAVADLU* | 80 days maturity, long slender grains, awned, white kernel. |
| *BUDIVIVADLU* | 100 days maturity, straw glume, short bold grains, redkernel. |
| *CHAINA* | 90 days maturity, straw glume, awned, white kernel. |
| *CHINNALUTCHCHALU* | 135 days maturity, medium slender grains, straw glume. |
| *CHERUKULUCHCHALU* | 90-125 days maturity, medium slender grains, white kernel. |
| *DHANIYAMVADLU* | 120 days maturity, medium bold grains, brown glume, scented. |
| *ERRAVADLU* | 120 days maturity, medium slender grains, brown glume, red kernel. |
| *GARIKALU* | 90-95 days maturity, straw glume, medium slender grains, red kernel. |
| *KAKKIREKALAVADLU* | 120 cm tall, black glume, scented. |
| *KOOKUMBANTHULU* | 110-115 days maturity, straw glume, awned, red kernel. |
| *LALDHAN* | 90 days maturity, brown glume, medium slender grains, awned, red kernel. |
| *LUTCHCHALU* | 110-120 days maturity, straw glume, medium slender grains, fine rice. |
| *MODDUGAREKALU* | 120 days maturity, brown glume, red kernel, bold grains. |
| *MUKKASOLALU* | 75 days maturity, brown glume, short bold grains, white kernel. |
| MULLODLU | 60 days maturity, white glume, red kernel, awned. |
| NALLAVADLU | 90-100 days maturity, black glume, red kernel, medium slender grains. |
| *PALALUTCHCHALU* | 125 days maturity, straw glume, very fine rice, white kernel. |
| *PANTHABHOG* | 100 days maturity, brown glume, white kernel, irrigated & rainfed rice. |
| *PISSOLAVADU* | Straw glume, medium slender grains, awned, whiter kernel. |
| *POLALAVADLU* | 90 days maturity, straw glume, awned, white kernel. |
| *RAGGALVANGI* | 95 days maturity, brown glume, white kernel. |
| *REGADIVADLU* | 120-130 days maturity, straw glume, white kernel. |
| *SOMALUCHCHALU* | 12 days maturity, brown glume, fine rice, red kernel. |
| *TELLAVADLU* | 90-95 days maturity, short, bold grains red kernel. |

The farmers to continue to grow the above landraces due to its adaptability in their climate, low input requirements, quality and taste of the rice tolerance/resistance to different biotic/abiotic stresses.

The interesting landraces included SMS-4150 (Dhaniyamvadly), SMS-4162 (Kakirekkalavadlu) and SMS-4163 for aromatic rice; SMS-4192 (Panthabhog) and SMS-4194 high yielding; SMS-4130 (Mullodlu) short duration cultivar maturing in about 60 days and SMS-4176 (Polalavadlu) an introgressed form between *O. sativa* and *O. rufipogon*. SMS-4202 (Somaluchchalu) and SMS 4214 (Safed) besides drought tolerance have very fine grain type. The rice germplasm collected from this region is a good source for drought tolerance.

The germplasm has been shared with Andhra Pradesh Agricultural University, Agricultural Research Station, Maruteru, Andhra Pradesh. A part of the collected germplasm have been conserved in National Gene Bank, National Bureau of Plant Genetic Resources, New Delhi.

## ACKNOWLEDGMENT

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# COLLECTING GERMPLASM OF OKRA AND ITS WILD RELATIVES IN SOUTHERN INDIA

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Exploration and collection of okra and its relatives were conducted under the joint sponsorship of IBPGR and NBPGR in Southern region of India. A total of 236 accessions of the genus *Abelmoschus* collected included 205 samples of cultivated okra belonging to *Abelmoschus esculentus* and *A. callei* and 30 of 5 wild species and 1 of a semiwild hybrid form. Cultivated okra had wide spread distribution. Three wild species and one variety were found to occur in Western Ghat areas and two others in plains. Wide variability in the collections mainly in fruit and plant types have been noticed in *A. esculentus* and on the basis of fruit characters 12 distinct types could be identified.

**Key words :** Okra, Genetic resources, wild relatives, *Abelmoschus* spp.

Genus *Abelmoschus* medic. of the family *Malvaceae* includes both Sudanian and Guinean okra which are important vegetables. It is distributed mainly in Asia and Africa. In India, it is grown under diverse conditions right from coastal plains to elevations as high as 1000m. Besides, another form of okra, now identified as *A. callei* (A. Chev.) Stevels is also found. Few Wild species also occur in Southern region. Genetic erosion in both cultivated and wild okra is quite rampant in the region due to change in land use pattern, cropping pattern and habitat disribution. This report pertains to survey and collection work on okra and its wild relatives carried out highlighting its variability, distribution and taxonomy in the region.

## MATERIALS AND METHODS

Exploration and collection of okra and its wild relatives were carried out in Kerala, Karnataka, Tamil Nadu and South and North Eastern parts of Andhra Pradesh during 1989-1991. The route map is given in Fig. 2. Sampling sites included roadside disturbed vegetation, forest pockets, farmers fields, backyards, tribal areas, pockets of ethnic importance, farmer's stores and markets. Mostly, biased sampling based on the types noticed in the field and

bulk samples from the stores were collected. MH herbarium, Coimbatore was consulted for identifying the wild species.

## RESULTS AND DISCUSSION

The details of collection mission is presented in Table 1. A total of 236 cultivated okra and 42 wild okra have been collected. Areas surveyed (Fig. 1) include very wet areas in Kerala and parts of Karnataka and dry areas in plains and plateau in Tamil Nadu and Andhra pradesh and parts of Karnataka.

**Table 1 Details of exploration & collection of Abelmoschus spp.**

| Areas | No. of sites | No. of spp. | No. of samples |
|---|---|---|---|
| Parts of Kerala, Tamil Nadu & Andhra pradesh | 113 | 1 | 41 |
| Parts of Kerala, Karnataka & Southern Tamilnadu | 111 | 2 | 60 |
| Parts of Kerala & Karnataka | 133 | 5 | 97 |
| Parts of Kerala & Tamilnadu | 46 | 5 | 20 |
| Nilgiri Biosphere reserve | 19 | 4 | 18 |
| Total | 422 | 5 | 236 |

Okra is mainly cultivated during rainy and summer seasons in uplands and paddy fallows in Kerala and in three seasons in other states. Both irrigated and rainfed crops are found. Details of passport information on samples collected is given in Table 2. In Kerala, the crop is mainly subsistence in nature but commercial in other states. Local old land races are mainly concentrated in Kerala, coastal Karnataka and pockets of Tamil Nadu.

Taxonomically two distinct taxa of okra viz. *A. esculentus* (L.) Moench. and *A. callei* (A. Chev.) Stevels occur in the region. The first one is commonly cultivated bindi of North or 'Vendai' of South, now called as Sudanian okra and the latter is 'Maravenda' of Kerala, now called as Guinean okra. The second one has been highly adapted to back yards and kitchen gardens in midlands and hills of Kerala. Okra is cultivated in wide variety of climates, soils and elevations in the region. Commercial cultivation of the released types viz. 'Pusa savani was very common in Karanataka, Andhra Pradesh and Tamil Nadu and the others such as 'Parbani Kranti' co-1 and co-2 are very rare. In Kerala okra is mainly a subsistant crop. Commercial cultivation under irrigation in paddy fallows during summer has become rare now.

Very distinct okra cultivars have been noticed in parts of Palghat, Kannur and Wynad districts of Kerala; Periyar, Salem and Kanyakumari districts of Tamilnadu and uttar Kannada and Dakshin Kannada districts of Karnataka.

Depending upon the local preferences, cultivation practices and environmental factors, distinct local cultivars such as 'Palvendai', 'Ezhila venda, Nila venda, 'Anakkomban' and 'Wynad short' are met. In coastal and tribal areas in Karnataka, two distinct local types with very long thin fruits and medium thick and short fruits have been collected. The thickest fruit type has been collected from foot hills of Western Ghats in Kanyakumari district in Tamilnadu. In the case of 'Maravenda' plants are biennial, with purple pigmentation on stem, petioles, leaf veins and tender fruits. Fruits are short to medium long, thick and multisided. It is tolerant to yellow mosaic disease and to drought.

**Table 2 Passport information of Abelmoschus spp.**

| Species | Common name | Situations | Status | Number of colln. | Ker | Kar | TN | AP |
|---|---|---|---|---|---|---|---|---|
| *A.* escullentus | Okra/ Sudanian | Backyard, okra farmers | Culti.fields | 191 | + | + | + | + |
| *A.* caillei | Guinean okra | Backyards | Cult. | 14 | + | + | + | 0 |
| *A.* moschatus ssp. *tuberosus* | - | Deciduous forests | Wild | 1 | 0 | 0 | + | 0 |
| *A.* moschatus ssp. *moschatus* var. *Moschatus* | - | Gardens/ road sides | Wild/cult. | 3 | 0 | 0 | 0 | 0 |
| *A.* manihot ssp. *tertraphyllus* var. *tetraphyllus* | - | Hedges/ road sides | Wild | 2 | + | + | 0 | 0 |
| *A.* angulosus | - | Rainforests/ road sides/ sholays | Wild | 31 | + | + | + | 0 |
| *A.* ficulneus- | - | Dry plains | Wild | 3 | 0 | + | + | 0 |
| *Abelmoschus* sp. (natural hybrid) | - | Backyards/ Hedges | Weed | 1 | 0 | + | 0 | 0 |

Fruit colour was whitish green in 95, whitish green with red tint in 2, red in 5, green in 36, light green in 16, light red in 1, dark green in 5, light purple in 2 and green with light purple tint in 2 collections. Fruit length varied from extra long in 1, long in 37, medium long in 76 and short in 58 collections. It was not known in the rest. Number of ridges on fruits varied from 5 sides in 90 to multi ridged types in 68 accessions. Cultivated okra

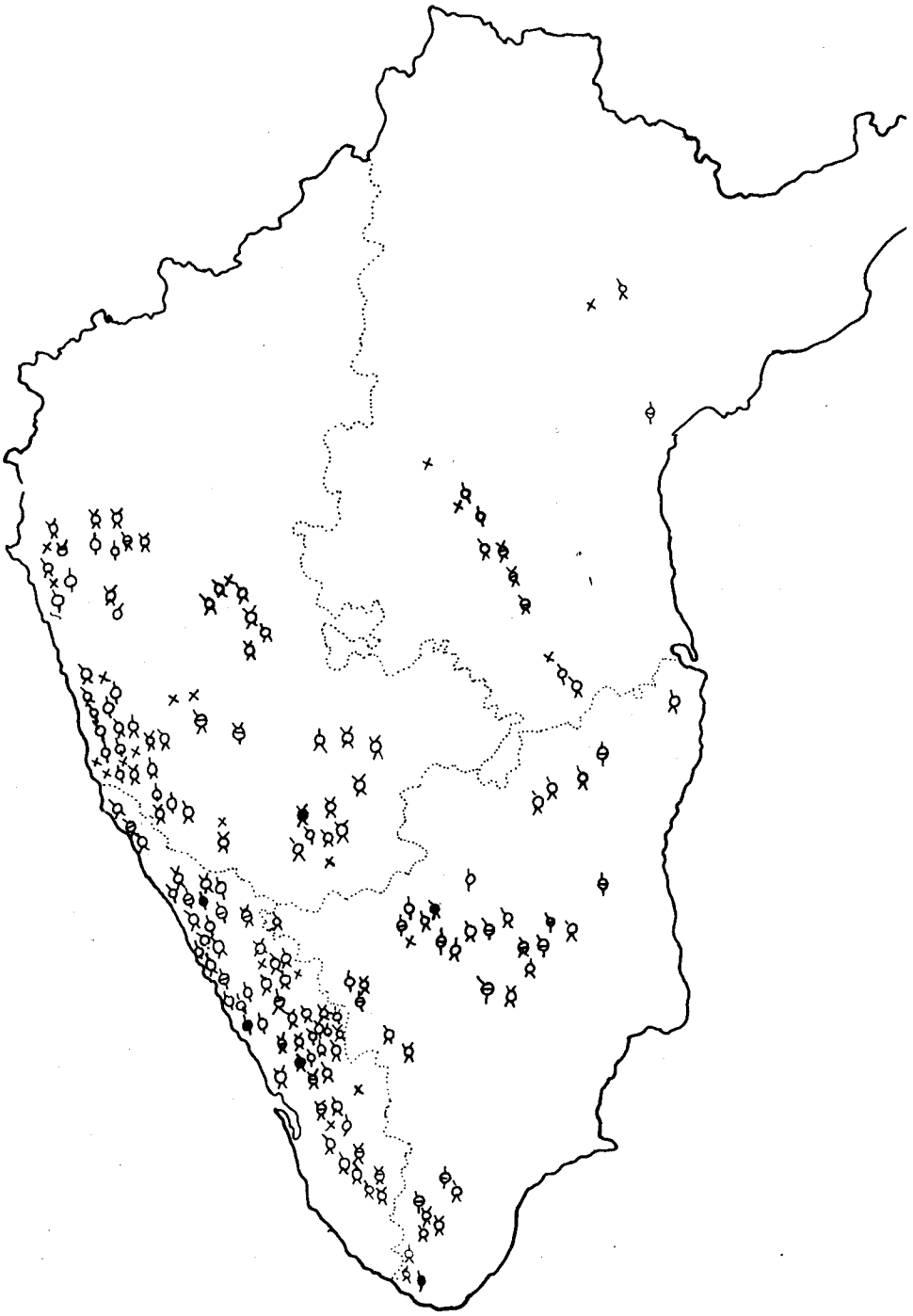

Fig. 1. Distribution of okra types in Southern Region
1. Not known; 2. Long whitish green; 3. Long redish; 4. Medium long multisided whitish green; 5. Medium long whitish green; 6. Long green; 7. Short multisided green; 8. Medium long multisided green; 9. Short multisided whitish green; 10. Medium long multisided redish green; 11. Short multisided redish green; 12. Medium long redish; 13. Long multisided whitish green

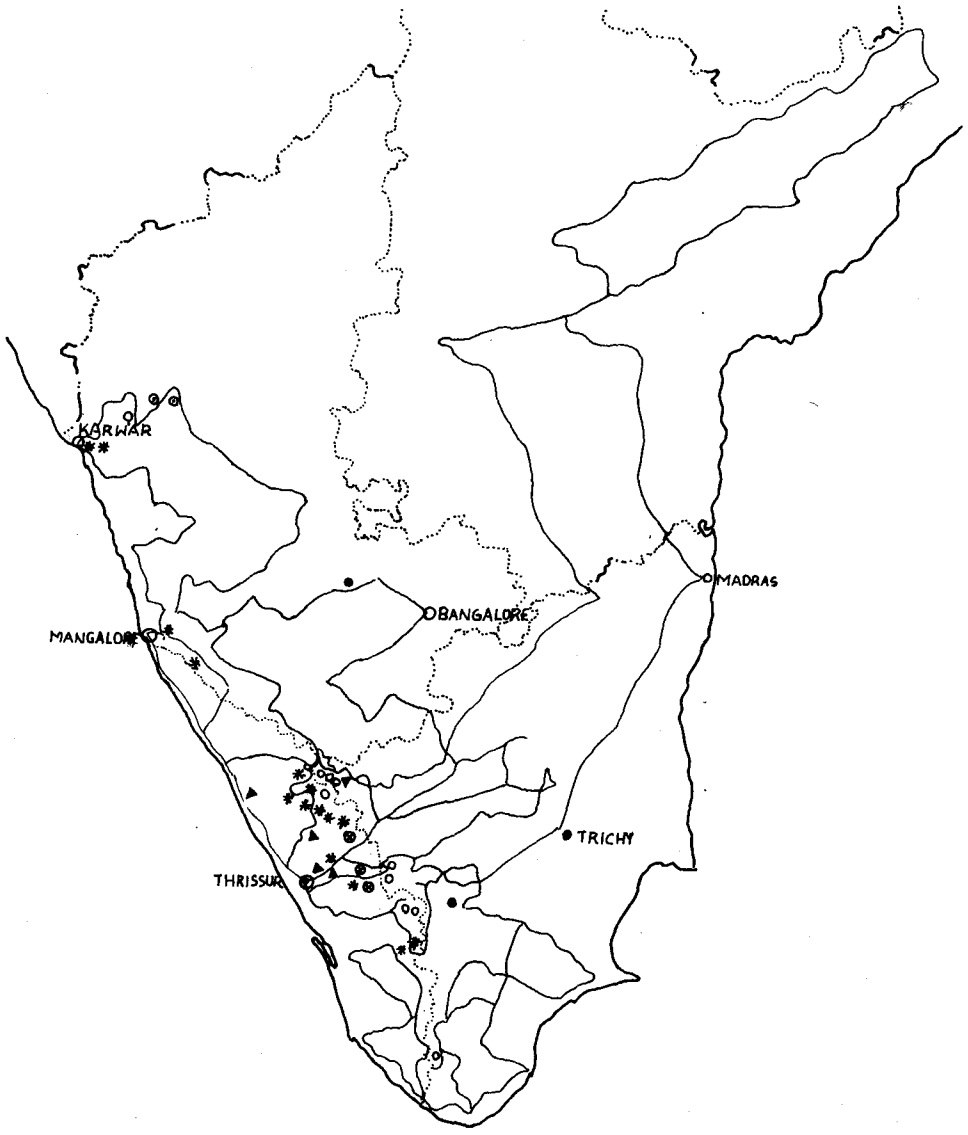


Fig. 1. Okra collection route and species distribution
1. *A. angulosus* var. grandiflorus; 2. *A angulosus* var. *purpureus;* 3. Intermediate forms of the above varieties; 4. *A ficulneus;* 5. *A moschatus* ssp. *moschatus* var. *moschatus;* 6. *A moschatus* ssp. *tuberosus;* 7. *A. manihot* var. *tetraphyllus;* 8. Natural hybrid between okra and var. *tetraphyllus*

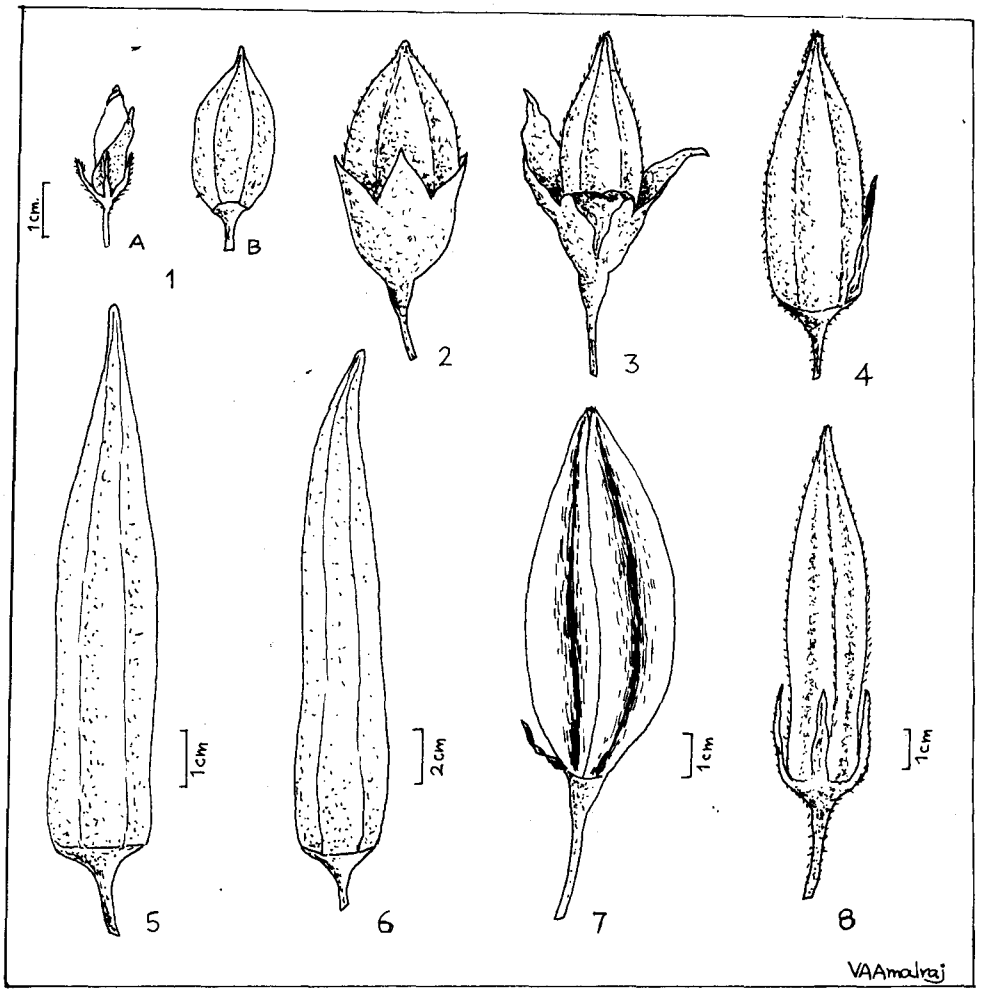


**Fig. 1. Fruits of *Abelmoschus* spp. 1. *A. ficulneus* (A. flower, B. fruit), 2. *A. angulosus* var. *purpureus*, 3. *A angulosus* var. *grandiflorus*, 4. *A manihot* spp. *tetraphyllus*, 5. *A manihot* ssp. *manihot*, 6. *A esculentus*, 7. *A. moschatus*, 8. *Abelmoschus* (hybrid)**

collections assembled from the region contained 12 distinct types based on the fruit characters.

Considerable work on the taxonomy of the genus has been carried out in the past. The revision of Indian species by Paul and Nair, 1988 has resulted in identity of 7 species in India. Of these, *A. moschatus, A. esculentus, A. angulosus, A. ficulneus* and *A. manihot* occur in Southern region. However in a recent International work shop on okra genetic resources held at NBPGR, New Delhi, India during 8-12 October, 1990 a group of scientists working on the world okra germplasm made the amendents on the taxonomy of the genus *Abelmoschus* based on the most recent works on taxonomy and the cytological evidences that a total of 8 species occur in the world with 5 sub species in *A. moschatus* and 2 varieties in *A. manihot* (Anon. 1990). Guinean type of okra has been identified as *A. callei*, Sudanian type as *A. esculentus* and *A. manihot* var. callei as *A. callei* which has been wrongly identified as *A. manihot* ssp. manihot in the post.

Thus, the overall picture based on the collections made by the authors in Southern Region of India in the light of the above short review of taxonomy of the genus, species such as *Abelmoschus esculentus* (L.) Moench. *A. moschatus* Medikus ssp. moschatus var. moschatus, ssp. tuberosus (Span.) Borss. *A. manihot* (Roxb. ex Hornem.) R. Graham var. tetraphyllus, *A. ficulneus* (L.) W. & A. ex Wight, *A. angulosus* Wall. ex. W & A. and *A. callei* (A. Chev.) Stevels occur in the region.

Distribution of these species has been given in Fig. 2. Western Ghats having innumerable niches becomes an abode of mainly two wild species, viz., *A. tetraphyllus* var. tetraphyllus in the northern stretches extending from North Kerala to Konkan and *A. angulosus* in the middle and southern parts of Ghats. In *A. angulosus* two extremely distinct types such as *A. angulosis* var. purpureus (Thw.) occupying higher slopes of Ghats above 4000 ft and variety grandiflorus (Thw.) occupying foot hills and midlands are noticed. Though these two are now not distinguished taxonomically in the latest classification followed by IPGRI, the authors feel that these two are distinct varieties of the species. Further, intermediate forms between the above two varieties have also been noticed in medium altitudes. In *A. moschatus* one distinct variety such as subspp. *moschatus* var. *moschatus* from midlands and plains of Kerala and another spp. such as *tuberosus* from semideciduous forests of Mudumalai in Tamilnadu have been collected. *A. ficulneus* is commonly found in plains of Tamil Nadu and Karnataka having black soil. Further, an intermediate form of okra between the cultivated and wild *A. tetraphyllus* var. tetraphyllus has been noticed in an interior tribal area in Uttar Kannada of Karnataka. This obviously leads to the conclusion that natural hybridization between okra and wild species takes place in certain situations generating intermediate forms rarely. However, on further segregation of the natural

hybrids, only wild forms resembling the original wild species are generated, thus gradually losing the wild genes from the cultivated one.

## ACKNOWLEDGEMENT

The authors are thankful to Director, NBPGR for the facilities provided.

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# VARIATION FOR QUANTITATIVE TRAITS IN OAT GERMPLASM

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Evaluation of 2576 oat germplasm in augmented design showed high range and per cent range of variation for grains/panicle, leaf width, 100-groat and grain weight, and leaf length. Panicle length, seed width, plant height and seed length exhibited medium range as well as per cent range of variation, however, less variations were observed for 50 per cent heading and maturity. Classification of germplasm based on frequency distribution into different classes revealed that majority of the genotypes concentrated towards mean. Both the extreme types of classes consisted of less number of genotypes.

**Key words:** Variability, germplasm, oat

Successful crop improvement programme depends upon the amount of variability either created or which already existed in the breeding material for valuable component traits. Germplasm serves as the most valuable reservoir of variability on which selection can be made directly for evolving superior genotypes or it may be used in hybridization programme. In view of above, the present investigation was undertaken to survey the extent of variation and classification of germplasm into different classes.

## MATERIALS AND METHODS

The material used for this study comprised of 2576 oat germplasm alongwith three check varieties evaluated in augmented design in 1991-1992 at G.B. Pant University of Agriculture and Technology, Pantnagar. The experimental area was divided into 23 blocks of 112 test genotypes plus three check varieties plots. Randomization was done for checks only. Plot size comprised of single row of one meter length with inter row distance of 40 cm. The observations were recorded on days to 50% heading, leaf length and

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width, plant height, days to maturity, panicle length, grains/panicle, seed length and width, and 100-grain and groat weight.

Each observation was adjusted for block effects according to augmented design analysis (Peterson, 1985). Range was estimated by taking the lowest and highest value for each trait. Germplasm were classified into different classes on the basis of frequency distribution.

## RESULTS AND DISCUSSION

Evaluation of 2576 oat germplasm showed considerable degree of variation for different characters (Table 1). Range as well as per cent range of variation observed was highest for grains/panicle, leaf width, 100-groat weight, 100-grain weight and leaf length. These traits might be expected to be more responsive to selection because of high magnitude of variations.

**Table 1. Mean, range and percent range of variation for different quantitative traits.**

| Characters | Mean | Range of variation | Percent range of variation |
|---|---|---|---|
| Days to 50% heading | 108.59 | 86.26-125.26 | 100.0-145.21 |
| Leaf length (cm) | 39.15 | 15.95-61.34 | 100.0-384.64 |
| Plant height (cm) | 119.33 | 66.62-170.96 | 100.0-256.62 |
| Days to maturity | 149.09 | 124.22-159.88 | 100.0-128.71 |
| Panicle length (cm) | 28.22 | 13.00-40.67 | 100.0-312.85 |
| Grains per panicle | 60.17 | 27.54-128.54 | 100.0-466.74 |
| Seed length (mm) | 13.26 | 8.58-17.15 | 100.0-199.88 |
| Seed width (mm) | 2.77 | 1.44-4.47 | 100.0-310.42 |
| 100-grain weight (gm) | 3.58 | 1.55-6.40 | 100.0-412.90 |
| 100-groat weight (gm) | 2.63 | 1.10-4.50 | 100.0-414.54 |

On the other hand, heading and maturity duration showed narrow range of variation which may be restricted to certain degree in response to selection. Variability for panicle length, seed width, plant height and seed length were moderate as shown by range as well as per cent range of variation. In general, characters like grains/panicle, leaf width, 100-groat weight, 100-grain weight, leaf length, panicle length, seed width, plant height and seed length provide base of diverse forms upon which effective selection can be practiced for isolation of desirable type for direct use or as a parents in hybridization

programme. These results were in general agreement with those of Frey (1965), Sampson (1971), and Rahman and Roquib (1987).

Classification of 2576 oat germplasm based on frequency distribution showed the pattern of distribution into different classes. The distribution pattern indicated that most of the lines were occupied the intermediate classes. The maximum frequency class was, in general, median class i.e. the lines of this class were distributed around the mean value. However, the genotypes occurred in extreme classes are expected to have contrasting feature and widely distributed to mean value. Thus grouping into different classes showed a general pattern of divergence of the traits.

Comparison of test materials with the best check showed that 169 and 426 genotypes were earlier in heading and maturity period, respectively. The lines with longer leaves were 65 while 55 lines showed broader type of leaves. Tall type of statured was found in 105 lines while 223 lines showed short statured. Longer panicles and more number of grains were recorded in 187 and 270 lines, respectively. Longer and broader seeds were shown by 38 and 63 lines, respectively. Plants with maximum 100-grain and 100-groat weight were 51 and 52, respectively. These lines may be used in oat improvement programme.

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# HARD SEEDEDNESS IN KHESARI (*LATHYRUS SATIVUS*) GERMPLASM

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Hardseededness is widely known in pulses and affects germination counts in field and laboratory conditions. The critical evaluation of hardseeds in 1,279 accesions of *Lathyrus sativus* indicated considerable variation for hardseed percentage in the accessions tested. The role of environment in causing hardseededness in this crop was also noted. Mechanical scarification with fine sand paper proved to be an effective method of removing seed coat impermeability to ensure the water uptake in order to record the actual germination percentage of germplasm accessions, which is a pre-requisite for their longterm conservation in the National Genebank.

**Key words :** *Lathyrus sativus*, hardseededness.

Khesari (*Lathyrus sativus*) is one of the important pulse crop in India. It is grown throughout India, especially in Northern, Central and Western India upto an altitude of 1200 mts. In India, it occupies approximately 4% of the total area under pulse crops and constitutes about 3% of the total pulse production (Anonymous, 1962). Despite its seed containing neurotoxic alkaloides, the crop is attracting attention because of its high protein content and tolerence to biotic and abiotic stresses. Efforts are being made to collect and store variability/genetic diversity in this crop which can subsequently be utilized in tailoring acceptable varieties with low neurotoxic substances. With this view in mind, a number of germplasm accessions of *Lathyrus sativus* were collected, their seed multiplied and sent to NBPGR for longterm conservation. In the prescribed practice of viability testing, prior to conservation of germplasm, it was observed that the accessions exhibited varied degree of hardseededness and caused difficulties in recording actual germination data. The present study was therefore, undertaken to study the extent of hardseededness and method of overcoming this problem.

## MATERIALS AND METHODS

The experimental material for the present study comprised of three lots of *Lathyrus* germplasm. The first lot consisted of 1070 germplasm accessions collected from Madhya Pradesh. The seed was grown and multiplied at Indira Gandhi Krishi Vishwa Vidhyala (IGKVV), Raipur during the Rabi 1993 -94 season. The second lot had 69 germplasm accessions which were grown and multiplied during Rabi 1993-94 season at Issapur farm of NBPGR, New Delhi and the third lot of 140 germplasm accessions was grown at NBPGR, Regional Station Akola, Maharashtra during the same period.

About 500 gms seeds of each accession was received for their longterm conservation in the National Gene Bank at NBPGR Hqrs, New Delhi. Sample of 200 seeds was drawn from each accession and used for germination test by keeping the seeds between moist towel paper in 4 replications, each consisting 50 seeds. The seeds were planted and kept in a slanting position in a germinator maintained at 20°C and 90% relative humidity (ISTA, 1985). After 10 days of incubation, the counts of normal, abnormal, hard and dead seeds were taken and their percentages computed.

The seeds of accessions showing more than 15% hardseededness but otherwise exhibiting good germination, were gently scarified with a fine grade sand paper for approximately 1 minute and kept for germinaton. The germination counts were recorded as per the method described above.

## RESULTS AND DISCUSSION

The results of the present investigation reveal the variability with regard to hardseededness in the *Lathyrus* germplasm screened for germination. The extent of hardseeds in the range of 1-10% under Akola and Raipur conditions was 47.14 and 36.47% respectively, while under Delhi conditions 33.33% accessions had hardseededness ranging from 71-80%. Although 5.79% accessions recorded hardseeds in the range of 81-90% under Delhi none of the accessions studied exhibited hardseededness beyond 90%.

Impermeable seed coat leading to hardseededness is a common feature in most of the legume crops. Such seeds will not germinate readily when placed under conditions considered favourable for germination due to their impermeable seed coat. The seeds of *Lathyrus sativus* like majority of the leguminous crops also exhibit hardseededness. Although hardseededness on one hand may be beneficial for maintenance of seed quality during storage, on the other hand, it may be undesirable as it may require certain specific treatments (physical/chemical) to overcome the dormancy due to impermeable seed coat and may also lead to staggered germination and a non uniform crop in the field.

This variation in percentage of hardseeds observed in various accessions of *Lathyrus* germplasm could be due to genotypic differences in the various accessions studied. Hardseeds develop when the seeds mature and lose moisture in accordance with relative humidity. Therefore, the environment through relative humidity has an effect on the rate of development of impermeability and the proportion of seeds which are actually impermeable at any stage during ripening and drying. Lebedeff (1947) observed in *Phaseolous vulgaris* that cultivars of a species could differ in their water permeability and that the differences are heritable. Similarly, distinct differences in degree of seed coat dormancy have been noted for several legume species (Bebawi and Mohamed, 1985, Bhattacharya and Saha, 1990 Lopez and Aviles, 1988).

The hardseed character in most of the legumes is thought to be due to thickening of palisade layer cells. Hardseededness in such seeds can be broken by softening the seed coat through various physical and chemical treatments.

**Table 1. Distribution of hard seeds in Lathyrus germplasm**

| | Akola | | Delhi | | Raipur | |
|---|---|---|---|---|---|---|
| Range (% Hard Seeds) | Total acc. (140) | % of total accessions | Total acc. (69) | % of total accessions | Total acc. (1070) | % of total accessions |
| 1-10 | 66 | 47.14 | 19 | 27.5 | 401 | 36.47 |
| 11-20 | 19 | 13.57 | 0 | 0 | 85 | 7.94 |
| 21-30 | 2 | 1.42 | 0 | 0 | 2 | 0.19 |
| 31.40 | 3 | 2.14 | 0 | 0 | 0 | 0 |
| 41-50 | 0 | 0.0 | 0 | 0 | 1 | 0.09 |
| 51-60 | 0 | 0.0 | 7 | 10.1 | 0 | 0 |
| 61-70 | 1 | 0.71 | 16 | 23.18 | 0 | 0 |
| 71-80 | 0 | 0.0 | 23 | 33.33 | 0 | 0 |
| 81-90 | 0 | 0.0 | 4 | 5.79 | 0 | 0 |
| 91-100 | 0 | 0.0 | 0 | 0 | 0 | 0 |
| Total acc. with hard seeds | 91 | 64.98 | 69 | 99.9 | 489 | 45.68 |

The most commonly practised method is mechanical scarification developed by Hughes (1915). Tomer and Kumari (1991) obtained 80-78% germination in *Vigna mungo* by scarification with sand paper against 28.70 percent in the control. In the present investigation rubbing *L. sativus* seeds

gently over a fine grade sand paper for approximately one minute resulted in removal of hardseededness and normal germination of all hard seeds. This method is very effective, quick, cheap, safe and is suitable for assessing seed viability of *Lathyrus sativus* in genebanks where seeds are received in limited quantities and high seed viability is a pre-requisite for storing the seeds for posterity.

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Short Communication

# METROGLYPH ANALYSIS IN *CUPHEA*

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**Key words :** *Cuphea*, fatty acids, variability, metroglyph, index score.

*Cuphea* species provide diverse type of medium chain fatty acids obtained from its seed oil. The oils have a wide range of industrial applications in the manufacture of soap, detergents, cosmetics, pharmaceuticals, surface coating and lubricant. At present these fatty acids are commercially obtained from coconut and palm kernel. Among the 200 species of the genus *Cuphea* some species are rich in lauric, capric and caprylic acids. Also capric acid is a renewable source which is presently available only from petrochemicals (Hirsinger, 1980; Graham *et al.*, 1981). Therefore, a need was felt to screen/identify the germplasm and to evaluate the suitable types of fatty acids by the metroglyph analysis. The metroglyph technique has proved to be very useful for picking up high yielding superior type of genotypes from germplasm collection. (Pandey *et al.*, 1990; Chauhan *et al.*, 1990). The seeds of 15 accessions/introduction of *Cuphea* procured through U.S.D.A, from Iowa State University, Iowa, U.S.A. were sown in nursery beds and the seedlings thus obtained were first raised in a glass house and latter transplanted in a field (twenty plants per row) in randomised block design with three replications. The data were recorded on 15 plants from each replicate on plant height, number of days to flowering, number of seed/flower, seed yield/plant, 1000 seed weight, major fatty acids (number of carbon atoms), days to flowering and seed yield (Kak *et al.*, 1995). The fatty acid content of seeds were analysed by GLC as suggested by Thies (1981). Metroglyph and Index score analysis were carried out according to the method suggested by Anderson (1957). The class intervals for various characters are presented in Table 1. The variation in each character is represented by a corresponding range in the length of rays. Different characters are represented by a different position of the rays on the glyph. The index value for each character has been divided into three classes viz. no. rays, short rays and long rays. The total index score was recorded by summing up the index scores.

**Table 1. Class interval and index values for 6 characters of *Cuphea***

| Characters | Index values | | | | | |
|---|---|---|---|---|---|---|
| | 1 | Sign | 2 | Sign | 3 | Sign |
| Plant height (cm) | 49.0 | 0 | 49.1-69.0 | ♂ | ≥ 69.1 | ♂ |
| Number of days to flowering | 32.0 | 0 | 32.1-52.0 | ♂ | ≥ 52.1 | ♂ |
| Number of seeds /flower | 10.9 | | 11-20.0 | | ≥ 20.1 | |
| Seed yield/plant (g) | 5.0 | | 5.1-8.3 | | ≥ 8.4 | |
| 1000 seed weight (g) | 1.3 | 0 | 1.31-2.9 | ♂ | ≥ 2.91 | ♂ |
| Major fatty acid (Number of C-atoms) | 10 | 0 | 10.1-12.0 | ♀ | ≥ 12.1 | ♀ |

Fifteen accessions/introductions analysed are as below :

| | | |
|---|---|---|
| 1. *C. glossostoma* | 2. *C. laminuligera* | 3. *C. lutea* |
| 4. *C. tolucana* | 5. *C. wrightii* | 6. *C. paucipetala* |
| 7. *C. leptopoda* | 8. *C. inflata* | 9. *C. lanceolata* |
| 10. *C. procumbens* | 11. *C. racemosa* | 12. *C. aperta* |
| 13. *C. painteri* | 14. *C. cyanea* | 15. *C. viscosissima* |

The plant height, number of seeds/flower, seed yield/plant and 1000 seed weight ranges from 29.0-88.0 cm, 3.0-30.0 g, 0.2-15.0 g and 0.18-4.0 g with a mean value of 56.6 cm, 121.13 g, 5.1 g and 1.94 g, respectively).

It takes between 47-92 days for flowering. The number of carbon atoms in fatty acids varies from 8.0 to 18.2. The content of fatty acid namely, capric acid, caprylic acid, lauric acid and linoleic acid varies from 0.15-69.5%, 10.0-87.3%, 2.0-70.0% and 1.6-60.0% respectively.

The results of metroglyph analysis are presented in Fig. 1. Each introduced accession is represented by a semi-circle, the X Co-ordinates of each circle being the number of seeds/flower and Y Co-ordinate being the seed yield/plant. The other characters have been represented by rays at different position on the glyph. The scatter diagram shows four complexes.

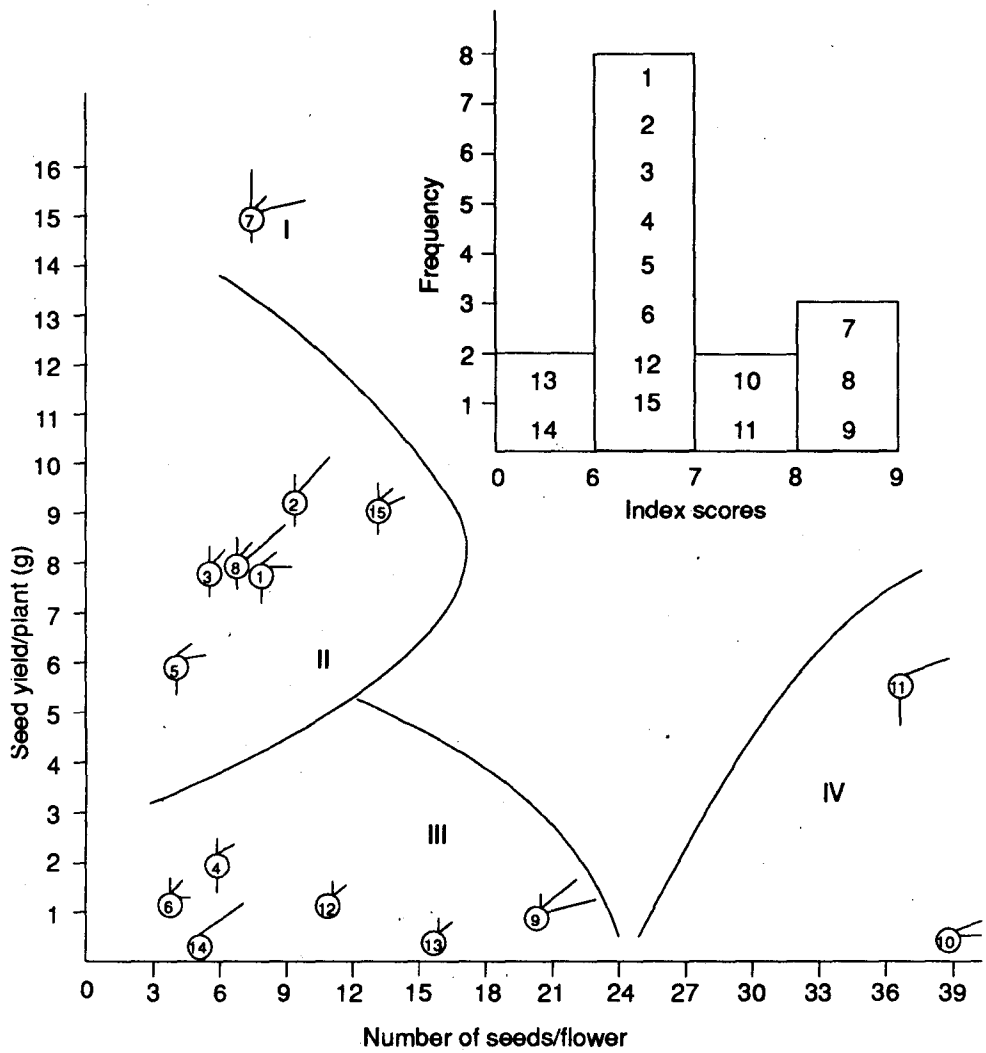


**Fig. 1. Scatter diagram in metroglyph analysis**

Complex I consists of a single accession (7) and is represented by three rays. The main characteristics of the complex were maximum height, moderate number of days to flowering and maximum 1000 seed weight. **Complex II** contains 6 accession (1, 2, 3, 5, 8, 15) and has minimum of three rays. The main features of this complex are average plant height, moderate number of carbon atoms with an average 1000 seed weight. **Complex III** contains 6 accessions (4, 6, 9, 12, 13, 14) and is represented by minimum of two rays except accession 14 which is represented by a single ray. The main characteristics of this group are average plant height, average to maximum number of days

to flowering and minimum to moderate number of carbon atoms. **Complex** IV comprised two accesion 10 and 11. The accession 10 has maximum days to flowering and accession 11 has maximum number of carbon atoms.

There were both similarities and dissimilarities among the complexes. Complex I contains a single accession (*C. leptopoda*) and has maximum amount of capric acid (83.8%) while all other fatty acids were less. This accession could be a good renewable source of capric acid which is presently obtained from petrochemicals. In Complex II, accession 8 and 15 (*C. inflata* and *C. viscosissima*) are also good source of capric acid, while accessions 1, 2 and 5 (*C. glossostoma* and *C. laminuligera, C. wrightii*) have more than 60% lauric acid which represent an ideal source for the manufacture of detergents. In Compelx III, accession 4 and 12 (*C. tolucana* and *C. aperta*) are also good source of lauric acid while the accession 13 and 14 (*C. painteri* and *C. cyanea*) contain more than 60% of caprylic acid. Complex IV contains only two accessions, 10 and 11 (*C. procumbens* and *C. racemosa*). *C. racemosa* does not contain any major acid except linoleic acid (60%) while *C. procumbens* contains major amount of capric acid (78%).

On the basis of frequency diagram the accessions 7, 8 and 9 (*C. leptopoda, C. inflata* and *C. lanceolata*) fall under index score of 8-9 which are very good source for capric acid, while accessions 13 and 14 (*C. painteri, C. cyanea*) fall under index score of 0-6 which are good source for caprylic acid. The accessions 10 and 11 (*C. procumbens, C. racemosa*) come under index score of 7-8, and are good source for capric acid and linoleic acid. The other accessions that fall between index score of 6-7 have mixture of other fatty acids. The above accessions could be selected for further breeding programme for their specific traits. Out of 15 accessions under study only *C. racemosa* contain 60% of linoleic acid while the other accessions do not contain more than 7% of linoleic acid. Similarly *C. procumbens* and *C. leptopoda* contain 78% and 83.8% of capric acid while other fatty acid are in negligible percentage. The present study shows the genus *Cuphea* forms tentatively four germplasm complexes into which various accessions sort out among themselves.

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**Short Communication**

# EVALUATION OF LINSEED GERMPLASM

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**Key words :** Evaluation, *Linum usitatissimum*, germplasm

Linseed (*Linum usitatissimum* L.) is being cultivated since antiquity in the Mediterranean coastal lands, Asia minor, Egypt, Algeria, Tunisia, Spain, Italy and Greece for fibre. In India, it is cultivated mainly for oil purpose. It occupies fifth place after groundnut, rapeseed and mustard, soybean and sesame. The seeds of linseed have long been the source of drying oils. It contains 32-45% oil content, which is used chiefly as edible oil and making paints, varnishes, linoleum, soft soaps and printer's ink etc.

A total of 621 accessions including exotic collections from Argentina (63), Australia (24), Japan (2), France (1), USA (3), USSR (3), Belgium (1), Romania (1) and Hungary (3) and indigenous germplasm from Madhya Pradesh (162), Uttar Pradesh (87), Himachal Pradesh (54), Bihar (44), Maharashtra (164), Rajasthan (2), Andhra Pradesh (3) and Karnataka (4) were included in the present study.

The germplasm accessions were grown in augmented block design at NBPGR, R.S. farm, Akola and evaluated in 2 consecutive *rabi* seasons of 1990-91 and 1991-92. Plot size for each accession was 1 row of 3 m with row to row spacing of 60cm. Varieties C-429 and RLC-6 were used as checks and were replicated in each block of 25 accessions. The observations were recorded on days to flowering, days to maturity, flower colour, flower shape, anther colour, plant height, number of primary and lateral branches/plant, number of capsules/plant, number of seeds/capsule, seed colour, seed size, yield/plant, oil content and resistance to powdery mildew and wilt. Data were recorded on five randomly selected plants of each accession, excluding border plants. Mean values were used for the analysis of quantitative data. In case of qualitative data, frequency of each descriptor state was calculated. Oil content of the seed samples was determined by using NMR analyser.

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The linseed germplasm exhibited considerable genetic variability for various characters studied (Table 1).

**Table 1. Estimate of variability parameters and morphological variation (% frequency) in linseed germplasm**

| Character | Range | Mean | Standard deviation | Standard error | CV% |
|---|---|---|---|---|---|
| Days to flowering | 59-90 | 61 | 4.708 | 0.206 | 7.718 |
| Days to maturity | 95-122 | 110 | 6.161 | 0.270 | 5.600 |
| Plant height (cm) | 13.6-55.5 | 43.2 | 7.432 | 0.326 | 17.203 |
| No. of primary branches/ plant | 11.4-65.0 | 28.7 | 7.261 | 0.318 | 25.299 |
| No. of lateral branches/ plant | 2.3-14.3 | 6.1 | 1.073 | 0.045 | 17.590 |
| No. of capsules/ plant | 3.1-34.2 | 12.7 | 4.146 | 0.188 | 32.645 |
| No. of seeds/ capsule | 2.3-10.0 | 7.1 | 1.156 | 0.049 | 16.281 |
| Yield/ plant (g) | 0.1-2.4 | 1.3 | 0.425 | 0.016 | 32.692 |
| Oil content (%) | 23.74-47.82 | 41.2 | 2.801 | 0.122 | 6.798 |
| Flower colour | blue (91.47), bluish purple (1.77), light blue (0.32), purple (0.16), white (6.28) | | | | |
| Flower shape | disc (67.31), funnel (26.89), star (2.42), tubular (3.38) | | | | |
| Flower size | large (6.28), medium (92.47), small (2.25) | | | | |

Yield is a complex inherited character influenced by the yield contributing components. Seed yield has positive correlation with effective capsules/plant, seeds/capsule and 1000-seeds weight (Ghatak *et. al.,*), and plant height (Guan

*et. al.*, 1987, Patel *et. al.*, 1989). In the present study the accessions identified for high number of capsules/plant were IC 59256, IC 60426, IC 96656, IC 10540, EC 41562, and EC 110289. The accession EC 110289 had highest capsules/plant (65.0). High seeds/capsule was observed in IC 53260, IC 60423, IC 60435, 63579, IC 96485 and EC 41481. Early maturing accessions viz. IC 61280, IC 61320, IC 96596, EC 526, EC 1395, EC 41621 and EC 41650 may be suitable for areas with high temperature ranges at the time of maturity and also could be used in hybridization programme to develop early maturing genotypes. Tall genotypes of linseed are considered better for fibre. Tall accessions with more than 50 cm height and less primary branches viz. IC 96534, IC 96535, IC 96549, EC 236, and EC 41774-A are suitable for fibre purpose. IC 96513 and IC 96514 showed high level of field resistance against powdery mildew and wilt. High yield was recorded in EC 236, EC 1413, IC 61289, IC 61223, IC 62335, IC 63578 and IC 96612.

In the present study oil content ranged from 23.7-47.8%. IC 61322, IC 96666, IC 96571 and IC 105404 showed more than 47% oil (Table 2). Naqvi

**Table 2. Donor accessions identified for various traits**

| Trait | Donor accession |
|---|---|
| Early maturity (<95 days) | IC 61280, 61320, 96596, EC 1537, 2288, 41536 |
| Plant height (> 55.5 cm.) | IC 96534, 96535, 96549, EC326, 22813, 41774A |
| No. of lateral branches/plant (>25) | IC 96487, 96504, 105405, EC 41720, 41768 |
| No. of capsules/plant (> 45) | IC 59256, 60426, 96655, 105404, EC41562, 110289 |
| No. of seeds/capsule (> 8.8) | IC 63579, 96485, EC 41481 |
| Bold seeds | IC 53269, 54967, 96466, 96536, 96588, 96746, 96752, 96761 |
| | EC 1025, 1050-B, 1395, 11074, 41465, 41567, 41478-B, 41650, 41700, 4164 and 244634. |
| Field tolerance to powdery mildew | IC 53288, 96513, 96514, 96532, EC 41481, 41495, 41621, 41622 |
| Yield/plant (>2.0 g) | IC 53298, 59011, 59255, 61291, 61315, 61324, 96618, 96629, EC 236, 1413 |
| Oil content (> 47.0%) | IC 61322, 96666, 96751, 105404 |

*et al.* (1987) reported range for linseed oil content 33.1-44.5% and negative correlation with protein content. The accessions identified for various useful economic characters viz. high yield, resistance to powdery mildew and wilt and high oil content are of immense value and in hybridization programme.

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Short Communication

# FORAGE SORGHUM GERMPLASM : EVALUATION IN THE PAST TWO DECADES

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**Key words :** Forage sorghum, quality traits, tolerance, forage characters, variation.

About 14,000 lines of sorghum germplasm have been collected and evaluated at Haryana Agricultural University during 1971-1994. A number of promising lines for various traits including forage types have been identified. These germplesm collections are being maintained and utilized in improvement programme.

## Range of variation

The range of variability for forage yield and quality characters is given in Table 1. Maximum variability was recorded for plant height, leaf characters, fodder yield and quality traits. Similar variability was also reported by Paroda and Lodhi (1981) based on the compiled information of earlier work.

## Promising genetic stocks

Identification of lines for desired trait during the evaluation of the germplasm is most essential to utilize in breeding programmes. The work done in this direction is reported in brief.

### a) Fodder characters

Out of the forage sorghum germplasm evaluated at CCSHAU Hisar, the promising genetic stocks for different morphological traits and high fodder yield have been identified (Table 2). There are large number of promising genetic stocks for each of the morphological traits. However, lines like IS 1044, IS 18580, AS 18578, PS 14413, PJ 7R, HC 136, S 285, S 171, S 308 and HFS 566 have been identified promising for the quality fodder yield and these are

advised to be utilized extensively in the breeding of ideal forage sorghum varieties. Multicut sorghum lines-SSG 59-3, HFS 566, J 69, MP Chari, G 46, G 76 and HFS 197 possess characteristics of regeneration and faster growth incomparision to other agronomically superior forage types.

**Table 1. Range of variation for different traits in sorghum germplasm lines**

| Sr. No. | Traits | Range |
|---|---|---|
| 1. | Days to flowering | 38-150 |
| 2. | Plant height (cm) | 39-473 |
| 3. | Number of leaves | 3-22 |
| 4. | Leaf length (cm) | 35.00-110.12 |
| 5. | Leaf breadth (cm) | 2.00-10.03 |
| 6. | Number of tillers | 1.0-15.0 |
| 7. | Stem girth (cm) | 2.6-9.3 |
| 8. | Leaf weight/plant (g) | 6.3-90.0 |
| 9. | Stem weight/plant (g) | 60.00-1133.33 |
| 10. | Leaf/stem ratio | 0.1-0.7 |
| 11. | Green fodder yield/plant (g) | 62-1510 |
| 12. | Dry matter yield/plant (g) | 5.7-4167 |
| 13. | Protein (%) | 3.01-8.75 |
| 14. | *In vitro* dry matter digestibility IVDMD (%) | 40.4-66.2 |
| 15. | Neutral detergent fibre NDF (%) | 57.48-73.30 |
| 16. | ADF (%) | 30.85-42.00 |
| 17. | Cellulose (%) | 21.35-32.73 |
| 18. | Lignin (%) | 3.80-7.00 |
| 19. | Protein yield (q/ha) | 2.27-102.80 |
| 20. | DDM (q/ha) | 25.6-102.8 |
| 21. | Hydrocyanic acid HCN (ppm) | 18-600 |
| 22. | Tannin (mg/g) | 12.5-160.0 |

**b) Biotic resistance**

Resistant/tolerant lines to biotic stresses were also identified. A list of promising accessions resistant to foliar diseases, stem borer, shoot-fly and birds damage.

**Table 2. Promising genetic stocks for different morphological and yield traits**

| | | |
|---|---|---|
| A. | *Morphological Characters* | Promising genotypes |
| | Early Vigour | IS 2309, 4776, 12308, 18577, 2123, 5585, S 260, 259, 241, 266, 244, 171, JS 20, SPV 459, SPV 462, SSG 59-3, M.P. Chari |
| | Early in flowering (less than 60 days) | IS 4068, 4878, 1059, 455, 362, 2305, 677, 601, 12308, 13100 HFS 496, 732, 566, 621, 639, 910, 574, 575, S 259, 260, 109, 250, 244, 241, 272, 294, P 37, JS 20, MP Chari |
| | Plant height | IS 18580, IS 1873, S 285, S 308, S 351, S 286, S 349, HC 136, PC 6, PC 56 |
| | Number of leaves per plant (more than 18) | IS 3192, 2123, 2205, 18551, 18573, 3240, 3238, 71694, 18577, 18575, 18580, 71687, 71664, 1044, S 325, 385, 505, 507, 604, 285, PC 6, PC56, P 57, G 46, J 470, PS 14413, SPV 8, V 60-1, HC 136 |
| | Leaf length (more than 65 cm) | IS 1044, 5538, 13674, 18573, 18577, 18578, SU 52, HC 136, S 325, S 351, S 375 |
| | Leaf breadth (more than 7 cm) | IS 18577, 18578, 1044, 2205, 13674, S 287, S 308, 171, S 194, S 285, HC 136, UPFS 24, UF Chari 2, PS 14413 |
| | Stem girth (more than 4 cm) | IS 3072, 3231, 3238, 3236, 6018, 3353, 3240, 71635, 3214, 71687, 3214, 71687, 31130, 71694, 3192, 71664 |
| | Midrib colour of leaf | White : IS 102, 2115, 2844, 18833, 19522, 6152, 24397, 18908, 24485, R 1962, 1590, 3850, 3026, 2991, 2992, 2996, A 2384, A 2385, G 57, PS 1062. |
| | | Green : IS 4776, 3551, 1361, 4552, 6323, 24349, 21661, S 411, S 287, S 301, S 301, S 250, S 462, SPV 809, A 1868, A 2485, R 472, G 69 |
| | | Brown : IS 11861, 21887, 21888, 21889, 21890, 21891, 23253, 651, S 440-11 |
| B. | *Yield Traits* | |
| | Leaf Weight/ plant (more than 65 g) | IS 1044, IS 18578, PS 14413, SU 52, HC 136, S 171, PJ7R |
| | Stem weight/ plant (more than 300 g) | IS 1044, IS 18578, IS 18580, PS 14413, S 194, S 285, S 308, HC 136 |
| | Green fodder yield/ Plant | IS 1044, 18580, 5613, 4516, 11758, 12073, 12040, 12126, 12074, 3868, 3261, 613, 3185, 3037, 5664, 12308, PS 194, HC 136, SI 18, PJ 7R, J 9, V 60-1, PC 6, Roma, Sel. 512, S 308, SI 56, SPV 84, SPV 70, SL 54, CSV 6, SPV 8, S 152, A 6, G 9917, PC 16 |
| | Dry fodder yield/ plant (more than 130 g) | IS 1044, 18578, 18580, 2384, 3268, HFS 566, 621, 639, 559, 546, 200, S 194, 285, 308, 505, HC 136, PS 14413, P 57, R 472, R a52, G 46, G 76 |
| | Regeneration | HFS 566, HFS 565, HFS 732, HFS 8116, HFS 96, HFS 197, SSG 59-3, S 199, AS 11, S 260, S 259, HC 136, MP Chari, IS 3238, IS 3240, IS 3237, IS 3374, G 73, G 76, IS 3353 |

are given in Table 3. Lines G 40, IS 8087, IS 3380, SPV 98, S 171, S 260, S 435 and *S. roxburghii* showed resistance to most of the foliar diseases. IS 2205, IS 5470, IS 2123, IS 12308, IS 5469 and IS 2205 lines had resistance to stem borer while IS 1054, IS 5469, IS 18551, IS 2123 and S 171 had resistance to shoot-fly. Lines IS 5469 and IS 2123 had resistance to both stem borer and shoot fly as well as possess good fodder characters. Therefore, utilization of such genotypes in breeding programme will lead to useful results.

**Table 3. Promising genetic sotcks resistance to biotic stress**

| Biotic stress | Promising genotype |
|---|---|
| Foliar disease resistant | IS 8087, 3037, 3383, 3380, 4068, 3374, 4878, 6143, 1141, 1061, 1499, 2194, 1458, 1255, 2269, 2944, 4492, 21119, 8347, 18829, 12178, 21415 |
| | S 253, 411, 254, 381, 260, 171, 308, 194, 241, 440, 151, 162, 96, 435, 375 |
| | G 40, 41, 50, 51, 57, 73, 76 |
| | SPV 98, SPV 80, 61-1-1, P 37, 1062 B, *S.roxburghii* |
| Stem borer tolerant | IS 470, 2123, 12308, 21209, 8104, 5566, 5469, 3374, 5470, 1224, 8513, 19522, 5604, 2205, 1151, 18548, 18584, 2464, 18583, 18678, 637, 1002, 5268, 8315, 18577, 1059, 4777, 4692 |
| | S 285, 171, 436, 184, 505, 501, 241, G 73, G 76, PS 28157-1, PS 14413, ICSV 700, ICSV 70-5, ICSV 708, SSG 59-3, *S. roxburghii* |
| Shoot fly resistant | IS 488, 1054, 18551, 660, 1003, 5469, 2123, 2146, 2212, 5410, 34664, 18577, 8585, 18811, 18584, 5604, 5470, 4663, 5566, 14385 |
| | S 171, 260, 491, 308, 498, 440, 241, PS 14454, P 37, E 302, ICSV 700 |
| Bird resistant | IS 14346, 1807, 1020, 827, 18433, 22121, 18584, 18677, FS 1, G 39, G 65 |

Eleven lines were found to be resistant to bird damage. This may be due to high tannin contents in their seers. The seed colour of most of these lines was brown, and have no adverse effect on quality of forage. Therefore, there is good scope of combining bird damage resistance with cultivar having desirable fodder traits.

### c) Forage quality traits

Lines having low HCN and tannin contents and high IVDMD and protein levels were identified. Some of the promising lines for these traits (Table 4) have been utilized to develop the present day varieties.

**Table 4. Promising genetic stocks for quality traits**

| Quality trait | Promising genotypes |
|---|---|
| Low in HCN | IS 4776, 2844, 6128, 3313, 6090, 1059, 3247, 2944 |
| | SRS 5, S 109, T 26, C 10-2, T 30, S 178, *S.roxburghii*, PC 6, L 309, V 60-1 |
| Low in Tannin | *S. roxburghii*, S 171, HC 136, C 433, S 109, S 120, S 152, S 375, S 308, SPV 98, SPV 94, PJ 7R, IS 3247, S 498, HC 260, IS 4776, V 60-1, IS 3214, M 35-1 |
| High protein | M.P. Chari, S 301, S 209, Impi. Jowar, HC 136, HC 171, PC 154, S 499, S 411, S 120, 54-1, HFS 566, S 520, IS 651, S 184, S 308, PC 1, IS 4770 |
| High IVDMD | IS 4770, IS 8312, IS 6380, EC 127664, IS 8314, IS 4776, HC 136, HFS 566, S 208, S 260, S 281, S 259, S 171, S 428, S 472, S 199, SU 520 |

Sorghum genotypes, Imp. Jowar, PC 1 and S 520 had high protein (more than 7%) whereas IS 4770, IS 8312, IS 6880 and EC127664 had high digestibility (more than 55%). However HC 136 and HFS 566 appeared to be most promising genotypes in quality as they had high contents of both protein and *in vitro* dry matter digestibility. The lines IS 1059, IS 3247, JS 29/1, IS 4776 and NS 256 have been observed to be stable in low HCN content (Lodhi *et al.*, 1979). Low content of both HCN and tannin is dominant to high HCN and tannin, hence it is possible for the breeders to develop low HCN and tannin lines using the above desirable genetic stocks.

**d) Good combining and stable forage sorghum lines**

The germplasm lines found promising based on their evaluation for yield and quality were utilized to study their combining ability and stability for various forage yield and quality characters. Forage sorghum lines identified as good combiners and stable are given in Table 5. Lines IS 1049, IS 6090, PJ 7R, C 406-8, T 30 and PC 6 were found to be good combiners for height and leaf characters while G 10, HC 136, SPV 102, SPV 98 and JS 263 were best combiners for fodder yield. HC 136 was good combiner for both fodder and seed yield. *S. roxburghii* was good combiner for IVDMD and tannin. IS 4776 was good combiner for protein and HCN while IS 1049 was good combiner for protein and IVDMD. PJ 7R and S 241 were stable for both morphological and fodder yield characters. Likewise, IS 4776 was stable for protein, low HCN, S171, *S. roxburghii* for IVDMD and low tannin, IS 1049 for protein and IVDMD. Utilization of germplasm lines having good combining ability and stability for more number of forage yield and quality characters is likely to be more useful for genetic improvement in forage sorghum (Lodhi and Grewal, 1988).

**Table 5. Good combining and stable forage sorghum genetic stocks**

| | | |
|---|---|---|
| A. | *Good general combining lines for* | |
| 1. | Morphological traits (Height, leaf length, leaf breadth, number of leaves & flowering etc.) | IS 1049, IS 6090, SSG 59-3, PJ 7R, C 406-8, T 30, PC 6 |
| 2. | Fodder Yield traits | T 48, T 30, G 10, HC 136, SPV 102, KS 29/1 C 406-8, IS 1488, CK 60A, SPV 98, JS 2643, SPV 99, *S. roxburghii*, IS 1049, C 433, PC 9 |
| 3. | Seed yield traits | SPV 80, G 10, HC 136, IS 6090, S 171 |
| 4. | Proetin % | IS 1049, *S. roxburhii*, IS 6090, C 433, IS 4776, CK 60A, SPV 98 |
| 5. | IVDMD % | JS 263, IS 1049, IS 6090, *S. roxburhii*, CK 60A, SPV 98 |
| 6. | Low HCN (ppm) | JS 263, IS 4776, IS 6090, S 202 |
| 7. | Low tannin (mg/g) | HC 136, S. roxburhii, SPV 4, S 171 |
| B. | *Stable lines for* | |
| 1. | Morphological traits | IS 84, S 241, PJ 7R, IS 3214, S 308,S 171 |
| 2. | Fodder yield | HC 260, PC 14413, S 194, PJ 7R, C 433, C 406-2 PC 6, C 19 |
| 3. | Seed Yield | S 171, SPV 346, IS 7090, S 308, IS 14346, HC 136, HD 3, S 109 |
| 4. | Stem borer tolerance | HC 19522-1, IS 5538, PS 28157, PS 19349-1, IS 1044, PS 14413, 285, S308, IS 12308 |
| 5. | Multicut traits | IS 14485, 18849, 14564, 18812, 3312, 3234, 3513, 3237, 3238, 3236, 3267, 472, 3192, 3240, 3366, 3310, 3318, 3329, 3191, SSg 59-3 |
| 6. | Protein % | IS 6090, S 171, IS 2123, IS 18573, IS 5538, HC 136, IS 5604, IS 1049, JS 263, IS 4776 |
| 7. | IVDMD % | IS 5470, IS 6090, IS 1049, *S. roxburghii*, IS 18573, SPV 98, S 171, S 259, IS 18583, HC 136 |
| 8. | Low HCN (ppm) | IS 1059, IS 4776, NS 256, IS 3247, JS 29/1 |
| 9. | Low tannin (mg/g) | HC 136, S 109, *S. roxburghii*, S 171 |

Although large number of above promising genetic stocks have been utilized in breeding superior forage sorghum cultivars, yet emphasis is further needed to collect, evaluate and utilize the forage sorghum germplasm to develop superior genotypes. There is necessity to give more emphasis on these aspects in forage sorghum improvement programme and available forage sorghum germplasm is required to be studied not only for forage traits but also for nutritive traits and resistance to disease, insect and pests.

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**Short Communication**

# PRELIMINARY EVALUATION OF LOCAL MAIZE GERMPLASM FROM U.P. HILLS

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**Key words :** Maize, variability, *Zea mays*

Maize (*Zea mays* L.) has adapted itself to an array of environments from tropics to temperate regions of both the northern and southern hemispheres. Being a cross pollinated crop, it permits free flow of genes beyond political boundaries to evolve new genetic recombinants which has enhanced its adaptability (Vasal and Taba 1987). However, poor genetic diversity among the local germplasm has been reported from the plain areas in India (Rachie, 1962). Contrary to this, the higher elevations of north-eastern hills of India, Nepal, Bhutan and Indonesia are endowed with rich genetic diversity in maize (Singh, 1979). Although occurrence of substantial variability has been documented from Chamba valley of Himachal Pradesh (Khehra et al. 1979), no systematic attempts have so far been reported with respect to variability studies in the indigenous wealth of maize crop from U.P. hills. In this context, local germplasm collected from eight districts of U.P. hills was evaluated, to study the extent of variability and genetic diversity to breed better varieties for the hills.

Systematic attempts for the collection of local germplasm of maize from U.P. hills (Kumaon and Garhwal Himalayas) were made in the recent past. The area surveyed included eight districts, viz. Almora (19), Nainital (7), Pithoragarh (22), Pauri Garhwal (6), Tehri Garhwal (15), Chamoli (5), Uttarkashi (4) and Dehra Dun (2). The seed samples were collected from the bulk of seed material, instead of individual ears, in order to pool extent of variability within and between populations. Seventy five local collections were evaluated in 4 rows plot each of 5 m length at experimental farm Hawalbagh, Vivekananda Parvatiya Krishi Anusandhan Shala, Almora. Bulk sib pollinations were performed for the maintenance of these collections. The observations on days to 75 per cent silk, *Helminthosporium turcicum, Helminthosporium maydis* leaf blight

incidence, grain colour and texture, plant, ear and husk cover traits were recorded on plot basis while the data on plant height, ear height, ear girth, ear length characters were recorded on 10 randomly selected plants in each plot.

It was observed that on the basis of variation in 75 per cent days to silk, these accessions can be grouped into 4 distinct maturity classes namely late, medium, early and very-early. In the very early maturity group, the silking duration varied from 40-42 days, while the early, medium and late maturity collections took 49-53, 60-62 and 64-67 days to 75 per cent silk respectively. Most of the collections belonged either to early maturity (41%) or very early groups (26%), whereas 26% collections were medium in maturity and only 5% were late maturing types. The range of variability in the maturity duration thus suggested farmers preference for shorter maturity group in the U.P. hills. The range and mean of 75 genotypes for 10 characters, under four maturity groups (Table 1) showed that plant height varied from 152-288

**Table 1. Means and ranges for different characters under 4 maturity groups**

| Sl. No. | Character | Late | Medium | Early | Very early |
|---|---|---|---|---|---|
| 1. | Days to silk (75%) | 65.0 (64.67) | 60.9 (57-63) | 51.2 (48-55) | 43.3 (38-47) |
| 2. | Plant height (cm.) | 233 | 237 | 205 | 181 |
| | | (204-288) | (191-277) | (154-237) | (152-232) |
| 3. | Ear height (cm.) | 132 | 135 | 106 | 81 |
| | | (99-207) | (77-181) | (74-136) | (45-128) |
| 4. | Ear length (cm.) | 171.1 | 15.5 | 13.4 | 12.7 |
| | | (15.4-18.4) | (13.2-17.0) | (11.2-14.8) | (9.-0-15.2) |
| 5. | Ear girth (cm.) | 13.6 | 13.0 | 12.4 | 12.1 |
| | | (13.2-14.0) | (11.4-14.2) | (10.6-15.5) | (9.0-14.4) |
| 6. | *H. turcicum** (1-5) | 2.4 | 2.1 | 2.7 | 2.8 |
| | | (2.0-2.5) | (1.5-2.8) | (1.8-2.5) | (2.3-4.5) |
| 7. | *H. maydis** (1-5) | 2.1 | 2.0 | 2.1 | 2.0 |
| | | (2.0-2.5) | (1.5-2.5) | (1.5-2.8) | (1.5-3.0) |
| 8. | Plant aspect** (1-5) | 2.5 | 2.5 | 3.1 | 3.1 |
| | | (2.5-2.8) | (2.3-3.0) | (2.0-4.0) | (2.8-4.8) |
| 9. | Ear aspect** (1-5) | 2.5 | 2.5 | 2.3 | 2.7 |
| | | (2.5-2.5) | (2.0-2.8) | (2.3-2.5) | (2.7-3.5) |
| 10. | Husk cover** (1-5) | 2.3 | 2.4 | 2.6 | 2.7 |
| | | (2.3-2.3) | (2.3-2.8) | (2.5-3.0) | (2.5-3.3) |

*1 Resistant, 5 Highly susceptible

**1 best, 2 poor

cm. in the collections with an average height of 181, 205, 237 and 233 cm in very early, early, medium and late maturity groups, respectively. The average ear height in the very-early maturity group was 81 cm with a range of 45-128cm. As compared to very early group the average ear height in early, medium and late groups were 106, 135 and 132 cm respectively. The variation with respect to ear length varied from 11-14, 13-15, 14-16 and 15-18 cm in the very-early, early, medium and late maturity groups, respectively. From the data on plant height, ear height and ear length in four maturity groups it appeared that these characters had negative association with the early maturity duration.

In general, the local collections showed susceptibility to *H. turcicum*. However, moderate incidence was recorded in some collections in late, medium and early maturity groups. On the other hand most of the varieties recorded moderate scores ranging from 2.0-2.3, indicating tolerance to *H. maydis*.

As regards to plant, ear and husk cover traits the medium and late type collections were better compared to the remaining maturity groups. Hence, late and medium collections indicated better yielding ability than early and very early collections. With regards to grain colour, the yellow and orange colours were observed to be dominant among the local germplasm followed by yellow-white mixed grain colour (Table 2). The frequency of the colours revealed that by and large yellow and orange grain colours are liked by the hill farmers, however, uniformity in grain colour was not important in many pockets. Further, observation on grain texture showed farmers liking for the flint grains as dint grains were absent among the collections.

**Table 2. Classification of local germplasm by grain colour and texture in different maturity groups**

| Maturity groups | Single coloured | | | Mixed coloured | | | Total |
|---|---|---|---|---|---|---|---|
| | YF | OF | WF | RF | YWF | OWF | |
| Late maturity | 1 | 1 | - | - | 2 | - | 4 |
| Medium maturity | 5 | 2 | 7 | 1 | 5 | - | 20 |
| early maturity | 6 | 6 | 2 | - | 4 | 2 | 20 |
| Very early maturity | 9 | 7 | 1 | 1 | 11 | 2 | 31 |
| Total | 21 | 16 | 10 | 2 | 22 | 4 | 75 |

YF = Yellow flint, OF = Orange flint, WF = White flint, PF = Purple flint
YWF = Yellow white flint, OWF = Orange white flint.

The present study indicated that the extent of variability was not large for all characters. Nevertheless, the desirable variability available for earliness, shorter plant height, and attractive grain type are of immense breeding value.

Some of the impressive collections can be used in the breeding programme for developing highly adapted early hybrids and composites for higher maize production in the hill region.

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**Short Communication**

# GENETIC DIVERSITY OF KHIRNI (*MANILKARA HEXANDRA* (ROXB.) DUBARD) IN CENTRAL AND SOUTH-WEST INDIA

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**Key words :** Genetic diversity, Khirni, *Manilkara hexandra*, India

Khirni (*Manilkara hexandra* (Roxb.) Dubard) is the native to South Asia and adapted to dry evergreen forests of North-Central India and Deccan plateau (Stewart and Brandis, 1972). It is a minor fruit adapted to arid and semi-arid conditions of Tropics. The tree is medium large to tall with spreading crown and straight massive bole, bear avoid or ellipsoid shape berry (Annon, 1962). In Gujarat and adjoining area, flower occurs in two seasons *viz.*, July-August and October-November. However only October-November flower set fruits which mature during April-May when other fresh fruits are not available in the market. In North India flowers occur during February-March and fruits ripe during June-July. The fruit is small in size contain one to three seeds, and sweet in taste. It is ideal for plantation in semi-arid to arid region and in marginal soil (sandy and laterite). It is also used as commercial root-stock for Sapota (*Manilkara achras*) all over in Sapota growing areas (Singh *et al.*, 1963; Mukhopadhaya 1986; Singh, 1969). It also produces good quality timber. It is a minor fruit and little work has been done for its improvement. Hence, an exploration was undertaken to sample genotypes ideal for fruit production, donors parent and also suitable as root stock for Sapota.

An exploration for collection of Khirni germplasm was undertaken in parts of Gujarat and Maharashtra in collaboration with Project Co-ordinator (Tropical fruits), IIHR, Bangalore; Department of Horticulture, PKV Akola, Maharashtra and Horticultural Experiment Station, (GAU) Gandevi, Gujarat during fruit ripening season (April-May, 1993). The area covered includes *in-situ* plantation on the bank of Tapti river in district Bharuch, Gujarat and

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*ex situ* plantation in district Akola, Nagpur and Bhandara in Maharashtra, located between 73.0° to 79.6° E longitude and 20.8° to 21.7° N latitude. The random sampling method to collect gene pool from a population and biased sampling methods to collect particular genotype based on the known traits were adopted (Sinha, 1981). However, the emphasis was given for biased sampling accomodating maximum variability from minimum number of accessions. Ten ripe fruits were collected from each genotype and observations on fruit morphological traits were recorded.

Thirteen genotypes exhibiting wide range of variability in tree canopy development, fruit morphological characteristics, pulp characteristics and quality of the fruits were studied. In general, the *in-situ* plantation of Gujarat were highly vigorous with thicker trunk girth, tall growing, wide spread crown in comparison to *ex situ* plantations of Maharashtra.

The tree canopy, development was highly variable from dwarf (40' tall) to highly tall (> 100') in height and in spread from low growth to highly spreading. Similarly variability was observed in plant morphological characteristics *viz.*, trunk girth, foliage characteristics, pulp colour and quality of the fruits. High variability was also observed in fruit morphological characteristics and quality of pulp (Table 1). The fruit length varied from 1.48

**Table 1. Values, range, mean and standard error for eight quantitative characteristics in *Khirni***

| NIC Number | Fruit length | Fruit circum-ference | No. of seeds per fruit | Seed wt. per fruit | Pulp wt. per fruit | Pulp/ seed ratio | TSS | Fruit average weight |
|---|---|---|---|---|---|---|---|---|
| 19915 | 2.08 | 5.26 | 1.28 | 0.85 | 10.76 | 9.00 | 23.40 | 10.00 |
| 19916 | 2.22 | 3.80 | 1.44 | 0.92 | 10.08 | 10.96 | 24.8 | 11.00 |
| 19917 | 1.74 | 2.80 | 1.36 | 0.70 | 4.50 | 6.43 | 22.20 | 5.20 |
| 19918 | 2.08 | 3.32 | 1.50 | 0.92 | 7.18 | 7.80 | 26.80 | 8.10 |
| 19919 | 2.08 | 4.28 | 1.72 | 0.60 | 6.80 | 11.33 | 25.0 | 7.40 |
| 19920 | 2.10 | 4.45 | 1.60 | 0.80 | 8.20 | 10.25 | 24.6 | 9.00 |
| 19921 | 1.48 | 4.00 | 1.80 | 0.62 | 5.38 | 8.68 | 23.4 | 6.00 |
| 19924 | 1.84 | 2.92 | 1.42 | 0.66 | 5.24 | 7.94 | 21.5 | 5.90 |
| 19925 | 2.06 | 3.60 | 1.50 | 0.82 | 7.18 | 8.76 | 22.0 | 8.00 |
| 19930 | 2.18 | 4.40 | 1.00 | 0.60 | 8.66 | 14.43 | 25.8 | 9.26 |
| 19931 | 2.16 | 4.10 | 1.34 | 0.70 | 8.25 | 11.78 | 24.0 | 8.95 |
| 19932 | 2.10 | 3.32 | 1.60 | 0.80 | 6.30 | 7.88 | 21.5 | 7.10 |
| 19933 | 1.90 | 3.40 | 1.50 | 0.85 | 6.05 | 7.12 | 21.00 | 6.90 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Range | 1.48 | 2.82 | 1.00 | 0.60 | 4.50 | 6.43 | 21.00 | 5.20 |
| | 2.22 | 5.26 | 1.80 | 0.92 | 10.75 | 14.43 | 26.80 | 11.00 |
| Mean | 2.00 | 3.74 | 1.47 | 0.76 | 7.27 | 9.41 | 23.54 | 7.91 |
| SE ± | 0.06 | 0.22 | 0.06 | 0.03 | 0.52 | 0.62 | 0.51 | 0.48 |

cm (NIC-19921) to 2.22 cm (NIC-19916); circumference from 2.80 cm (NIC-19917) to 5.26 cm (NIC-19915), average number of seeds per fruit from 1.0 (NIC-19930) to 1.80 (NIC-19921), seed weight per fruit from 0.60g (NIC-19930) to 0.92g (NIC-19916 & 19918) pulp weight per fruit from 4.05g (NIC-19917) to 10.08g (NIC-19916) pulp seed ratio from 6.43 (NIC 19917) to 14.43 (NIC-19930), TSS (brix) from 21.00 (NIC-19933) to 26.80 (NIC 19918) and average fruit weight from 5.20 g (NIC-19917) to 11.00 (NIC-19916).

### Promising Germplasm

**NIC-19916** : This genotype is located in village Balot, (Jogaria), Distt. Baruch, Gujarat on the river bank of Tapati. It has highly vigorous growth, height 70′, trunk girth 11′, crown spread > 80′ leaves longer and broader. The sandy soil and arid climate was observed to be highly favourable for its vigorous growth and heavy bearing.

**NIC-19920** : It is situated on the river bank of Tapati in village balot (Jagaria) District Baruch, Gujarat. Tree medium tall, medium spreading and drooping habit. It bears fruit light orange to golden orange, highly sweet, less latex, better taste and aroma.

**NIC-19930** : It was identified from *ex situ* plantation in. Pawni forest range in Bhandara district of Maharashtra. It has crown medium in height and spread, trunk girth medium, drooping growth, bears fruits highly sweet, very less latex, highly soft pulp, seed medium size and brown.

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**Short Communication**

# STABILITY ANALYSIS OF GREEN POD YIELD IN FRENCH BEAN

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**Key words :** French beam, stability, green pod yield

French bean (*Phaseolus vulgaris* L.) is a sensitive crop to the vagaries of environment. Consequently, yield fluctuates with variations in environments. Hence, a study was conducted to assess genotype × environment interactions and stability of 13 genotypes in Shimla conditions.

Thirteen exotic collections (hereafterward referred to as EC) *viz.* - EC 14907, EC 22367, EC 24646, EC 39439, EC 42960, EC 43036, EC 57080, EC 94469, EC 99539, EC 10080, EC 102711, EC 108101 and Premier, imported from various sources, were tested in a randomised block design with 4 replicates in 5 years (1985-1989). Each genotypes was sown in 4-row plots, each row was 2 m long and spaced at 0.5 m apart. Plant to plant distance was 10-15 cm. At the time of sowing, nitrogen @25 kg/ha, phosphorus @70 kg/ha, and potassium @50 kg/ha were applied. Data on green pod yield (Q/ha) was calculated on the basis of plot (2 × 1.5 m) yield and used for statistical analysis for stability parameters (Eberhart and Russell, 1966).

The differences were highly significant among the genotypes for green pod yield (Table 1). Environment played a major role in expression of green

**Table 1. Analysis of variance of stability for green pod yield of 13 genotypes of French bean**

| Source of variation | d.f. | S.S. | M.S. |
|---|---|---|---|
| Genotypes | 12 | 13643.74 | 1135.97** |
| Environment + (G × E) | 52 | 28601.35 | 550.02** |
| Environment (Linear) | 1 | 15891.85 | 15891.85** |
| Genotype × Environment (Linear) | 12 | 6128.58 | 510.17** |
| Pooled deviation | 39 | 5834.50 | 149.60 |

**P = 0.01

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pod yield. The environment (linear) component was significant, indicating that environments differ markedly and thereby satisfying the requirement of stability analysis. Significant genotype × environment (linear) interaction indicated genotypic differences for regression over environmental means (Table 1), and that genotypes behaved differently in different environments during 5 years of study.

Regression 'b' and deviation from regression '$S^2d$' (Eberhart and Russell, 1966) were considered to adjudge the stability of genotypes. A genotype with maximum yield expression for unit 'b' value and non-significant '$S^2d$' value would be ideal for general cultivation.

For green pod yield, EC 57080 and EC 108101 with higher mean values (127.28 and 112.86) with significant 'b' value of 1.22 and 0.9 and non-significant deviations from regression might be stable over the years in a favourable environment. Also, the genotypes such as EC 100680 and Premier showed relatively better mean values with low 'b' values (0.006 and 0.31) indicating their better performance in poor environments (Table 2).

**Table 2. Estimates of stability parameters (mean, b and $S^2d$) for green pod yield (Q/ha) in French bean**

| Genotype | Source | Mean | 'b' | $S^2d$ |
|---|---|---|---|---|
| EC 14907 | U.S.A. | 86.92 | 1.37 | 316.74** |
| EC 22367 | U.S.A. | 89.40 | 0.82** | 366.86** |
| EC 24646 | Sweden | 70.78 | 0.76** | 559.74** |
| EC 39439 | U.S.A. | 96.92 | 0.64 | 288.94** |
| EC 42960 | U.S.A. | 87.76 | 1.76 | 498.16** |
| EC 43036 | U.S.A. | 112.90 | 0.71 | 12.68 |
| EC 57080 | Australia | 127.28 | 1.22** | -20.91 |
| EC 94469 | Bulgaria | 99.58 | 2.48 | 35.09** |
| EC 99539 | U.S.S.R. | 89.48 | 1.32 | 78.59** |
| EC 100680 | Netherlands | 96.72 | 0.006 | 68.27** |
| EC 102711 | Australia | 85.84 | 0.33 | -563.76** |
| EC 108101 | U.S.A. | 112-86 | 0.91** | 9.35 |
| Premier | U.S.A | 79.58 | 0.31 | 153.85** |

Grand mean – 94.93; S.Em. – 6.12; C.D. – 16.96; **P = 0.01

On the basis of green pod yield, EC 57080 (*ex* Australia) and EC 108101 (*ex* U.S.A.) were adjudged as stable genotypes in Shimla conditions and may prove popular. In India, these two genotypes should be tested in different locations over the years to establish their superiority and stability.

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Short Communication

# ELITE *CINNAMON ZEYLANICUM* GENOTYPES ISOLATED FROM GERMPLASM OF INDIA AND CEYLON

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**Key words :** Cinnamon germplasm, elite genotypes

*Cinnamomum zelynicum* Blume is a native of Ceylon, is also found growing in south India, (Ridley, 1893). This species from its wild state is being cultivated in both the countries for spice and leaf oil production. The highly cross pollination characteristic recorded wide variability in the morphological parameters which caused confusion in taxonomical studies. Paul and Dutta (1978) and Paul and Sahoo (1993) studied the variations in morphoeconomic characters. Besides, the leaf oil chemo types in Cinnamon were reported by Rao *et al.* (1988). Hence, Cinnamon germplasm accessions collected from Ceylon and India (Tamil Nadu and Bangalore) during early seventies were cultivated at RRL, Bhubaneswar to isolate elite genotypes of *C. zeylanicum.*

The germplasm seed progenies were grown in one hectare area with a population of 2500 plants. Though the bark and leaf oils were studied, the population was screened based on tongue taste of bark and leaf petiole. Twenty elite plants isolated from 70 gutty progenies of 7 year old were multiplied vegetatively and planted in isolated area. The fresh leaf and bark oil of six to seven years old elite plant progenies were estimated by Clavengers apparatus and oil quality was analysed by GC using 2 m long Carbowax M-20 column.

The six year old Cinnamon progenies recorded wide range of leaf oil content (0.2 to 1.20 percent) with an average of 0.78 per cent, while the seven year old population had 0.60 to 1.4 per cent leaf oil with mean value of 0.90 per cent. Among the selections RRL(B) C-5 recorded the highest oil content in both the years (0.95 per cent in 6th year and 1.20 per cent in 7th year). While the progenies recorded increase in leaf oil content with age, the selection RRL(B) C-6 produced 0.8 per cent oil in both the years.

The range of bark oil content of elite Cinnamon progenies were 0.15 to 0.38 per cent and 0.20 to 0.70 per cent 6th and 7th year respectively. Similar reports are made by Paul and Sahoo (1993). The increase in oil content in older plants might be due to increase in oil glands in leaf and bark.

The leaf oil analysis yielded 73.63 to 92.19 per cent and 90.8 to 95.7 per cent eugenol in the 6th and 7th year respectively. Similar the cinnamic aldehyde content of the bark oil is also increased with the increase in the age of the plants in all the elite population. But the genotypes had shown significant different in their leaf and bark oil quality and the selecton RRL(B) C-6 found to be the best (94 per cent eugenol and 83 per cent cinnamic aldehyde) among all the genotypes. The laboratory has released this variety alongwith the composite seeds of elite population to commercial growers.

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Short Communication

# GENETIC DIVERGENCE IN INDIGENOUS MAIZE (*ZEA MAYS* L.) GERMPLASM OF U.P. HILLS

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**Key words :** Genetic divergence, maize

Classification of indigeneous maize based on genetic divergence may provide a basis for selection of parents with heterotic combination (Ahloowalia and Dhavan, 1963; Key, 1987 and Ordas et al. 1994). An attempt was therefore, made to study the genetic diversity, using multivariate statistical technique based on measurement of yield and thirteen yield attributes, among indigenous maize germplasm from hills of Uttar Pradesh (U.P.).

One hundred indigenous accessions of maize belonging to hilly areas of U.P. alongwith five check varieties, VL 16, VL 42, Hunius, Vijay and MCU 508 were sown in augmented block design with 13 blocks at VPKAS (ICAR), Almora. Plot size was 3.0 m × 1.2 m. with inter and intra-row spacings of 60 cm and 25 cm, respectively. The data were recorded on five randomly selected plants in each genotype for different characters *viz.* plant height (cm), ear height (cm), ear/plant, ear length (cm), ear girth (cm), grain rows/ear, grains/row, ear weight/plant (g), grain yield/plant (g) and shelling index (%). However, days to pollenshed, silking and dry husk, and 200 grain weight were recorded on plot basis. Recommended agronomic practices were adopted through various stages of crop growth.

Analysis of the data was done in augmented block design (Petersen, 1985). Principal component analysis was used to transform all the variables into new set of independent variables. The first several principal components that accounted for more than 90% of the total variation were used for non-hierarchical euclidean cluster analysis (Beale, 1969).

Correlation matrix of the adjusted values was used for principal component analysis which yielded into 14 eigen vectors and eigen roots. First principal component had highest eigen root (7.89) and also accounted highest proportion

(56.4%) of the total variation present in the original data. The magnitude of eigen root and proportion of total variation decreased for subsequent principal components and ended with minimum eigen root (.003) and proportion of variation (.02%) for fourteenth principal component. Cumulative percentage of total variation indicated the first seven principal components accounted for more than 95% of the variation present in the data. Therefore, first seven principal components, in reduced dimension, were used for non-hierarchical euclidean cluster analysis.

Cluster analysis was initiated with 7 principal component scores by arbitrarily assigning 12 clusters and by reducing one cluster each at every subsequent stage, thus, four cluster solutions with 12, 11, 10 and 9 clusters were obtained. Sequential F ratio test showed that merging of 11 clusters into 10 clusters make F ratio significant at 5% level of probability and, therefore, solutions converged with 11 clusters which aptly described the data. The grouping of 100 accessions into 11 non-overlapping clusters, obviously, showed the diversity among indigeneous maize of U.P. hills.

The distribution pattern of 100 germplasm accessions varied from a minimum 2 in cluster X to a maximum of 16 in cluster VI (Table 1). Intracluster

**Table 1. Composition of clusters based on genetic divergence in maize.**

| Cluster | No. of accession | Germplasm accessions included in clusters |
|---|---|---|
| I | 10 | P 442, P 584, P 446, P 263, P 99, P 94, P 1, P 525, P 14, P 15 |
| II | 10 | P 35, P 88, P 37, P 54, P 78, P 74, P 39, P 76, P 66, ML 21 |
| III | 07 | ML 46, P 440, P 579, ML 12, ML 48, P 7, P 581 |
| IV | 10 | P 637, P 34, P 17, P 97, P 51, P 81, P 73, P 53, P 13, P 42 |
| V | 11 | P 244, P 86, P 115, P 116, P 105, P 123, P 432, P 114, P 12, P 414, P 430 |
| VI | 16 | ML 44, P 98, P 56, ML 22, P 264, P 18, P 71, ML 36, P 16, P 40, P 47, P 75, P 44, P 79, P 45, P 55 |
| VII | 10 | ML 2, ML 3, ML 13, P48, ML 40, P 50, P 49, ML 4, ML 5, ML 7 |
| VIII | 07 | P 80, P 19, P 20, P 38, P 72, P 82, P 69 |
| IX | 08 | ML 45, P 343, P 63, P 445, ML 42, P 70, P 96, P 636 |
| X | 02 | P 77, P 46 |
| XI | 09 | P 439, P 583, P 43, P 447, P 580, P 87, P 437, P 83, P 443 |

distance was maximum in cluster VIII (2.39) while minimum (1.16) in cluster X (Table 2). Thus, seven accessions grouped in cluster VIII seem to be more heterogeneous owing to highest intracluster distance. The estimates of inter cluster distance revealed that members grouped in cluster III were more

distantly (9.66) related to cluster VIII. CLuster VII was also distantly related to cluster V, cluster VII, cluster I and cluster IX. Inter-cluster distances were also appreciably higher between cluster III and X, cluster V and X, cluster VII and X, cluster III and IV, and cluster II and III.

The cluster means indicated that accessions grouped in cluster VIII had medium maturity, highest plant and ear height, largest ear size with maximum number of grains/row, ear weight/plant and 200- grain weight. Cluster III possessed early maturing accessions with medium stature, lower ear placement and highest shelling index, whereas late maturing accessions having lowest shelling index were grouped in cluster X. The accessions that possessed maximum number of rows/ear were grouped in cluster IV.

**Table 2. Average inter and intra-cluster (in bold) distances (D) in maize**

| Cluster | I | II | III | IV | V | VI | VII | VIII | IX | X | XI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I | **1.73** | | | | | | | | | | |
| II | 4.79 | **1.96** | | | | | | | | | |
| III | 2.68 | 7.15 | **1.92** | | | | | | | | |
| IV | 4.83 | 2.93 | 7.32 | **1.54** | | | | | | | |
| V | 2.55 | 5.45 | 2.62 | 6.47 | **1.37** | | | | | | |
| VI | 3.07 | 2.33 | 5.34 | 2.67 | 4.14 | **1.71** | | | | | |
| VII | 3.21 | 5.99 | 3.21 | 6.40 | 2.79 | 4.60 | **2.04** | | | | |
| VIII | 7.16 | 4.72 | 9.66 | 3.00 | 8.84 | 5.22 | 8.42 | **2.39** | | | |
| IX | 3.32 | 3.54 | 4.73 | 5.01 | 2.72 | 2.50 | 4.14 | 7.20 | **1.81** | | |
| X | 6.29 | 2.58 | 8.67 | 2.93 | 7.40 | 3.74 | 7.39 | 3.17 | 5.35 | **1.16** | |
| XI | 2.68 | 4.40 | 4.19 | 4.57 | 4.00 | 2.82 | 4.07 | 6.48 | 3.39 | 5.01 | **2.07** |

The final goal of most of the breeding programmes in maize is to develop hybrid/composite outyielding the existing ones in yield coupled with adaptability. It has been observed that, in general, indigenous maize germplasm possess high adaptability as these are build up on same agroecological niches. To harness better recombinants for yield attributes, the breeder would like to choose genetically diverse parents. Inter-mating of such lines may result in providing desirable recombinants, which may subsequently be utilized in the development of superior open-pollinated populations on hybrids. Significance of diversity in the selection of parents has also been stressed by Ahloowalia and Dhavan (1963), Dhillon and Singh (1983), Prasad and Singh (1986), Key (1987) and Saxena and Sandhu (1989).

The validity and reliability of divergence, therefore, lies in the selection of parents showing heterotic relationship with degree of divergence upon

resume of inter-mating. Many workers including Prasad and Singh (1986), Key (1987) and Ordas *et al.* (1994) have reported that degree of heterosis is related to the divergence of the parents in spite of some irregularities. Statistical distance represents the index of genetic diversity. Members grouped in a cluster are presumably least diversly which may be utilised to develop a population. Consequently a crossing programme could be formulated with the potential parents belonging to different clusters which exhibit high divergence. Mean of all the inter-cluster distances may be considered as guide line for the selection of diverse parents from different clusters. Considering the inter cluster distance and cluster means, inter-mating of parental lines from cluster VIII with parental lines either from cluster I, III or VII, and also between cluster III and IV is likely to produce desirable recombinants.

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**Short Communication**

# PERPETUAL COTTONS OF ANDHRA PRADESH

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**Key words :** Perpetual Cottons, Andhra Pradesh

Uncultivated cottons from Kathiawar, Konkan and Bengal and their specimens are preserved in the British Museum and Edenburg herbarium. It is believed that a red flowered cotton, a century ago, was abundant and more important than it is today. Hutchinson *et. al.* (1947) and Hutchinson (1954) have described the perennial forms of cotton, closer to the ancestral type. A brief review of the genetic wealth in *Gossypium* with special reference to wild species has been published by Narayanan, (1985). Samba Murthy *et. al.* (1994) reported three groups of perennial cottons of Andhra Pradesh. The wild and cultivated cotton plants of the world has been well compiled and documented by Watt (1907). The present note gives a brief account of preliminary morphological aspects of perennial cottons.

## Exploration and Range of Distribution

Exploration for the collection of cotton germplasm in parts of Andhra Pradesh was organised jointly by the Central Institute for Cotton Research, Nagpur and National Bureau of Plant Genetic Resources, New Delhi in December 1993. Nearly 84 accessions involving 32 *G. hirsutum*, 30 *G. arboreum*, 4 *G. herbaceum* and 18 accessions of uncultivated perennial cottons were collected. The areas covered included Guntur, Mahboobnagar, Kurnool, Prakasam and Nalgonda districts in Andhra Pradesh (table 1). The perennial cotton plants generally exist in house backyards, temple compounds and in vacant places in traditional cotton growing districts of Andhra Pradesh. The perennial cottons are known by various vernacular names eg. Pagadapathi, Pamidipathi and Jadapathi and exhibit morphological variations.

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**Table 1. Vernacular names and source of collection of perennial cottons from Andhra Pradesh**

| Sl. No. | Accession No. | Vernacular/Local name | Species | Source (Village and District) |
|---|---|---|---|---|
| 1. | SP 3907* | JADAPATHI | *G. arboreum* | KONIDEDU, KURNOOL |
| 2. | SP 3908* | PAGADAPATHI | *G. arboreum* | GONAVARAM, KURNOOL |
| 3. | SP3909 | PYDIPATHI | *G arboreum* | NANDAVARAM, KURNOOL |
| 4. | SP 3910 | PAGADAPATHI | *G. aboreum* | MITTAPALLI, KURNOOL |
| 5. | SP 3912* | PAGADAPATHI | *G. arboreum* | KOILKUNTLA, KURNOOL |
| 6. | SP 3914* | PAGIDIPATHI | *G. arboreum* | OWK, KURNOOL |
| 7. | SP 3918 | PYDIPATHI | *G. arboreum* | KALUGOTLA, KURNOOL |
| 8. | SP 3926* | PAGADAPTHI | *G. arboreum* | VEERAREDDIPALLE, KURNOOL |
| 9. | SP 3927 | PAMIDIPATHI | *G. arboreum* | VEERAREDDIPALLE, KURNOOL |
| 10. | SP 3928 | PAGADAPATHI | *G. arboreum* | VEERAREDDIPALLE, KURNOOL |
| 11. | SP 3951 | PAGADAPATHI | *G. arboreum* | HOLAGONDI, KURNOOL |
| 12. | Sp 3977* | PAGADAPATHI | *G. arboreum* | DURGI, GUNTUR |
| 13. | SP 3981 | PAGADAPATHI | *G. arboreum* | DACHEPALLI, GUNTUR |
| 14. | SP 3982* | PAGADAPATHI | *G. arboreum* | VEERAPURAM, GUNTUR |
| 15. | SP 3984* | | *G. arboreum* | PRATHIPADU, GUNTUR |
| 16. | SP 3985 | | *G. arboreum* | PRATHIPADU, GUNTUR |
| 17. | SP 3986 | | *G. arboreum* | PRATHIPADU, GUNTUR |
| 18. | SP 3987 | | *G. barbadense* | CHOUTUPPAL, NALGONDA |

* Established in the wild Species Garden at CICR, Nagpur.

### Morphological Description

Eighteen accessions of uncultivated perennial land races of *G. arboreum* were collected from the areas of Andhra Pradesh and sown in July, 1994 at CICR research farm for the establishment in the existing wild species garden. Preliminary morphological evaluation was done in relation to phyllotaxy and floral taxonomy. Morphologically, the established perpectual cottons could be classified in to groups A and B.

Group A consisted of SP 3914, SP 3984 and SP 3982. The plants are perennial and tall in habit and some time attaining height upto 10 feet with long trailing thin branches. Leaves are thick and leathery, consistent and deeply serrated, 5 lobed occasionally with an extra tooth on one or both sides of the central lobe. Lobes are curvilinear, midrib distinct, the central one very frequently purple coloured. Flowers are large, corolla three times of length of

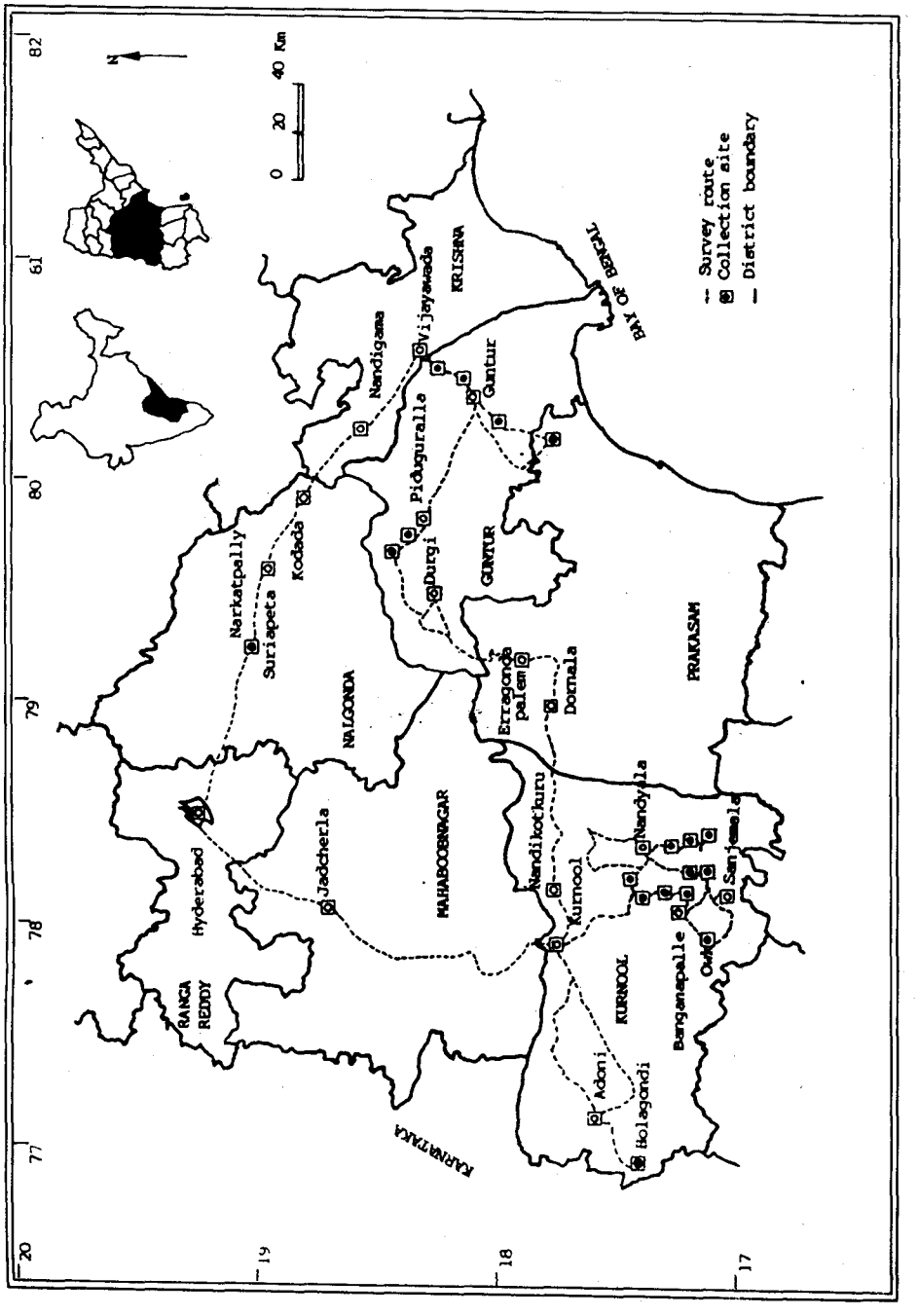


Fig. 1. Survey route followed for the collection of cotton germplasm in Andhra Pradesh

the bracteole, convolute and convolvulate, deep purple red with well marked hairy folds. Bracteoles are small, usually one third the length of the corolla, veins few, circular attachment often cospicuous but not glandular, calyx large, purple, truncate. Capsules are more or less rounded, 3 celled, acuminate with 6-8 seeds in each cell. Seeds are small, irregular and coated with green fuzz.

Group B consisted of SP 3908, SP 3912, SP 3977 SP 3907 and SP 3926. Perennials in this group can be differentiated from the other cultivated *G. arboreum* races. Plants are upto 2.4 m height, densely branched, dark purple in colour, leaves leathery, long sinus, 5 lobed and with an extra rudimentary lobe towards left or right of the central lobe. Inflorescence is much elongated, shoots with many lateral axillary buds which mostly becomes abortive. Peduncle is usually shorter than subtended petiole. Petals are deep purple red with darker patches at the base and well marked hairy folds. Bracteoles are small conspicuous but not glandular. Calyx is purple truncate or slightly 5 angled, gland dots very distinct. Capsules rounded, 3 celled with tapering ends, pitted and predominantly gland dotted. Generally, each locule contains 5-7 seeds. Seeds are small, irregular in form, coarsely coated with greenish velvet fuzz. Plants are highly tolerant/resistant to pests like bollworms and sucking pests in natural and uncultivated conditions. Perennials of group A and B are very close to each other and have remarkable resemblances in morphotaxonomy with *G. arboreum* race *sudanense*. However, in order to identify the races of the above perennials of *G. arboreum*, further critical cytogenetical and numerical taxonomical investigations are needed.

**Economic Utility**

Perennial cotton plants of *arboreum* species generally exist in house backyards and temple compounds. Since ancient time the lint is used for preparing wicks of lamps for worshipping in temples and sacred threads. Extracts of nascent leaf is used in curing skin disease of infants and sometimes used as are for ear aches in rural areas of Andhra Pradesh. It has been often affirmed that this was the cotton specially used by the Egyptian priests in construction of their robes. However, there seems to be some hesitation in accepting the frequently asserted antiquity of the Egyptian knowledge in *arboreum* perennial cottons (Watt, 1907).

These perennial cottons possess variability in useful traits like fibre and pest resistant characters which can be utilised by appropriate breeding procedure as a donar to improve these traits (Samba Murthy *et. al.* 1994). Similarly the perennials of *arboreum* species can be exploited for bollworm resistance. Further studies are needed on receptivity of stigma, biochemical analysis, photoperiodic and drought parameters.

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**Short Communication**

# RESISTANCE IN TRADITIONAL RAINFED RICE CULTIVARS FOR BACTERIAL LEAF BLIGHT (*XANTHOMONAS COMPESTRIES PV. ORYZAE*)

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**Key words :** Bacterial leaf blight, traditional cultivars, rainfed rice, resistance.

Increasing use of modern rice varieties with high fertilizer inputs has necessitated suitable management of disease to achieve high returns. Bacterial leaf blight (BLP) caused by *Zanthomonas compestries* pv. *Oryzae* have been reported to be one of the major disease of shallow rainfed agroecology of plateau region. (Variar et al 1990) causing estimated yield loss to the extent of (20-30%) in eastern India (Widawsky and O'Toole, 1990). This necessitated the development of resistant cultivars. Therefore, there is a need of donor genotypes for resistance with a view to incorporate them in improved cultivars. In this context vast and untapped potential of locally adopted traditional cultivars offers great promise. The present paper reports bacterial leaf blight resistant accessions identified from a collection of traditional cultivars.

One hundred and eighty three accessions collected from plateau region of Bihar and adjoining parts of West Bengal were evaluated for bacterial blight (*Xanthomonas compestries pv Oryzae* (Uyeda & Ishiyama) during 1990-93. Each accession was tested atleast for two seasons. The accessions were transplanted using single seedling/hill with spacing 20 × 15 cm and high fertility 120 N, 18 P and 17 K kg/ha. Seedlings were clip inoculated 45 days after transplanting following Kauffman et. al. 1973. The scoring was done when the susceptible check T(N)1 was completely damaged, following standard evaluation system (SES) for rice (Anonymous 1988). The agromorphological characters and phenol reaction of resistant accessions were also recorded using 10 plants per accession.

Fifty seven accessions (31.1%) had score of 2 and 3 and the rest were either moderately resistant or susceptible (Fig. 1). None of the accessions showed score of 0 to 1. Accessions showing consistently high levels of resistance were Sikkinanhiya (HRC 701), 42-34 (HRC 702), Kalamdani (HRC 706), Jugadi (HRC 733), Azamdulla (NIC 105735), Majhidhan (NIC 105724), Radha Kanka (NIC 105730), Bilaiti Bhogna (NIC 105737) and Maghidhan (NIC 105752).

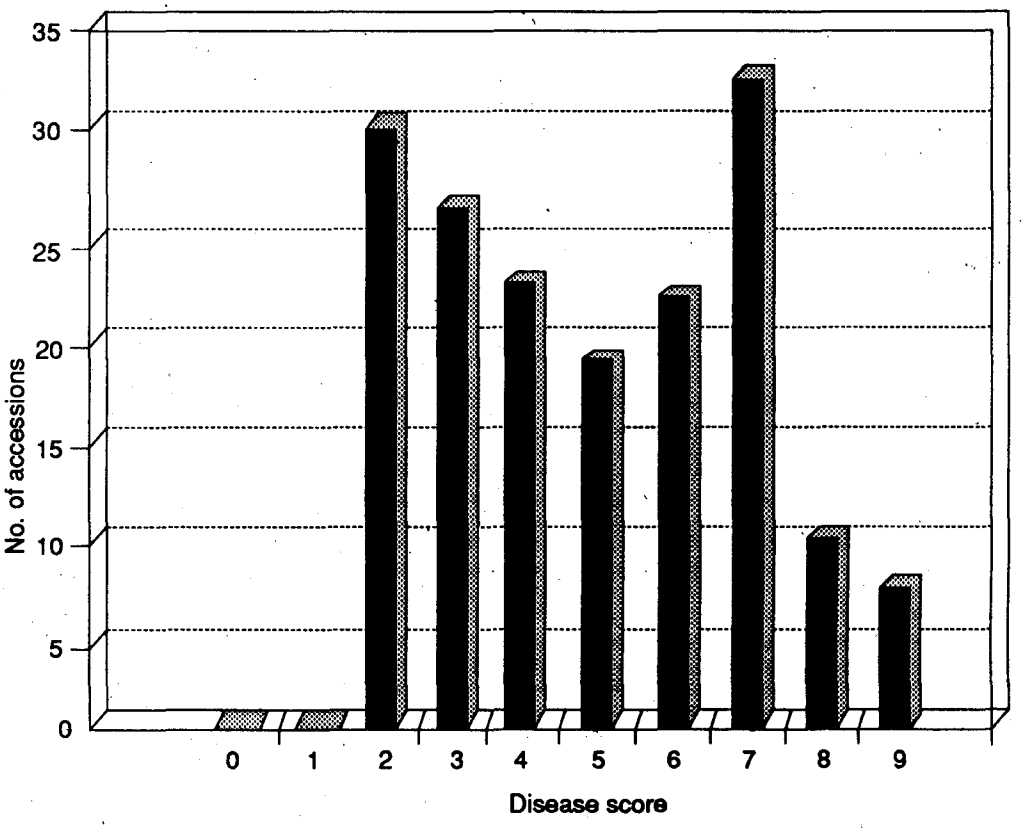


**Fig. 1. Frequency distribution of rice accessions for BLB (n=183)**

The present collection comprised accessions mostly from medium and lowlands and thus indicated prevalence of resistance to bacterial blight, because bacterial blight in such agroecology leading to adequate differentiation of suspectible and resistant accessions is followed by human and natural selection. Several accessions has desirable agromorphological characters in addition to BLB resistance (Table 1) and hence may serve as useful donors for varietal improvement programmes.

**Table 1. Morphoagronomic characters of some selected bacterial leaf blight resistant accessions.**

| Accessions | Source | Plant height (cm) | 50% flowering (days) | Panicle length (cm) | Spikelets/ panicle (No.) | Fertility (%) | 200 grain wt(g) | Grain length (mm) | L/B ratio | Phenol reaction |
|---|---|---|---|---|---|---|---|---|---|---|
| HRC 701 | Sikkinanhiya | 106 | 105 | 24.7 | 106.0 | 90.1 | 5.0 | 6.4 | 3.0 | + |
| HRC 716 | Sikkinanhiya | 117 | 108 | 23.2 | 115.8 | 78.0 | 4.0 | 5.0 | 2.9 | + |
| HRC 733 | Gopalbhog | 120 | 104 | 25.6 | 59.0 | 84.8 | 6.3 | 6.6 | 2.6 | - |
| HRC 735 | Jugadi | 115 | 97 | 26.5 | 55.0 | 80.0 | 53 | 6.2 | 2.5 | +++ |
| NIC105687 | Lau | 133 | 111 | 27.7 | 155.0 | 66.1 | 5.8 | 6.0 | 2.4 | +++ |
| NIC 105703 | Ajondholi | 110 | 105 | 24.9 | 122.5 | 80.0 | 5.0 | 6.4 | 2.9 | +++ |
| NIC105735 | Majhidhan | 103 | 105 | 23,3 | 113.5 | 73.6 | 5.8 | 6.2 | 2.7 | + |
| NIC105735 | Azamdulla | 120 | 104 | 21.3 | 109.0 | 86.7 | 4.9 | 6.3 | 2.8 | +++ |
| NIC105737 | Bilaitibhogna | 110 | 99 | 22.8 | 168.8 | 82.1 | 4.2 | 5.9 | 2.8 | +++ |
| NIC105750 | Samundardhan | 108 | 93 | 24.2 | 127.8 | 71.6 | 5.7 | 5.9 | 2.3 | +++ |
| NIC105752 | Maghidhan | 98 | 109 | 22.0 | 86.0 | 88.6 | 5.1 | 6.7 | 3.2 | +++ |
| NIC105810 | Jhingasar | 126 | 101 | 25.2 | 117.8 | 83.6 | 5.8 | 7.2 | 3.1 | + |

HRC - Hazaribad Rice Collections

NIC - National Indeginous Collections (NBPGR, Ranchi)

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**Short Communication**

# COLLECTING CULTIVATED AND WILD SPECIES OF CORCHORUS IN GUJARAT, INDIA

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**Key words :** Corchorus, exploration, germplasm

The genus *Corchorus* has about 40 species distributed throughout the tropical regions of Africa, South America, Australia, China and South East Asia (Kundu et al., 1959). In India eight species are found (Hooker, 1894; Sinha *et al.* 1988). *C. capsularis* Linn and C. *olitorius* Linn. are commercially cultivated for fibre, while *C. aestuans* Linn., *C. depressus* Linn., *C. fascicularis* Linn., *C. trindes* Linn., *C. trilocularis* Linn. and *C. urticaefolia* Lam. are wild and have not been commercially exploited. Some of these (*C. aestuans, C. capsularis, C. depressus, C. fascicularis* and *C. olitorius*) are of medicinal value. India is primary centre of origin of *C. capsularis* and possesses a rich diversity. Hence an exploration was undertaken to collect germplasm diversity from parts of Gujarat during December 1989-January 1990.

Germplasm collection was carried out in Ahmedabad, Amreli, Banaskantha, Bhavnagar, Jamnagar, Junagarh, Kheda, Mehsana, Panchmahal, Rajkot, Surendranagar and Vadodara districts characterized by north-western plains, central highlands and coastal landscape with varying climate (arid-semi/arid) and soil type. The surveyed area lies between 20° to 25° north latitude, 69° to 75° east longitude and 25 to 300 m altitude. A total of one hundred and sixty four collections (Table 1) comprising of *Corchorus aestuans, C. depressus, C. fascicularis, C. olitorius, C. tridens, C. trilocularis* and *C. urticaefolia* were collected from 153 different sites characterized by barren/waste places, along water reservoirs, near ponds, hillocks, Gir forest, coastal areas and cultivated fields (Fig. 1). Bulk, random and non random sampling methods were followed for collecting 50 capsules and large number of seeds at each site. Herbarium specimens were made and passport data were recorded on standard sheets.

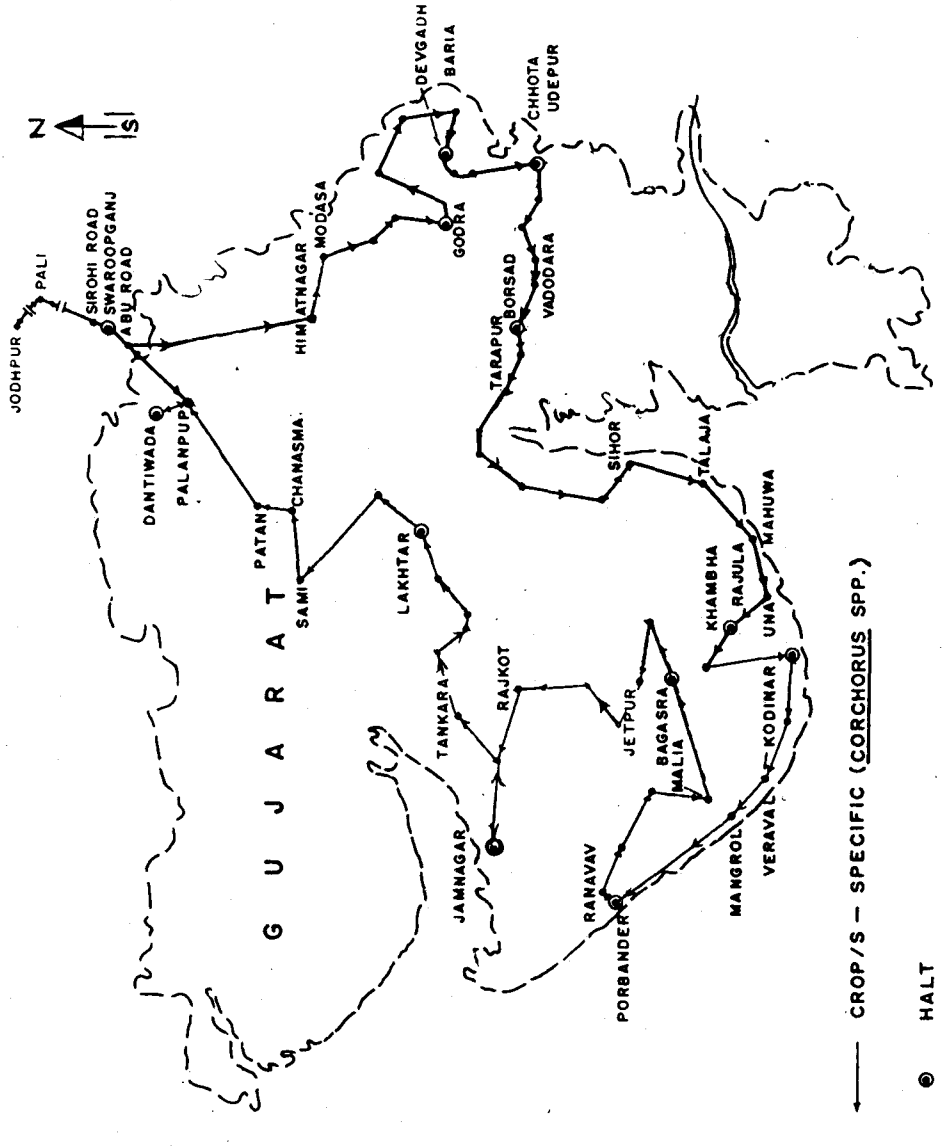


Fig. 1. Map showing route followed during collection of cultivated and wild speices of *Corchorus* in Gujarat, India

A remarkable variability was found in different species of *Corchorus* for their growth habit (erect, spreading), plant height (dwarf, medium., tall), plant type (less to highly branched), stem colour (green, purple), leaf shape (simple, ovate, oblong, lanceolate, serrate margin), leaf size (small, medium, large), leaf colour (light to dark green), pubescence, number of flowers per peduncle (solitary to five), flower colour (dull yellow, yellow), number of capsules per cluster (one to five), capsule shape (compressed, round, angled, straight, curved), capsule size (short, medium, long), capsule surface (smooth, rough), number of locules per capsule (three to five), seed colour (light brown, lead black, steel grey, light black), seed surface (smooth, rough, wrinkled) and seed shape (round, angular, wedge-shaped). The material collected was sent to N.B.P.G.R. Headquarters, New Delhi along with passport data for providing National Indigenous Collection (NIC) numbers and onward supply to the concerned Institute for evaluation and conservation.

It was noted during the exploration trip that Junagarh, Amerli and parts of Bhavnagar districts were rich with all the seven species of *Corchorus*. An intensive exploration is needed to further sample germplasm from

**Table 1. Collection of different species of *Corchorus* from parts of Gujarat.**

| Districts | *Corchorus* spp. | | | | | | | Total collections |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| Ahmedabad | 02 | - | - | 03 | - | 03 | 01 | 09 |
| Amreli | 05 | 01 | 01 | 13 | 01 | 08 | 07 | 35 |
| Banaskantha | - | - | - | 02 | - | 01 | - | 03 |
| Bhavnagar | - | - | 02 | 04 | - | 06 | 05 | 19 |
| Jamnagar | - | 01 | - | 04 | - | 01 | - | 06 |
| Junagarh | 04 | 05 | 01 | 15 | 02 | 11 | 10 | 48 |
| Kheda | 02 | - | - | 02 | - | 01 | 01 | 06 |
| Mehsana | 02 | - | - | 01 | 01 | 01 | 02 | 07 |
| Panchmahal | 03 | 01 | - | 03 | 03 | 01 | - | 11 |
| Rajkot | 01 | - | - | 07 | - | 02 | - | 10 |
| Surendranagar | - | - | - | 02 | - | 01 | 01 | 04 |
| Vadodara | 04 | - | - | 02 | - | 02 | - | 08 |
| 12 | 23 | 08 | 04 | 58 | 07 | 37 | 27 | 164 |

1 = C. *aestuans* L.; 2 = *C. depressus* L.; 3 = *C. fascucilaris* L.; 4 = *C. olitorius* L.; 5 = *C. tridens* L.; 6 = *C. trilocularis*; 7 = *C. urticaefolia* Lam.

unexplored areas as reported by Shah (1978). The germplasm collected may be helpful in various crop improvement programmes.

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**Short Communication**

# EVALUATION OF TURMERIC GERMPLASM FOR YIELD AND QUALITY

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**Key words :** Evaluation, turmeric, yield quality, genotype

Turmeric is a colourful spice combining properties of a dye, cosmetic and drug. Turmeric owe its properties to the colouring principle *curcumin.* Alleppey turmeric from Kerala, renowned for the high curcumin content is in short supply in trade circles. This has necessitated the evaluation of turmeric genotypes so as to identify high yielding types with high *curcumin* content suitable for Kerala conditions. With this objective the present study was undertaken at the College of Horticulture, Vellanikkara, Thrissur during 1991-93.

A preliminary evaluation of 17 turmeric genotypes obtained from NBPGR Regional Station, Vellanikkara, Thrissur was conducted during 1991-92. Selection was based primarily on fresh rhizome yield and types producing more than 3 kg/$m^2$. During 1992-93 an experiment was laid out in a randomized block design with 11 treatments and three replications. The treatments comprised 10 selected NBPGR collections and *Sugandham* the variety popular throughout India served as control. The plot size was 2 $m^2$ with 50 cm interchannel. Seed rhizomes (720 g/plot) were planted on raised beds at a spacing of 25 × 25 cm. The cultural and manurial practices adopted were as per the Package of Practices Recommendations (Anon., 1989). The biometric characters were recorded four months after planting. The crop was harvested when the vegetative parts withered by nine months after planting. Fresh rhizome yield was recorded and the curing percentage and *curcumin* content were analysed as per standard procedures.

Data on biometric characters, yield and *curcumin* content are presented in Table 1. Among the biometric characters plant height alone showed significant difference depending on turmeric types. Maximum plant height was shown by the type VK 112 (156.00 cm) followed by CK 99 (141.00 cm) which were on par. Though not significant, maximum number of leaves/plant (24.00) and

maximum number of tillers/plant (2.00) were recorded for VK 116. The type VK 112 had maximum leaf length whereas leaf width was highest for VK 121. In conformity with the present finding, Subbarayudu *et al.* (1976) and Philip and Nair (1983) also could not observe any significant variation in number of tillers among the turmeric types.

**Table 1. Biometric characters, yield of rhizomes, curing per cent and curcumin content as influenced by turmeric types**

| Treatments | Accession | Plant height (cm) | No. of tillers/ plant | No. of leaves/ plant | Leaf length (cm) | Leaf width (cm) | Raw yield kg $ha^{-1}$ | Curing (%) | Cured yield kg $ha^{-1}$ | Curcumin content (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| VK 88 | IC 70130 | 126.33 | 1.88 | 23.00 | 56.33 | 14.33 | 32.88 | 20.76 | 6.83 | 5.02 |
| VK 96 | IC 70133 | 119.67 | 1.63 | 18.67 | 45.67 | 12.00 | 30.40 | 22.98 | 7.00 | 7.85 |
| VK 99 | IC 88752 | 141.00 | 1.47 | 15.00 | 53.67 | 15.00 | 29.97 | 17.71 | 5.33 | 6.98 |
| VK 107 | IC 70011 | 135.00 | 1.28 | 13.00 | 57.67 | 15.00 | 32.10 | 19.62 | 6.29 | 6.99 |
| VK 109 | IC 136894 | 138.00 | 1.28 | 12.33 | 47.00 | 11.67 | 29.40 | 22.22 | 6.51 | 5.13 |
| VK 111 | IC 88643 | 89.33 | 1.67 | 13.67 | 45.67 | 14.67 | 24.53 | 23.76 | 5.83 | 6.82 |
| VK 112 | IC 136887 | 156.00 | 1.73 | 17.33 | 63.67 | 17.00 | 22.2 | 20.35 | 4.51 | 7.23 |
| VK 115 | IC 88658 | 132.33 | 1.62 | 15.33 | 50.33 | 15.00 | 31.53 | 18.37 | 5.79 | 6.29 |
| VK 116 | IC 88662 | 98.00 | 2.00 | 24.00 | 50.33 | 14.83 | 38.83 | 21.68 | 8.43 | 6.88 |
| VK 121 | IC 136868 | 102.00 | 1.61 | 14.00 | 53.67 | 17.33 | 43.02 | 16.32 | 7.00 | 5.40 |
| Sugandham | (control) | 117.67 | 1.14 | 12.67 | 54.67 | 15.00 | 25.42 | 17.43 | 4.44 | 5.25 |
| | | 23.71* | NS | NS | NS | NS | 3.52* | 0.64* | 0.78* | 0.22* |

NS - Not significant

* - significant at 5% level

Raw rhizome yield was significantly influenced by the turmeric types. Highest raw yield (43.02 tonns $ha^{-1}$) was recorded for VK 121 and it differed significantly from other types. Curing percentage was found to be significantly high in most of the types except VK 121 and VK 99 when compared to the check variety. The highest curing percentage was recorded for VK 111 (23.76%) followed by VK 96 (22.98%).

The turmeric genotypes, differed significantly with regard to cured yield. The cured yield was significantly high in all the types except VK 112 which was *at par* with *Sugandham*, the check variety. Cured yield was found to be

maximum for VK 116 (8.43 tonnes $ha^{-1}$) followed by VK 96 and VK 121 (7.00 tonnes $ha^{-1}$) which were *at par*. Significant and positive correlation of rhizome yield with number of leaves as observed by Reddy and Rao (1988) holds true in this study also. VK 116 which recorded maximum number of leaves produced significantly high rhizome yield also.

Significant difference was observed in the *curcumin* content among the turmeric germplasm. Excepting VK 88 and VK 109, all other types had high curcumin content compared to the check variety. The *curcumin* content was found to be highest in VK 96 (7.85%) followed by VK 112 (7.23%) and these are collections from Kerala representing the Alleppey type.

The results indicated that the turmeric types VK 116 and VK 96 are promising with regard to cured yield of rhizomes and high *curcumin* content.

## ACKNOWLEDGMENT

The authors express sincere gratitude to Sri. K.C. Velayudhan, Officer in-charge, National Bureau of Plant Genetic Resources, Regional Station, Vellanikkara, Thrissur for supplying the turmeric types for evaluation.

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**Short Communication**

# PROSPECTS OF ROSE GERANIUM AS A NEW ESSENTIAL OIL YIELDING CROP FOR WESTERN HIMALAYA

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**Key words :** Rose-geranium, chemotype, foliage, genetic stock

Rose geranium (*Pelargonium graveolens* L. Herit), although a native of South Africa, is extensively grown in Spain, Morocco, Congo, Melagasy, Egypt, France, Spain, East Africa and erstwhile USSR. In India 65 tonns of geranium oil is imported from abroad and only a small quantity is produced within the country. Some of the pelargoniums growing in India are *P. zonale, P. inquinans, P. peltatum, P. lateripes, P. capitatum, P graveolens, P. odoratissimum, P.quercifolium* and *P. radula.* Only *P.graveolens* with its varieties and strains, is cultivated mainly for the distillation of oil of geranium (Annon, 1966).

In India, although it was introduced in the hills of Tamil Nadu (altitude of 1400 to 2000 m.a.s.l.) in early twentieth century but commercially its cultivation began in 1953. In northern India, it was introduced at Regional Centre of CIMAP, Haldwani (Gulati *et al.*, 1982) but not much success could be achieved due to intervening hot summer and water stagnation in rainy season.

National Bureau of Plant Genetic Resources, Regional Station, Bhowali made a successful attempt for the first time by establishing it in hilly areas of Uttar Pradesh.

A demonstration has been conducted in farmer's field for large scale cultivation in the year 1994.

Two chemotypes collected from different locations were grown at this station.

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* NBPGR, Pusa Campus, New Delhi-12.

(1) Sample from Almora were well adapted but its original source is unknown. Plants were fast growing, attaining luxuriant growth in a short time. It has light pink colour flowers with a fading red streak, foliage was light green. The quantity of oil produced was too low (0.05% only). Presently it is being maintained as a genetic stock in the field.

(2) Sample from Hyderabad (orignally Egyptian type, well adapted but slow growing), possess bright pink-purple flower with bright red streak, very light pubescence on stem and foliage appears slightly bluish green. It contains 0.18% quality oil with geraniol (12.22%), Linalool (18%) and Citronellol (26.89%) (Table-1) which is considered reasonably good quantity. Three to four cuttings can be taken for oil extraction. This sample has been recommended for large scale cultivation in U.P. hills.

**Table 1. Effect of growth regulator (1000 ppm Indole Butyric Acid) on stem cuttings during different seasons**

| S.No. | Plant parts | Treated | | Un-treated | | |
|---|---|---|---|---|---|---|
| | | June-July % | Aug. % | Jan.-Mar. % | June-July % | Aug. % |
| 1. | 2-3 nodes with terminal end or shoot apex | 90 | 59 | 88 | 61 | 44 |
| 2. | 2 nodes | - | - | 15 | - | - |
| 3. | 4 nodes | 52 | - | 47 | 43 | - |
| 4. | 6 nodes | 83 | 62 | 53 | 77 | 12 |
| 5. | Single leaf- old | Nil | - | - | Nil | - |
| 6. | Single leaf- new | Nil | - | - | Nil | - |

Abb. - Not recorded, % - established

*Climate*: Geranium can be grown from sub-tropical with humid conditions to temperate climate. In plains, it can be grown only as an annual crop. It can not withstand water stagnating conditions and hot winds. At NBPGR, Regional Station- Bhowali, where the average rainfall during crop growing year was 1000 mm/ annum and winter temperature dropped to a minimum of -2°C, it not only survived but gave sufficient number of cuttings in the following season, thus exhibiting perennial behaviour under hilly conditions.

*Propagation*: Plants are propagated by stem cuttings; terminal portion upto 8-12 cm length and cuttings with 6 nodes gave the best results and also those treated with 1000 ppm IBA (Table 2). Rainy season or humid conditions are congenial for its regeneration/establishment.

*Nali Measurement prevalent in U.P Hills; 1 Nali = 2160 sq. feet

**Table 2. Composition of geranium oil*: sample from Hyderabad**

| Main components | % |
|---|---|
| Rose oxide,cis. | 1.64 |
| Linalool oxide,cis. | 0.71 |
| Menthone | 0.47 |
| *Iso menthone* | 7.80 |
| C-10 aldehyde | 1.06 |
| *Linalool* | 18.00 |
| *Citronellyl formate* | 6.90 |
| -Terpenol | 2.33 |
| Geranyl formate | 1.79 |
| *Citronellol* | 26.89 |
| Nerol | 0.81 |
| *geraniol* | 12.22 |
| epi. - endesmol | 3.37 |
| Geranyl tiglate | 1.42 |
| Phenyl etyl tiglate | 0.55 |
| Phenyl ethyl tiglate | 0.42 |

*Oil distilled at NBPGR, New Delhi

Land preparation: A slightly slopy land is preferred. Small pits are dug and to each pit 30 g rock phosphate and 200 g compost manure and a pinch of DDT (@10 kg/ha) is recommended. Leaf harvest can be taken up 3-4 times from second year. The harvesting of tender leaves is done before the flower commences and lemon like note changes to rosy odour. Adequate foliage should be left after each harvest.

*Plant stand*: In hills in terraced fields, 320 plants can be grown in a *nali** (16000 plants/ha). At present rooted plants are being supplied by the farmer at village Sirodi, Bhowali, Distt-Nainital, U.P.

*Prospects*: Considering high price of the oil (Rs. 4000 kg or more), low input requirements, perennial habit, rose geranium has high potential as an industrial crop in the hills. It will improve the economic condition of those farmers depended on low yielding conventional crops like wheat and paddy on upland areas, beset with many problems.

If distillation units are provided for oil extraction at some points between villages it will further improve the economy of the local people.

## ACKNOWLEDGEMENTS

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**Short Communication**

# SPIKELET STERILITY IN RICE GERMPLASM

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**Key words :** Spikelet, sterility, rice

A total of 1319 rice germplasm (254 early, 327 medium, 738 late) lines, which were collected from Orissa and adjoining areas, evaluated during wet season (June-December) of 1990 and 1991 at NBPGR Base Centre, Cuttack. Seeds of all lines were directly sown on 6.6.90 and 10.6.91 in 3 rows of 4 m. length with 20 × 15 cms. spacing. Normal fertilizer dose 40:20:20 N.P.K. was applied. At maturity, panicles from main tillers of ten randomly tagged plants from the middle row of the plots were taken. The filled and unfilled grains were separated and sterility percent was calculated.

**Table 1. Spikelet Sterility in Rice Germplasm**

| Sterility % | Germplasm lines evaluated | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Early | | Medium | | Late | | Total | |
| | No. | % | No. | % | No. | % | No. | % |
| 0.10 - 10.0 | 16 | 6.29 | 30 | 9.17 | 157 | 21.27 | 203 | 15.39 |
| 10.10 - 20.0 | 56 | 22.04 | 57 | 17.43 | 285 | 30.61 | 398 | 30.17 |
| 20.10 - 30.0 | 52 | 20.47 | 81 | 24.77 | 134 | 18.15 | 267 | 20.24 |
| 30.10 - 40.0 | 37 | 14.56 | 54 | 16.51 | 67 | 9.07 | 158 | 11.97 |
| 40.10 - 50.0 | 22 | 8.66 | 42 | 12.84 | 36 | 4.87 | 100 | 7.58 |
| 50.10 - 60.0 | 23 | 9.05 | 27 | 8.25 | 21 | 2.84 | 71 | 5.38 |
| 60.10 - 70.0 | 12 | 4.72 | 19 | 5.81 | 13 | 1.76 | 44 | 3.33 |
| 70.10 - 80.0 | 9 | 3.54 | 10 | 3.05 | 9 | 1.21 | 28 | 2.13 |
| 80.10 - 90.0 | 7 | 2.75 | 6 | 1.83 | 14 | 14 | 1.89 | 27 |
| 90.10 - 100.0 | 20 | 7.87 | 1 | 0.30 | 2 | 0.27 | 23 | 1.74 |
| Total | 254 | 19.25 | 327 | 24.80 | 738 | 55.95 | 1319 | 100.00 |
| Av. St. % | 38.26 | | 33.28 | | 22.26 | | 28.07 | |

The germplasm lines were divided into early (< 120 days), medium (121 to 150 days) and late maturity (> 151 days) types. Variation was observed in the percentage of sterile grains even among the same maturity group. Freqeuncy distribution of lines in different maturity groups showed different trend of sterility (Table 1, and Fig. 1). Average sterility percentage was highest among the early varieties (38.26%) followed by medium (33.28%) and late maturing varieties (22.26%).

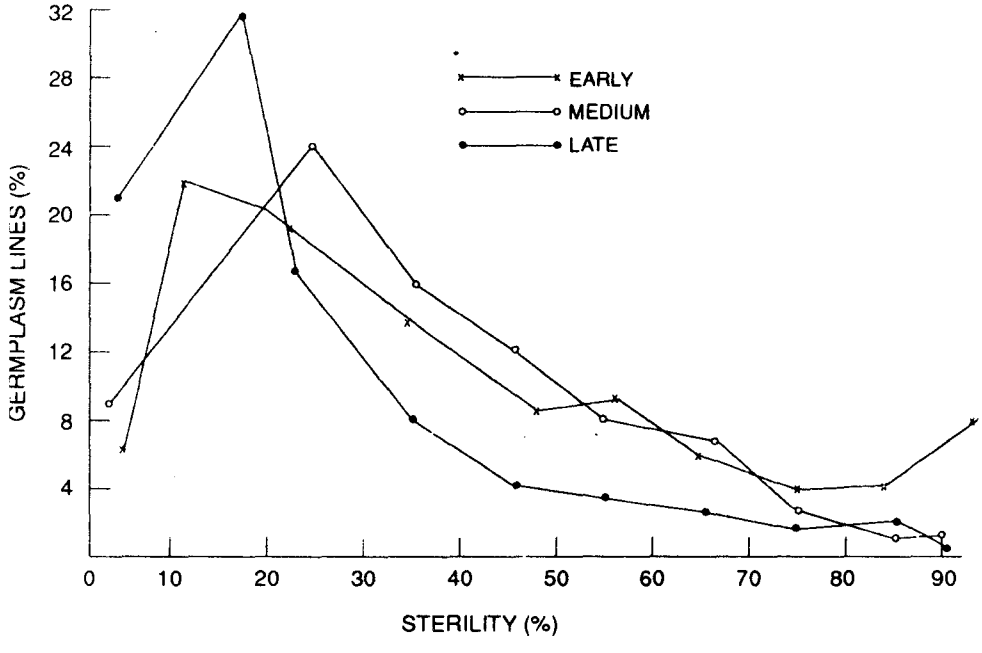


**Fig. 1. Spikelet sterility in Rice Germplasm**

High sterility in early germplam may be due to the variation in environmental condition at Cuttack for these lines because most of the early germplasm were collected from upland areas of Koraput, Phulbani, Bolangir, Mayurbahanj districts of Orissa and Santhal parganas of Bihar which consists of high hills and plateau areas and temperature is not very high (26-28°C) as compared to Cuttack (30-32°C) during flowering. The other factor of high sterility in early and medium duration varieties may be the high rainfall during August (308.9 mm. and 435.7 mm.) and September (209.2 mm. and 155.5 mm.) in 1990 and 1991 respectively at Cuttack which interfere in the anthesis, fertilization and grain development. The low sterility in late varieties may be due to the fact that less rains and favourable tempetrature at the time

of flowering and grain development during October and November months. Exceptionally high number of early varieties (20) showed very high sterility (90.1 to 100%) and out of these four lines viz. M-248, M-330, M-392 and D-1571 showed 100% sterility at Cuttack condition which need further research and may be due to temperature sensitive genetic male sterility (TGMS) or photosensitive genetic male sterility (PGMS) which could be utilized in two lines hybrid rice programme after confirmation.

## Chief Editor's View

The present issue of IJPGR has accomplished the promise of updating the journal's publication. ISSN number, a gateway to International Genetic Resources Community System, has been alloted to IJPGR. Thus, the information published in it is rnore accessible for abstracting and is refferred throughout the world. These achievements have thrown greater responsibilities on scientists communicating their findings through IJPGR, a sole journal in India relating to PGR activities. As the bowl of information recevied at our end is overflowing, we have to be selective for publication, communicating only meaningful, better quality articles of high relevance. If the articles deal with the evaluation and characterisation of PGR, a very clear statement of the merit of identified accessions in term of their contribution of desirable genes and their availability for users, should be made by the authors and these accessions be made available for their safe conservation in the National Gene Bank. The new genetic stocks and genetic resources with desirable gene and gene combinations can also be registered similar to those of Crop Science journal published in USA. We will publish articles related to germplasm exploration and collection with meaningful analysis of diversity observed and collected on a particular plant species or several species in a given agro-climatic region. Definite suggestion for future explorations will be appreciated. A statement on time schedule when the newly collected germplasm will be made available in the Genebank and to users in such articles will be mandatory. Other articles will be considered for publication based on their originality and relevence to PGR. Any suggestion in this regard is welcomed.

(*continued from first cover page*)

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