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Agro-Ecosystems: An Assessment

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Agro-ecosystems stand out from the natural ecosystems as they have been converted from the latter and managed by human beings for their own use. These may often overlap with forests, grasslands and coastal ecosystems where agricultural plots/croplands form part of a mosaic of land uses. Around 37 per cent of the global land (excluding Greenland and Antarctica) is under agriculture including the managed pastures (FAO, 2000a). Global agriculture provides 95 per cent of all animal and plant protein. Beyond the economic value of the goods produced, agro-ecosystems also provide employment to millions. Nearly 45 per cent of the world's population is reported to be living in households dependent on agriculture and the labour directly engaged in agriculture makes 46 per cent of the world's total labour force (WRI, 2000).

Reported declining trend in their condition and capacity notwithstanding, it is remarkable that agro-ecosystems have been successful in terms of their ability to keep pace with the increasing demands of the ever growing human and livestock populations for food, feed, fibre and other items. There appears to be little scope for bringing more land under agriculture in future and it has become essential to obtain more output from a given area. Intensification of agricultural production has progressed rapidly as irrigated farmland expanded, the use of purchased inputs and adoption of new technologies grew, fallowing time decreased and cropping intensity increased. However, agriculture faces enormous challenge of meeting the food needs of an additional 1.7 billion people projected as the population increase over the next 20 years, particularly when almost 65 per cent of cropland worldwide has already undergone some degree of soil degradation and over pumping of groundwater by farmers exceeds the recharge rates in many areas.

Recent Findings (WRI, 2000)

- Food production is still likely to continue to rise significantly in coming years in response to the increase in demand but soil health appears to be deteriorating at an alarming rate. Continuously adding more purchased inputs supported by new technologies may offset a part of this setback but regional disparities are likely to widen, hitting the poor the hardest.
- Water quality is on the decline. Adverse impact on the quality of downstream groundwater is bound to increase due to heavy leaching of chemical inputs (fertilizers, pesticides, etc.) while problems of water logging and salinization will pose more serious threat under irrigated agriculture wherever drainage facilities are inadequate.
- With nearly 17 per cent dependence of croplands on irrigation, agriculture is currently the largest user of freshwater globally. Hard competition with other kinds of water use, particularly for drinking and industrial needs, is likely to grow further and pose a serious problem.
- Agricultural biodiversity, the cream of natural biodiversity selected and enhanced by humans for their use over the past ten centuries, is on the fast decline track – both in terms of crops and also their traditionally grown varieties. Narrowing genetic bases and increasing crop and varietal uniformity over large contiguous areas usually mean more vulnerability to widespread incidence of diseases and pests and this may imperil food security, global trade in agricultural produce and products and, most of all, the livelihoods of small farm families. (Box-1).
- Regarding carbon storage, signals are unclear at present. Data collection methodologies and analysis techniques remain contested. Agro-ecosystems, overlapping grasslands and forests to some extent, store 26 to 28 per cent carbon and their management styles can impact concentration of carbon dioxide in the atmosphere. This concentration has increased significantly during the last century but apportioning contributions to different ecosystem categories is difficult at present.

To sum up, these findings paint a grim picture despite low resolution but they are mostly along the accepted lines and convincing also. It is widely believed that the web of life is flaying but inferences vary regarding the extent and reversibility of the damage to life support

Box 1. Agro-biodiversity and Agricultural Ecosystems

Agricultural biodiversity (or agro-biodiversity) is a sub-set of biodiversity that is the result of the careful selections and innovative developments of farmers, herdsmen and fisher folk over more than ten thousand years and also includes progenitors and close relatives of cultivated plants and domesticated livestock. Agricultural biodiversity has also been remarkably increased by the contributions of professional breeders engaged in plant and livestock improvement programmes. In general, agro-biodiversity refers to the variety and variability of plants, animals (including pollinators and predators) and microbes on earth that are important to food and all other agricultural production systems along with management systems and traditional practices used by farmers and farming communities.

Agricultural ecosystems (or Agro-ecosystems) are those highly diverse ecosystems that are used for agriculture in similar ways, with similar components, similar interactions and functions. These include the genetic resources, the physical environment, the human management practices and their interactions. Their processes are reflected in functioning of farming systems comprising croplands, animal husbandry, pastures, aquaculture, agro-forestry and other land use systems. They may be managed as monocultures, polycultures or mixed systems in numerous combinations like crop-livestock systems and agro-silvi-pastoral systems.

Source: FAO, 1999

systems. The World Resources Report (WRR) takes due note of this point while stating that "we currently lack much of the baseline knowledge we need to assess ecosystem conditions adequately on a global, regional, or sometimes even on a local scale" (WRI, 2000). It also pleads for vigorous support to a more comprehensive Millennium Ecosystem Assessment that is likely to begin soon. It concludes on a positive note that useful experiences are available around the globe to check, contain and repair the observed damages, in great measure if not fully. There are still workable options but time for action is running out.

Developing Countries Perspective

Extent

Findings of the WRR (WRI 2000) bring out several contrasting features between the developed and developing worlds when global generalizations are attempted to be resolved at the regional and national scales. Firstly, data collection, storage and reporting systems are not yet adequately developed in a large number of developing countries where short cuts often substitute systematic surveys. Secondly, averages based on selected information are used to show the trends but these scores mask more meaningful information than what they convey. For example, WRR quotes FAO (2000a) statistics to state that 69 per cent of agro-ecosystems consist of permanent pastures while the remaining 31per cent are under crops on the global scale (FAO, 2000a). However, pastureland makes up 89 per cent of agro-ecosystem area in Oceania, 83 per cent in Sub-Saharan Africa, 82 per cent in South America and 80 per cent in East Asia. On the other hand, croplands occupy 92 per cent of agro-ecosystem area in South Asia and 84 per cent in Southeast Asia. Crops cover nearly 94 per cent of agro-ecosystem area in India. There is further significant variation even in croplands when we compare areas under annual grain crops, fibre crops, oilseeds, vegetables, fruits, plantations and other crops. While knowing global trends serves a useful purpose in developing global strategies and funding priorities, policy decisions and administrative measures relate to the scenario at the national, state or even smaller administrative boundaries where ecosystems function and people live in them. This discussion suggests that local people need to be involved in the assessment of the condition and capacity of ecosystems rather than relying on information that is gathered for a different purpose altogether but used for making assessments.

It is noteworthy from the reported data that agro-ecosystems cover nearly 36 million km^2 occupying about 28 per cent of land area with sizeable differences in regional shares. Combined share of Asia, Africa and South America is 64 per cent while that of Europe, Russia and North America is 35 per cent. It is also remarkable that out of the estimated 2.8 billion people living in or near agro-ecosystems, nearly 2 billion live in Asia. These findings have obvious policy and planning implications.

Conversion

When farmers convert a natural ecosystem to agriculture, they usually change both the composition of the ecosystem and how it functions. Agriculture in converted areas may also increase pressures on surrounding ecosystems through the introduction of non-native species that may become invasive and displace indigenous species. It is notable that bio-invasions are considered second only to habitat loss (usually through conversion) as a threat to global biodiversity. Not all conversions are, however, equally damaging. Some, like the traditional agro- forestry

systems in many Asian countries, may retain several features of the original ecosystem. Synergistic cultivation of the shade-loving large cardamom in forest area in Sikkim state of India by the Lepcha community illustrates this point in actual practice.

FAO statistics reveal that the total area under agriculture has expanded by about 8 per cent globally during the 30 years period beginning 1966. At national scale, however, land conversion, both to and from agriculture, has taken place at much higher magnitude with contrasting patterns observed in the industrialized and developing countries. Components of these aggregate values are more relevant from an ecosystem perspective since they show the dynamics of change. The overall expansion at the global level notwithstanding, agricultural area actually decreased in the United States, Europe and also in Oceania though for different reasons. Whereas South Asia's total agricultural area has remained almost unchanged during the past 20 years, agricultural land increased by nearly 0.8 per cent per year during 1986-96 in China and Brazil and by 1.38 per cent per year in West Asia (FAO, 2000b). These dynamic patterns of conversion at the national and regional level and also the causal factors are of greater relevance to the ecosystems management. Number of people engaged in agriculture and the sizes of operational farm holdings are also important considerations to give human face to agro-ecosystems.

Intensification

With the demand for agricultural produce rising steeply and good agricultural land becoming scarcer, inputs (like irrigation, fertilizer, pesticides, mechanical operations and labour) began to be applied more intensively during the last three decades to increase agricultural production. Number of crops harvested per unit area in a year also increased in many countries. While global expansion of agricultural area has been modest in recent decades, intensification has grown rapidly (WRI, 2000). Even if yields continue to grow under these conditions, this does not necessarily indicate that agro-ecosystems are in good shape because increased inputs often mask the underlying soil degradation.

Area under irrigation grew from 153 mha in 1966 to 271 mha during the last three decades. Although the irrigated land forms just about 5.5 per cent of all agricultural land and 17.5 per cent of the cropland yet irrigation is more extensive in some regions than in other. China and India together have nearly 41 per cent of global irrigated area while Western Europe and USA hold additional 12.5 per cent. In marked contrast, the arid and semi-arid regions of Sub-Saharan Africa and Oceania (mostly Australia) contain only 3 per cent of the world's irrigated land.

Market-oriented irrigated agriculture tends to turn traditional subsistence but low risk farming into high-risk commercial farming. In many developing countries like India crop failures are not uncommon pushing the farmers to face great hardships, particularly when inputs have been purchased on loans from money-lenders. Soil salinization, caused by poor irrigation management, and loss of soil fertility due to over-cultivation and imbalanced application of fertilizers further add to the problems of illiterate and resource-poor farmers. Absence of ownership rights, insecurity of land tenure and little direct access to market impose additional limitations to a losing proposition.

Economic Importance and Livelihoods

Agriculture is most important to the economies of low-income countries, accounting for nearly one-third of their Gross Domestic Product (GDP). This share is even more than 50 per cent in many parts of Sub-Saharan Africa. In the group of middle-income countries, contribution of agriculture to national GDP is around 12 to 25 per cent. GDP of high-income countries of North America and Western Europe, on the other hand, is remarkably dominated by other economic sectors and the contribution of agriculture is just 1 to 3 per cent even though the value of the agricultural output in these countries represents 79 per cent of the real market value of world's total agricultural products (WRI, 2000).

It appears that the conventional measures of agriculture's share of GDP grossly underestimate agriculture's contribution to national economies. For example, agricultural share in GDPs of the Philippines, Argentina and the United States is stated to be 21 per cent, 11 per cent and 1 per cent respectively but the total value of agriculture, including manufacturing and services further along the marketing chain, turns out to be 71 per cent, 39 per cent and 14 per cent of their total GDPs.

In addition to agro-ecosystems' contribution in terms of economic goods produced by them, they also provide employment to millions. Agricultural labour makes nearly 46 per cent of the global labour force. A comparison of the industrialized countries with developing ones in this respect brings out striking difference with obvious

policy implications. In North America, just 2.4 per cent of the labour force is directly-engaged in agriculture while this per cent is 56 to 65 in East, South and Southeast Asia and also in sub-Saharan Africa. Pre-dominance of agricultural labour in most of the developing countries represents in a way the livelihood, employment, income and cultural heritage.

Human Nutrition and Food Security

Crop production appears at present to have the potential to continue to provide for adequate human nutrition. Globally, agro-ecosystems produce enough food that can provide every person on earth the minimum human nutrition of around 2700 kcal per day (FAO, 2000a). However, many people do not have adequate access to that food with the result that nearly 800 million people remain hungry and undernourished, most of them in Sub-Saharan Africa, the Caribbean and South Asia.

In case the global population rises to 7.5 billion people by 2020 as projected, the demand for cereals and meat is expected to grow by 40 per cent and 58 per cent respectively with 85 per cent of this increase coming from the developing countries. Also, the demand for roots and tubers is expected to grow by 37 per cent, with 97 per cent of this increase coming from the developing world (FAO, 2001). Furthermore, if the poverty alleviation programmes make the expected headway, there will be an additional increase in demand for food as the poor and malnourished may like to use their enhanced income to buy food that they were not able to afford earlier.

Long-term capacity of agro-ecosystems depend primarily on natural processes and human management practices, how they degrade, maintain, or improve soil health status, water availability (also quality) and nutrient balance. Agricultural productivity has already been greatly reduced in about 24 per cent of agricultural land while additional 40 per cent are considered to be strongly and very strongly degraded (beyond rehabilitation). Most severely affected areas happen to be in South and Southeast Asia where populations are among the densest and agriculture most extensive (WRI, 2000). Soil nutrient balances are also reported to be negative in most crops and cropping systems in Latin America and the Caribbean indicating decline in soil fertility. Nutrient depletion is also widespread in Sub-Saharan Africa. Other areas where the capacity of agro-ecosystems to produce food appears to be most threatened ("Hot Spots") include northeast Brazil and sections of Argentina, Bolivia, Colombia and Paraguay.

Soil degradation may have more immediate impact on the food supply in developing countries as agricultural productivity is estimated to have already declined significantly on around 16 per cent of their agricultural land, especially on cropland in Africa and Central America. Estimates show that about 74 per cent of Central America's agricultural land, 65 per cent of Africa's and 38 per cent of Asia are degraded and have reduced productivity (WRI, 2000).

The economic and social impacts of soil degradation have been far greater in developing countries than in the case of industrialized countries where decline in soil status is often masked by application of high levels of fertilizer and other inputs. In addition, their most important grain producing areas have deep and geologically young soils that can withstand considerable degradation without showing adverse effect on yield.

A striking feature of global agriculture is its focus on relatively few species. Only about 120 crops are economically important while more than 90 per cent of the caloric intake of world's human population comes from just 30 crops. This somewhat narrow base notwithstanding, there has traditionally been immense genetic diversity within these crop species, and this diversity, conserved and enhanced by farm families over the past ten centuries, has historically helped to maintain the productivity of agro-ecosystems and it is still a valuable reservoir of genetic material for modern plant breeding and also for the candidate genes manipulated through biotechnology and genetic engineering tools.

Crop genetic diversity is however, on decline today. Modern high yielding varieties are taking on more uniform characteristics, and these varieties are planted over large areas in monocultures. This tendency is not limited to high-income countries where the commercialization of agriculture is most prevalent. Modern superior crop varieties are displacing traditional varieties throughout the world, threatening the loss of an enormous genetic resource and increasing the vulnerability of large areas of homogeneous crops to incidence of virulent pests and disease epidemics. Across all developing countries, modern varieties were reportedly grown on 74 per cent of rice area in 1991, 74 per cent of wheat in 1994 and 60 per cent of maize in 1992 replacing the locally adapted cultivars.

Special Features of Agro-ecosystems in Developing Countries

- The earliest agro-ecosystems began developing around

ten centuries ago in some areas that now happen to be in the developing world.

- The eight distinct Centres of Origin of Cultivated Plants, outlined by Vavilov and his team in 1920s, also occur in the developing countries. Putative progenitors and their closely related wild forms continue growing and evolving there constituting the valuable reservoir of genes for resistance to pathogens and pests and also for adaptation to abiotic stress environments.

Box 2. On-farm Conservation of Agro-biodiversity

Genetic diversity in cultivated plants is important to farmers for reducing the risk of widespread incidence of diseases and pests damaging their crops. It is equally important to plant breeders and bio-technologists, whether working in public sector organizations or in biotech corporations, as it serves as the reservoir of genes for obtaining the target genes controlling the desired traits. It is also important to conserve this genetic diversity for use of future generations enabling them to meet their needs and also to face the unforeseen changes in climate and soil degradation or the sudden appearance of insect virulent forms of pathogens and insect pests in coming years.

There are about half a million seed samples of different crops kept under long-term storage in gene banks of Future Harvest International Research Centres and placed under auspices and supervision of the FAO. More than twice this number is also stored in *ex situ* collections stored in national gene banks. While this kind of germplasm collection and storage in gene banks promotes their evaluation and utilization by breeders and other researchers, it also cuts off further evolutionary development of these materials. Notwithstanding the risks involved in storage, this approach of conservation requires frequent testing of these samples to check their viability and also their seed multiplication for replacement when the viability falls below a prescribed level. A less-expensive and nature-friendly method is being practiced by farmers over the past nearly ten thousand years to achieve the twin objectives of on-farm conservation and furthering the co-evolution of resistant genes in crop varieties. *In situ* on-farm conservation of agro-biodiversity is also the best way to maintain and promote traditional knowledge of the farming systems in which the farmers' varieties have evolved.

Source: Swaminathan, 1998

- Genepool of plants picked up by early humans for their food security increased remarkably as the agriculture spread and farm families continued to conserve, enhance through continuous selections, share and exchange seed and propagation materials. This is reflected in the recognition of areas of crop diversity around the world, mostly in the developing countries. Their heritage of agricultural biodiversity and associated knowledge continued to evolve in the public domain for common good. The focus remained on food security and healthcare. Trade concerns developed much later. Ancient wisdom documented in old scripts, preserved in India among other centres of learning, considered agriculture occupation as the most respected by the society while trading came next to it. A glaring association between agro-biodiversity-richness and economic poverty is, however, visible at present around the globe reflecting the advantage of research and technology in adding value to crop genetic diversity.
- Agricultural research continues to be primarily in the public sector in the developing countries even at present and Farmers' Rights are widely respected with priority accorded to recognize them legally. This is in marked contrast to the paradigm shift to proprietary research linked to claims for intellectual property rights, often devoid of bio-ethics and bio-safety considerations, as observed in some highly industrialized countries and also reflected in provisions of WTO-TRIPS agreement (UNEP 2000; WWF 2000).
- Agriculture and related activities continue to remain the predominant sector for employment to growing populations in developing countries and the health and capacity of agro-ecosystems are of prime concern to them. Agriculture is contributing a large share to GDP of these countries but growth and investments in this sector are not rising as required to achieve sustainability. Operational holdings are small and getting smaller in most of these countries while land tenure is insecure and the reforms are overdue. Poor development of direct linkage to markets and on-location value-addition through post-harvest processing are linkage factors to economic progress of farm families comprising the rural and tribal population.
- Farm families in developing countries have been practicing on-farm *in-situ* conservation and enhancement of agricultural biodiversity through successive generations (Box 2). Their past and present contributions need legal recognition in the form of Farmers' Rights and also positive incentives

Box 3: Farmers' Rights

Farmers' Rights were recognized by the FAO Council in its resolution 5/89, balancing thereby the Breeders' Rights approved vide resolution 4/89, as "rights arising from the past, present and future contribution of farmers in conserving, improving and making available plant genetic sources, particularly in the centers of origin/ diversity". Through an Annex of the International Understanding on Plant Genetic Resources (IU), parties agreed that Farmers' Rights would be recognized through an international fund.

How Farmers' Rights will be operationalized is of critical importance to the continuing on-farm (*in situ*) conservation of crop genetic resources. These rights have not been precisely defined but two perceptions have emerged, namely, interpreting them as a legal concept or considering them as a general political concept. The former envisages them an alternative form of intellectual property rights covering, for example, the products of farmers' selections and breeding effort while the latter considers them in the form of various entitlements expecting an international fund to finance crop genetic resources' concerns and relevant developmental work.

Unfortunately, the proposed international fund under the FAO has not yet been established. In the meantime, legal protection of Breeders' Rights is being pressed as an obligation under Article 27 (3b) of the TRIPS Agreement of the World Trade Organization. The 1978 version of the International Convention for the Protection of New Varieties of Plants (UPOV) allows a farmer to re-sow the seed harvested from protected varieties for his own use (farmers consider this as their "right" while some term it as a "privilege"). The 1991 version is more specific as it states that the discretion rests with national governments in deciding whether or not to uphold the Farmers Rights while restricting the Breeders' Rights. It is also obvious that farmers' varieties would need to be sufficiently distinguishable and describable in order to be eligible for protection under the new Protection of Plant Varieties and Farmers' Rights; varieties that satisfy a stricter criterion qualifying for stronger and/or longer protection.

Source: Dutfield, 2000; Swaminathan 1996

at the local, national and global levels. Providing opportunities to rural farm families for increasing their income through generating off-farm jobs for them needs priority attention (Box 3).

- Global food security and also the farmers' aspirations look towards synergistic linkage between public and private sectors with the strong support of international institutions and funding agencies to reap benefits from traditional good practices combined with advances in biotechnological research. This development is also expected to contribute significantly to efforts aimed at maintaining and promoting the health and capacity of agro-ecosystems (Box 4).

Box 4. Farmers' Livelihood Security

Multilateral agreement under the World Trade Organisation (WTO) contains a series of interlocking agreements whose provisions set out the rules governing the international trade. Its non-discrimination rules forbid the member states to treat the foreign products less favourably than domestic 'like products' or from treating the products imported from one member state less favourably than like products from another member. Its Article XI prohibits quantitative restrictions (QRs), like quotas or bans, on imports or exports with certain specified exemptions.

India joined the WTO on 1st January 1995 accepting obligatory structural adjustments. Six separate complaints, including one of the United States, were lodged against India with the WTO Dispute Settlement Body in 1997 alleging continued application of QRs on imports. With its heavy dependence on agriculture and small industries that sustained mass employment and contributed significantly to national Gross Domestic Product (GDP), India was among the nations that were resorting to protection through QRs. Following negotiations, an agreed schedule for removing all the QRs by 1' April 2001 was formally notified by India to the WTO. This commitment was met by India by removing QRs on the remaining 715 commodities on that date. Removal of QRs raised the public concerns apprehending that the WTO regime was skewed in its application against the interests of the developing countries.

Indian economy is essentially agriculture-based and this sector directly engages about 64 per cent of the labour force. It also contributes nearly 26 per cent of GDP and about 18 per cent of the total value of the country's exports. Its role is particularly important since it is source of livelihood to over 700 million people with total dependence of farm families (land also the landless labour) managing 1,066 million operational farm holdings.

Removal of QRs and consequent likely spurt in import of food items may pose a serious threat to the livelihood of farm families and associated farm labour. It is being pleaded that protection of livelihood of farmers in agro-based developing economies needs to be treated as the basic human right and this right should be specifically protected under the WTO rules in recognition of the unique contributions of farmers towards developing & enhancing and on-farm conserving the agricultural biodiversity. One way of doing this may be to introduce a "Livelihood Security" Box in the provisions of the WTO giving an option to developing countries like India, China and others to deny import of food items to provide livelihood security to farmers.

Source: Swaminathan, 1995

Issues and Policy Implications

Production of Goods and Services by Agro-ecosystems

Agricultural ecosystems not only produce food and meet other basic requirements of human and livestock populations but they also serve as the backbone of national economies of most of the developing countries and also function as major driving force propelling global market systems creating demands and purchasing power. Around 45 per cent of the world's human population and nearly 46 per cent of the global labour force are directly linked to agriculture. Keen interest and increasing concerns about agro-ecosystems notwithstanding, national policy makers find it increasingly difficult to identify the issues involved and to fully appreciate their policy implications. This section attempts to capture WRR's major findings and identify the issues and their policy implications from the developing country perspective.

Major Findings	Issues	Policy Implications
Food Production		
Food production is likely to continue rising for some more time but it already faces constraints and severe regional imbalances.	• Sustainability of the use of natural resources	Developing National Policy on sustainable use of natural resources.
	– Assessment of sustainability	Developing suitable indicators in national/local context and promoting their use
	• Increasing soil degradation	Developing National Land Use Policy.
	– Soil erosion	Promoting soil conservation measures.
	– Water logging	Linking irrigation with adequate drainage.
	– Soil salinity/alkanlinity	Improving water management and adopting reclamation measures based on salt tolerant crops and trees, soil amendments and leaching where feasible.
	• Decreasing water availability and quality	
	– Increasing sectoral competition for water use	Developing National Water Policy with long-term perspective and preparing medium and long-term action plans.
	– *Receding groundwater level* in many areas	*Encouraging* appropriate cropping schemes and crop rotations.
	– Excessive use of chemical fertilizers and pesticides	Promoting soil-test based application of fertilizers and integrated pest and nutrient management.
	• Shrinking agrobiodiversity	Reducing dependence on one or a few crops/varieties/crop rotations and promote market-linked diversification of farming systems.
	• Changing climate and atmospheric carbon	Improving data collection, analysis and modeling techniques.
		Making advance preparations by increasing resilience in agro-ecosystems and developing suitable options.
Projected Food Demands:		
Global population is projected to rise to 7.5 billion by 2020. Demand for cereals and meat is is expected to grow by 40 per cent and 58 per cent respectively with 85 per cent increase from the developing countries. Likewise, the demand for roots and tubers is expected to grow by 37 per cent	• Improving productivity	Increasing budgetary support to Natural Resource Management.
	• Intensification of production system	Increasing focus on research and providing more funds.
		Developing further 'Green Revolution', that has been achieved by many developing countries in several cereal crops, into a sustainable 'Ever Green Revolution' by adopting the emerging new innovative technologies and

Major Findings	Issues	Policy Implications
with 97 per cent of this increase coming from the developing world.		covering more crops. Negotiating transfer of new technologies from the developed countries and corporate sector. Developing post-harvest technology, storage facilities, processing and market linkages. Promoting diversified farming systems with economically feasible and socially acceptable incentives.
Intensification While the global expansion of area under agriculture has been modest during the past three decades, intensification has grown rapidly.	• Sustainability of the agricultural production systems • Sustainable use of natural renewable base resources • Containing adverse impact on other ecosystems	Developing National Agricultural Policy with long term perspective and action plans. Promote integrated nutrient and pest management. Encouraging appropriate cropping systems and diversified crop rotations. Improving use-efficiency of inputs. Focus on better water management practices and conjunctive use of water resources. Supporting green manuring and other practices for increasing organic carbon content of soils. Promoting application of high technological innovations to boost productivity and stabilize production. Ensuring availability and affordable costs of non-renewable purchased inputs. Developing intensification technologies for the benefit of resource-poor farmers with small operational holdings. Providing insurance cover to protect small farmers against high risks involved in high-inputs technology. Supporting diversified farming systems. Developing Village Knowledge & Service Centres based on single-window delivery.
Irrigated Agriculture: Out of the global cropped area under irrigation, 41 per cent lies in China and India, 12.5 per cent in Western Europe and USA, but only 3 per cent in arid and semi- arid regions of Sub-Saharan Africa and Australia.	• Improved water management • Higher water-use efficiency • Better soil healthcare • More productivity • Minimising adverse impacts	Providing more investment in research on irrigated agriculture with a focus on developing new innovative technologies. Reducing water conveyance losses. Promoting conjunctive use of all water resources. Supporting better cropping systems and diversified farming. Ensuring that irrigation must be accompanied by adequate drainage system. Providing soil testing facilities and soil health care service. Developing indicators for monitoring of adverse impacts and be prepared with land reclamation technologies where needed. Encouraging farmers to manage their irrigation water resources themselves by forming Village Water Cooperatives and Self- Help Groups.
National Gross Domestic Product: Agriculture's contribution to national GDPs is more than 50 per cent in many parts of Sub-	• Agriculture-based economic development in low- and middle-income developing countries	Developing National Agriculture Policy and lobbying for higher investment in agriculture.

Major Findings	Issues	Policy Implications
Saharan Africa, one-third in other low income countries, 12 to 25 per cent in middle income countries but just 1 to 3 per cent in high-income countries of North America and Western Europe.		According status of industry to agriculture. Providing more budgetary funds for research and extension in public sector plans. Developing promotional schemes for agro-products and provide incentives to entrepreneurs. Promoting public and private sector collaboration for greater investment in agriculture. Promoting agro-based cottage processing and manufacturing industries in rural areas. Developing quality control of agricultural produce and products. Expanding internal and export markets for agricultural produce and products. Negotiating with developed countries to get greater market access for agriculture under WTO.
Dependence of People: The developing countries have nearly 65 per cent of the global area under agro-ecosystems, and Asia alone has over 70 per cent of the people living in or around these ecosystems. Agriculture engages 46 per cent of the Global labour force. While this per centage is 56 to 65 in East, South and Southeast Asia and also in Sub-Saharan Africa, it is just near 2 per cent in North America. Area under agriculture remained almost unchanged in South Asia during the last 30 years but increased substantially in West Asia and Brazil while it decreased remarkably in developed countries.	• Vital role of agriculture in national income generation and human welfare • Agriculture-based planning and model for economic development • Increasing population pressure and decreasing per capita agricultural area • Increasing demand for food and other agricultural produce • Food and Nutrition Security • Livelihood Security • Focus on basic needs for farm families and other farm workers • Use and protection of indigenous knowledge • Documentation of case studies on good practices	Developing national strategy for agricultural development and preparing perspective long-term and medium-term action plans with provision of adequate funds for proper implementation. Increasing investment in research to increase productivity per unit area and per unit time. Negotiating to obtain new technologies and make their best use to enhance productivity and stabilize production gains. Involving local people in technology assessment employing participatory rapid appraisal techniques. Generating more employment in rural areas and provide opportunities to farm families to earn additional income to meet their basic needs. Providing scientific back up to indigenous knowledge of farm communities and making use of the prevailing good practices. Promoting processing of agricultural produce and agro-based manufacturing cottage industries in rural areas to add value to the produce and providing more off-farm employment and livelihood security to farm families. Strengthening Food-for-Work rural development programmes to facilitate access of poor people to food and nutrition. Giving legal recognition to Farmers' Rights and operationalise them as human rights to support on-farm *in-situ* conservation of agricultural biodiversity.

Pressures/Threats faced by Agro-ecosystems and Policy Responses

Both the condition and capacity of an ecosystem are strongly influenced by its location and its dominant physical characteristics. Since agro-ecosystems arose through conversion by humans to serve their needs, they share some basic features with their original natural ecosystems from which they arose. They are also highly diverse in terms of soils, topography, climate, rainfall, crops and livestock and also in culture of the people living in them and their income levels from agriculture/ livestock. It is, hence, more appropriate to identity pressures/ threats and assess policy responses based on different categories of these ecosystems.

Category of Agro ecosystems	Pressures/Threats	Policy Responses
Rainfed Agro-ecosystems	• Instability in biological productivity caused essentially by the aberrant weather	Focussing on watershed management system considering that water is the foremost critical factor in rainfed farming and rain is the only source of water, directly and through recharging of the groundwater.
	• Wide range in rainfed production systems and uncertain water availability	Strengthening traditional soil and water conservation practices and fine-tuning them with scientific backup since case studies have shown that water availability is not a serious constraint if rainwater is managed properly.
	• Increasing human and livestock pressure	
	• Continued decline in soil organic matter due to poor bio-mass production and inadequate integration of crop and livestock farming	Promoting research through developing inter-disciplinary and multi-institutional consortia based on appropriate linkages and people's participation.
		Adopting area-based planning with a focus on the irrigated production system as a whole rather than on individual crops or livestock to boost economy.
	• Decline in agro-biological diversity	Developing and using suitable indicators for technology assessment, promoting participatory rapid appraisal techniques and involving local people to draw upon indigenous traditional knowledge.
		Promoting integrated nutrient and pest management programmes and also providing proper healthcare for the livestock.
		Encouraging ecologically sound cropping patterns and diversified farming systems.
		Where the annual rainfall exceeds 1150 mm, giving attention to paddy and plantation crops. Promoting inter cropping and also aqua-culture under 750-1150 mm rainfall conditions and employing tubewell protective irrigation while ensuring the recharging process of groundwater.
		Increasing emphasis on oilseeds and legume-based cropping systems and arid horticulture (with drip irrigation) under 500-750 mm rainfall conditions.
		Supporting arable farming linked to Animal husbandry and range land management where average annual rainfall is below 500 mm.

Category of Agro ecosystems	Pressures/Threats	Policy Responses
		Providing strong support and incentives to promote on-farm *in situ* conservation of agrobiodiversity with proper backup *ex situ* conservation in gene banks.
		Giving priority to poverty alleviation programmes and Food-for-Work projects.
Arid Agro-ecosystems	• Growing human and livestock population pressures	Providing greater support to research and technology development.
	• Chronic water shortages and weather aberrations	Promoting 'Composite Mapping' by using database on the status of renewable natural resources, land use and soil degradation status.
	• High vulnerability of soils to wind erosion, weather aberrations, salinity and sodicity in soils and groundwater, low water retention capacity of soils, high infiltration rate, poor structure and crusting of soils with low organic matter content and available phosphorus, low nutrient buffering capacity of soils particularly the micro-nutrients.	Improving and promoting traditional water harvesting and under-ground storage methods under less than 200 mm rainfall conditions.
		Improving technology for dry land cropping including proper moisture conservation, suitable planting methods, mixed and strip cropping and use of drought and salt tolerant crops and varieties.
	• Intensive irrigated cropping in Canal command areas with Inadequate drainage	Upgrading silvi-pastoral system, agro-forestry and range-land management to meet the growing animal grazing needs.
	• Irrigation with saline/brackish waters	Promoting arid horticulture, where feasible, based on sprinkler and drip irrigation systems.
	• Use of heavy machinery for farm operations, particularly on marginal lands	Encouraging integrated nutrient management in dryland farming under canal irrigation or brackish water situations.
	• Growing desertification processes	Providing support to reclamation of degraded lands by using soil amendments combined with land shaping, rainwater harvesting, soil profile modification, more suitable planting techniques and salt tolerant crops and their varieties.
		Strongly supporting the programmes on sand stabilisation using suitable plant species, erecting wind breaks, developing shelter belts and involving local people.
		Promoting participatory crop improvement and technology assessment programmes involving local people in decision-making.
		Monitoring the spread of desertification using satellite imageries and GIS techniques and adopting preventive strategy and action-plan.
		Adopting poverty alleviation projects developing more skills, generating additional income to farm families and promoting Food for Work programmes.
Irrigated Agro-ecosystems	• Long-term sustainability of agricultural production systems	Supporting research on cropping and farming systems best suited to diverse soil, water and climatic situations of irrigated ecosystems.

Category of Agro ecosystems	Pressures/Threats	Policy Responses
	• Depletion in soil fertility and decline in productivity	For the areas having limited water availability, focusing on crop diversification and on development of management practices for diversified farming systems.
	• Decreasing biodiversity and increasing genetic uniformity in crops	Promoting diversification of farming systems, crops and their varieties to avoid increase in genetic vulnerability to widespread epidemics of diseases and pests.
	• Soil salinity/alkalinity and water-logging	Supporting studies on different kinds of physical and chemical degradation of soils due to intensified agriculture coupled with indiscriminate use of irrigation water and non-judicious fertilizer application in irrigated areas.
	• Poor water and nutrient management practices	Providing adequate drainage in irrigated areas. Where natural drainage is impeded, promoting more efficient pressurized water management techniques like sprinklers and drip irrigation.
	• Excessive use of chemical inputs	
	• Over-exploitation of groundwater leading to rapid lowering of water table	Adopting land reclamation measures including the use of soil amendments, leaching and salt-tolerant crops and varieties.
	• Use of poor quality waters for irrigation	Increasing the water use efficiency and promoting conjunctive use of rainfall, surface water and groundwater to maintain hydrological balance and avoid overexploitation of groundwater.
		Promoting integrated nutrient and pest management schemes, application of fertilizers based on proper soil testing results and scheduling of irrigation based on water requirements of different crops.
		Discouraging cultivation of high water requiring crops like sugarcane and paddy in areas using brackish water for irrigation.
		Promoting the best suited cropping schemes and crop rotations to prevent heavy withdrawal of nutrients due to exhausting cropping schemes and inadequate replenishment of nutrients, particularly micro nutrients.
Hilly and Mountainous Agro-ecosystems	• Natural instability and ecological fragility	More investment in research and appropriate technology development with a focus on proper watershed management.
	• Increasing population and tourists pressure	Developing location/area-specific technologies and adopting soil and water conservation techniques like contour bunding and bench terracing combined with improved agronomic practices.
	• Inaccessibility, poor infrastructure and undeveloped market links	Promoting diversified and integrated farming systems incorporating food crops, vegetables, horticulture, commercial crops, floriculture, plantation crops, agro-forestry, livestock, farming and silvi-pastoral system.
	• Cultivation on sloping land with high risk of soil erosion and water loss	Promoting cultivation of high value and low volume crops like fruits, medicinal plants, spices, ornamentals and plantation crops.
	• Unplanned shifting cultivation practices	Supporting minor irrigation and water saving techniques like sprinklers and drip system.

Category of Agro ecosystems	Pressures/Threats	Policy Responses
	• Decreasing diversity in farming systems	Developing post-harvest technology including processing and product-manufacturing units with adequate storage facilities for perishable produce like milk, cut-flowers and vegetables.
	• Land use conversion	Supporting development of suitable agricultural implements and machinery, like small-sized power tillers, with particular attention to the small operational holdings.
	• Inadequate forest management systems	Providing simplified credit support and crop insurance cover for stepping up the use of inputs and adoption of modern technology.
		Encouraging replacement of the "shifting cultivation' practice by promoting integrated horti-agricultural systems and providing additional income opportunities.
Coastal Agro-ecosystems associated	• Ecological fragility • Land use conversion	Developing and adopting eco-friendly technologies. Providing protection to mangroove vegetation and biodiversity.
		Regulating land use in coastal zones.
	• Poverty and illiteracy	Promoting off-farm additional income generation schemes for resource-poor farm families ensuring gender sensitivity.
	• Negative impact of anthropogenic pressure	Focusing on improving literacy, healthcare and developing additional skills.
	• Climate change	Promoting livestock and aquaculture-based diversified agricultural systems.
	• Uncertainty to the lives and properties, particularly those in lowlands, due to high tidal floods and cyclones	Developing Village Knowledge Centres Network, with the help of Self-Help Groups, linked to weather forecasting and early warning systems.
		Aiding the construction of protective embankments with wind-breaks and shelter belts.
	• Rapidly increasing municipal wastes, industrial effluents and domestic residues	Improving drainage not only assist flood control but also to meet agricultural requirements through internal field drainage.
		Supporting on-farm reservoir for rainwater storage.
		Promoting integrated agri-horticultural systems including vegetables, plantation crops and aquaculture while managing salinity and growing salt-resistant varieties.

Sustainable Agriculture with Sustainable Development: The Way Forward

Intensive irrigated agriculture, with high chemical input use and unsustainable crop rotations, has thrown up problems in some areas in the form of soil degradation, water logging, salinity, disturbed hydrological cycle, pollution, nutrient imbalances, biodiversity loss and high vulnerability to new diseases and pests. Agriculture has received more attention in recent years not only for its contributions to global food and nutrition security and providing sustenance and employment to nearly half of the human population but also for its important role in international trade and because of its adverse impact on environment (Pillai, 1999).

Several organizations have commissioned comprehensive studies on assessment of the status and sustainability of ecosystems, including agro-ecosystems, on a global scale. Their approach and methodologies differ but their results show alarming deterioration. The World Resources report, using findings of a Pilot Analysis of Global Ecosystems, presented a scenario showing clearly declining trends in five major ecosystems

but also pointed to striking regional differences. A more comprehensive Millennium Ecosystem Assessment by UNEP is underway (WRI, 2000).

Another kind of attempt is being made by WWF in collaboration with United Nations Environment Programme (UNEP) and World Conservation Monitoring Centre (WCMC) by bringing out Living Planet Reports measuring the world's natural wealth in forests, freshwaters and coastal and marine areas based on changes in populations of selected indicator species for computing Living Planet Index (WWF, 2000). This report for 2000 has an additional feature in the form of the "Ecological Footprint" that measures a population's consumption of food, other materials and energy in terms of the area of the biologically active land or sea required to produce those resources and to absorb the corresponding waste. Interestingly, it shows among other things that the "Cropland Footprint" (a measure of the area required for an individual to produce all the quantities of crops which that individual consumes) of a person living in North America or Western Europe is more than twice of that of an individual residing in Latin America, Asia/Pacific or Africa from where most of the world's hungry and undernourished people have been reported (UNEP, 2000).

Leaders from 185 countries pledged during the World Food summit, held in Rome in 1996, to work towards eradicating hunger (FAO, 1996). Follow up meeting, World Food Summit: Five Years Later, was held in Rome in November 2001 to review the progress made towards the goal of reducing the number of hungry people by half by 2015 and consider ways to accelerate the process. Unfortunately, current data indicate that the number of under-nourished is falling at a rate of 8 million each year, far below the average rate of 20 millions per year required to reach the target. Although a headway has been made yet much remains to be done. The message is clear that ways and means need to be found for raising the productivity of agro-ecosystems substantially and faster, in an ecologically sustainable manner, and economic access to food of the hungry people will have to be increased. This calls for developing strategies and action plans for promoting sustainable agriculture with sustainable development in developing countries with agriculture-based economies.

Win-Win Options

Lack of adequate and sustained funding has slowed down agricultural development in many developing countries whose national economies largely depend upon agricultural production. Financial institutions tend to invest in areas with assured environment (like irrigated agriculture) expecting that it will generate more agricultural output and higher economic growth at lower cost than in areas under stress and uncertain environments (like rainfed and arid agriculture). Such investment is also seen to help in poverty alleviation since a faster economic growth may provide more employment opportunities with higher wages while more agricultural production may lower food prices, both the outcomes being beneficial to the poor. People living in areas under stress environments should also benefit from these developments that seem to assist in availability of cheaper food, offering increased market opportunities for growth, and also opening new options to underemployed agricultural workers to migrate to more remunerative jobs in intensive agricultural areas. Arguably, this migration may also decrease environmental degradation because of reduced population pressure in stressed areas that are likely to benefit additionally from the migrants sending remittances back home.

This model for economic development has received a setback from recent experiences in India (and also China) showing that the right kind of investments in semi-arid rainfed areas can increase agricultural productivity in diversified farming systems to much higher levels than previously expected and may compare well in gains from comparable investments in irrigated areas that have reached the point of diminishing returns. There are numerous such situations under the wide spectrum of rainfed agro-ecosystems that offer 'win-win-win' options, that is, higher growth ensuring economic security, greater poverty alleviation and lower environmental degradation meaning higher aggregate social returns. When resource-poor farmers in developing countries are being motivated to go for new technologies and adopt high-cost (purchased inputs) and high-risk crop production packages, it is time for the international financial institutions to reconsider their priorities and eligibilities for investments in agricultural development, particularly with the objective of poverty alleviation and supporting ecosystems and integrated management systems of natural resources (Swaminathan, 1998).

It is now widely recognized that countries and regions that are currently exporting food and other agricultural produce need to assess sustainability of their production levels and identified "Hotspot Areas" that require priority attention. Suitable criteria/indicators for the desired

assessment need to be developed to begin with and the analysis must lead to the development of a budgeted action plan along with supportive recommendations on policy, administrative and other regulatory measures. It is not intended to suggest a universal model or some ready-made solutions for adoption. Developing suitable options and sharing the lessons learned from such process may be more helpful. A study conducted recently on food insecurity in rural India, for example, inferred that every state had its own strengths and weaknesses in relation to achieving the goal of sustainable food security and, hence, required different action plans for this purpose (WFP and MSSRF, 2001).

Policy Recommendations

While recognizing the limitations in making general policy recommendations regarding agro-ecosystems due primarily to their highly diverse nature, some strategies are being suggested with a view to providing some options for the policy makers and managers working in agriculture-based developing economies. It is obvious that the priorities and follow up action plans will depend upon national policies and planning processes that respond to specific development (and also environment) needs and people's aspirations.

Strategy 1- Promoting High Productivity and Sustainability of Production Systems

- Defending the location-specific gains already achieved under different categories of agro-ecosystems by paying more attention to conservation and enhancement of soil and water resources, forests, biodiversity and other basic life-support systems.
- Extending the gains made under irrigated agriculture to rainfed, semi-arid, hilly and coastal areas by adopting new yield enhancement and stabilization technologies and opting for low water requiring but high value crops.
- Making new gains through farming systems' intensification, diversification and value addition by making full use of the results obtained from molecular biology and innovative bio-technologies by forging new partnership with industry.
- Providing users-driven institutional support and centralized services to small and marginal farm families for adopting eco-farming based on integrated pest management, efficient water management, integrated nutrient supply, post-harvest technology and marketing access.
- Strengthening research on farming systems and diversified cropping schemes (Crops, horticulture, livestock, aquaculture and agro-forestry).
- Bridging the gap between the actual and potential yield levels (already achieved on research farms and demonstration plots) under major farming systems.
- Promoting the use of safer chemicals, in particular the pesticides, by regulating the production, import, export, disposal and use of Persistent Organic Pollutants, as recommended by The Stockholm Convention on POPs signed by 91 countries on 22-23 May 2001).

Strategy 2 - Assigning Top Priority to Land Care and Management Systems

- Conserving prime farmland for agriculture by protecting them from conversion to other uses, often for short-term gains.
- Preventing the loss of the biological potential of the soil (desertification) by taking effective measures to check different kinds of soil erosion.
- Restoring the degraded land by providing incentives, based on agroforestry and other arable practices.
- Implementing land reforms to overcome land-tenure insecurity.

Strategy 3 - Treating Water as a Social/Public Resource

- Developing strong public policy for regulation of water use (The model adopted by Israel may serve as a model for promoting irrigation with mixed sewage waters).
- Improving traditional rainwater harvest and underground storage methods.
- Promoting ecologically sound cropping patterns based on eco-zoning of crops.
- Supporting sprinkler and drip irrigation to improve water use efficiency.
- Adopting conjunctive use of surface and ground waters for irrigation (ensuring thereby more crop for every drop).
- Providing incentives for recycling of rainwater and home-used (waste) waters by developing and enforcing building bylaws for compulsory provision for this purpose.

Strategy 5- Strengthening Conservation of Living Aquatic Resources

- Regulating the land use in coastal areas by enforcing suitable policy, administrative & legislative measures.

- Promoting aquaculture-based diversified farming systems.
- Providing off-farm additional income opportunities to farm families with attention to gender sensitivity.

Strategy 6 - Supporting On-Farm Conservation of Agro-biodiversity

- Providing effective incentives to farming communities to support the *in situ* on-farm conservation of agro-biodiversity.
- Providing legal recognition to Farmers' Rights including their livelihoods security under WTO's Agreements on Agriculture and TRIPs (See Box 3 & 4).

Strategy 7 - Developing the Protocol on Agro-Biodiversity under CBD

- Negotiating the Multi-lateral System of Exchange of Food Security Crops under the International Treaty on Plant Genetic Resources for Food and Agriculture.
- Enacting legislation (to be done by both the developed and the developing countries) supportive of access to genetic resources linked to equitable benefit-sharing and bring the private sector and industry under its purview.

Strategy 8 - Supporting Anticipatory Research to Face Consequences of Climate Change

- Assisting on-farm *in situ* conservation of agro-biodiversity and long-term preservation of ex situ collections kept in Gene Banks for possible tapping of this reservoir of genes for enhancing plant adaptation to future climatic changes.
- Funding systematic world-wide research on avoidance and mitigation measures to face consequences of projected climatic changes.
- Expediting the pace of implementation of the Kyoto and Montreal Protocols through inter-governmental negotiations.

To sum up, the policies for management and use of land, water and biological resources are required to be based on ecological considerations, meteorological data and marketability criteria (McNealy and Scherr, 2001). Basic principles underlying these policies should be based on ethics and equity in the use of natural resources. Future research efforts should aim at developing eco-technologies that blend traditional and frontier technologies. Participatory multi-stakeholder management of natural resources should provide a "win-win" situation for all while offering all-inclusive (not exclusive) use and equitable sharing of benefits. Under protection of intellectual property, there should be a provision for compulsory licensing of rights (with justified reasoning) in case of discoveries that are of importance to human food, health security and ecological security (for example, discoveries that may help in combating the alien invasive species). The developing countries, whose national economies are primarily based on agriculture, are vigorously lobbying for a level playing field for negotiations under the WTO's Agreement on Agriculture while asking for the protection of food security and also addressing the farmers' livelihood concerns (Dutfield, 2000; Crucible Group II, 2000).

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Resistance to Net Blotch *[Helminthosporium teres* Sacc.] and Leaf Spot [*Bipolaris sorokiniana* (Sacc.) Shoemaker] in Barley

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Barley accessions including released varieties, advanced lines and exotic were screened under artificial inoculation for resistance to net blotch (*Helminthosporium teres* Sacc.) and leaf spots (*Bipolaris sorokiniana* (Sacc). Shoemaker) under field conditions for two years. Out of the 239 accessions evaluated, six were highly resistant to net blotch and 15 were highly resistant to leaf spot. Five lines namely, DL 472, RD 2052, BH 87, KARAN 16 and K 18 were highly resistant to both the diseases.

Key words : Barley Germplasm, Leaf Spot, Net Blotch, Resistance

Barley (*Hordeum vulgare* L) is an important grain cereal used for a variety of purposes in India including animal feed, human food and in industry for malting and brewing. Barley suffers from many diseases and amongst them the stripe (yellow) rust and leaf blights (net blotch and leaf spot) are of major importance in the main barley growing area of the north-western plains, where the better management is provided to the crop and the crop growth is luxuriant. Due to cultivation of barley under warm humid climates of north-eastern and north-western plains during mid February to end of March under better management, the incidence of leaf blights caused by *Bipolaris sorokiniana* (Sacc.) Shoemaker and net blotch caused by *Helminthosporium teres* (Sacc.) have increased. The effect of these diseases is quite devastating if prevalent together, causing severe damage by premature forced drying of foliages and poor grain filling in susceptible varieties. The barley cultivation for malting purposes is to be done under optimum management of nutrient and water, for which the blights are likely to become the major production constraint both for yield and grain quality. There are only a few classified reports in the country on the sources of resistance to the two diseases identified after the artificial screening (Prakash and Misra 1976, 1977; Singh and Chand 1981 and Singh and Singh 1978). However, none of those sources, except BG 105, is available at present either with the national barley programme or with the collection at National Bureau of Plant Genetic Resources, New Delhi. Moreover, most of them were old native lines with lot of undesirable traits. Therefore the germplasm evaluation under artificial inoculation was undertaken at Directorate of Wheat Research (DWR), Karnal with improved lines, released varieties and exotic sources to identify the diverse sources of resistance. This will help in organizing the leaf blight resistance breeding programme in barley.

Materials and Method

The experiments were conducted at DWR, Karnal during 1998-99 and 1999-2000 crop seasons. In total 239 barley genotypes consisting of released varieties, advanced lines and exotic germplasm accession received from ICARDA, Syria and CIMMYT, Mexico in form of the international observation nurseries, were planted in two rows of 5m length at 30 cm distance between rows. The field screening for the net blotch and leaf spot was done under artificially inoculated conditions. The crop was raised as per recommended agronomic practices and the disease epiphytotic conditions were created by providing sufficient irrigation in the field. The susceptible check entry RD 25-3 was planted on borders all around the screening blocks. The crop was inoculated with a spore suspension of both the pathogens separately on each side by keeping the concentration of spores around 10^5/ml of water, after 40 days of sowing. The spore culture was prepared by growing pathogens on autoclaved sorghum grains for two weeks at 25± 1°C. The spore suspension was prepared in water by shaking the grains of sorghum having spores of pathogens and putting few drops of Tween 80 in water. The suspension was later sieved in muslin cloth and was sprayed during evening by knapsack sprayer. Proper moisture conditions were maintained in the field by spraying of water on crop for three subsequent days and later by providing surface irrigations. The observations on disease incidence were taken separately for *B. sorokiniana* and *H. teres* in 0-9 scale, as proposed by Saari and Prescott (1985) at dough stage. The categorization was made as follows :

0-1=Highly resistant, 2= Resistant, 3-4=Moderately resistant, 5-6= Susceptible and 7-9= Highly susceptible.

Table 1 Reaction of barely genotypes to net blotch (*Helminthosporium teres*) and leaf spot (*Bipolaris sorokiniana*)

Reaction type (on 1-9 scale)	Net blotch *(H.teres)*	Leaf spot *(Bipolaris sorokininana)*
1 (Highly resistant)	4th INWFBCB-130, DL 472 RD 2052, BH 87, KARAN 16, K18	20th IBON-3, 20th IBON-38, 20th IBON-71, 20th IBON-87, 20th IBON–139, BONMRA(94-95)-73 DL 472, DG 105, RD 2052, BH87, EB 921, DWR21, K18, KARAN 16, KARAN 741
2 (Resistant)	22nd IBON-62, BG 105, BCU 944 BCU 1235, BCU 1596, BCU 1606, BCU 1623, CLIPPER, CANUT, DWR 16, DWR 18, DWR 19, DWR 21, ICARDA 55, K 19, LAKHAN, RD 103	20th IBON-96, 22nd IBON-283, 2nd INFBON-8 BONMRA (94-95)-24, BONMRA (94-95)-28, BCU 944, BCU 1412, BCU 1606, BCU 2137, DWR 19, DWR 20, DL 100, RD 103, RD 2035, UBE 469,
3-4 (Moderately resistant)	96 Genotypes	82 Genotypes
5-6 (Susceptible)	81 Genotypes	81 Genotypes
7-9 (Highly susceptible)	39 Genotypes	46 Genotypes

The entries found resistant during 1998-90 crop season, were re-tested during 1999-2000 to confirm their reaction to both the diseases.

Results and Discussion

Based on the two consecutive year's evaluation under artificial inoculation for the two diseases, the barley genotypes were classified into various categories (Table 1). It was observed that six entries such as 4th INWFBCB-130, DL 472, RD 2052, BH 85, Karan 16 and K 18 were highly resistant to net blotch were as 15 accessions (Table 1) were highly resistant to *Bipolaris sorokiniana* (leaf spot). There were five lines identified as highly resistant (DL 472, RD 2052, BH 85, Karan 16 and K 18) for both the diseases.

Out of 239 genotypes tested most of the genotypes fall into the categories of moderately resistant to susceptible types. It has also been observed that most of the lines with high resistance to both the diseases are of the Indian origin, though a few of the exotic barley varieties/high are also having resistance to the leaf blights. Similar studies on identifying resistant sources for net blotch and leaf spot diseases were done by Prakash and Misra (1976, 1977), Singh and Singh (1978) and Singh and Chand (1981) in Indian barley. However the resistant lines identified now are in much improved background and can be directly utilized in the resistance-breeding programmes.

In addition to the above two diseases, two genotypes namely DL 472 (yellow rust) and RD 2052 (cereal cyst nematode) are also known sources of resistance to another disease/pests of economic importance. Since the national programme on barley has taken up the work on malt barley improvement for optimally managed cultivation, the importance of the leaf blights has increased in the states of Punjab, Haryana and Western Uttar Pradesh were hot and humid atmosphere during March may catalyze the disease development affecting the crop yield and grain quality.

The lines identified above may be used as donor parents in the leaf blight resistance-breeding programme, as they are mostly coupled with good yield potential and not in any wild or grassy background.

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Evaluation of Citrus Germplasm in North-eastern Hill Region

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Evaluation of citrus germplasm comprising 15 species and 8 hybrids, maintained at ICAR Research Complex, Barapani farm, indicated a wide range of variability in growth and physico-chemical characters within the different species and types. Based on the physico-chemical evaluation of fruits, certain land races like Soh bitara and Kinnow mandarin in sweet orange and mandarin group, lemon mayer and galgal and citragequate can be exploited for commercial scale under mid hills altitude. The fruits of other species which have no commercial value as edible fruit can be utilized for the extraction of oil, citric acid as well as for manufacturing of pectin and in citrus improvement program as a parent.

Key words : Citrus, Evaluation, Germplasm, Landraces

The north-eastern hill (NEH) region of India is endowed with enormous genetic diversity in a number of crops (Singh, 1981) and holds an important position with regards to citrus wealth. Diverse forms of fruits of different *Citrus* species grow wild or semi-wild in different states in the region (Verma and Ghosh, 1979). A large number of exotic and indigenous citrus species/ types and landraces were collected and maintained at ICAR Research Complex of NEH Region, Barapani farm, Meghalaya, with the twin objectives of conservation and evaluation for further utilization.

Materials and Methods

Out of a large collection, 23 citrus types belonging to 15 species and 8 hybrids planted at the same time and maintained at germplasm block at ICAR Research Complex, Barapani, Meghalaya were evaluated for their vegetative growth and physico-chemical characteristics. Observations on the vegetative growth of plant like height, stem girth and spread were taken in the month of December, while fruits for physico-chemical analysis were picked up randomly from the plant as per their maturity. For each species/types individual fruit was weighed on a monopan balance. Fruit size i.e. length and diameter and rind thickness were measured with the help of Vernier calliper. The juice of individual fruit was extracted with the help of manually operated juice extracter machine and after straining through muslin cloth the quantity was measured by measuring cylinder. Total soluble solids (TSS) was recorded with the help of hand refractometer. The acidity and ascorbic acid content in the fruit juice was estimated as per the standard method described in A.O.A.C. (1984).

Results and Discussion

Vegetative Growth

A wide range of variation in different parameters of vegetative growth among the different species/types and landraces of citrus was observed (Table 1). The plants of Calamodin mandarin, followed by Kinnow and citremon, were found to be vigourous in respect of plant height as compared to other citrus species and types studied. The growth of Satkara plants was mimimum, indicating the dwarfing habit. This may be due to the reason that it grows at lower altitude (less than 400m) and has therefore not adopted well under mid hills conditions (above 900 m). The plants of Cleopatra mandarin and Volkamar lemon exhibited vigorous growth in respect of girth and mean spread respectively. The differential behaviour in vegetative growth among different species/types and land races maintained at Barapani may be attributed due to inherent differential species characters. Similar findings were reported by Singh *et al.* (1999) and Verma *et al.* (1999) under different agroclimatic conditions.

Physico-Chemical Characters

As evident from the data presented in Table 2, wide variability exists in the physico-chemical characters of fruits of different species and types. Among the sweet and sour orange fruit, a good amount of variability was observed. Highest single fruit weight (155.2 g), size of fruit, segments per fruit (11.3), juice content (44.0 ml) and acidity (2.4%) was recorded in Soh bitara fruits. The ascorbic acid, acidity, total soluble solid and rind thickness was found to be minimum in Soh bitara, Kamla Australia, Soh nairiang and Dulcis malta respectively. The fruits of Karun Jamir had the maximum

Table 1. Plant growth of different citrus species/types and landraces after 13 years of establishment at Umiam, Meghalaya

S. No.	Citrus species	Plant height (cm)	Stem girth (cm)	Plant spread (cm)		
				EW	NS	Mean
Sweet orange *(C. sinensis)*						
1	Kamla Australia	442.5	48.7	305.0	305.0	305.0
2	Sohbitara	440.0	38.0	200.0	220.0	210.0
3	Soh Nairiang	446.6	39.9	231.6	236.6	234.1
4	Dulcis malta	450.0	40.0	310.0	400.0	355.0
Sour Orange *(C. aurantium)*						
5	Karun Jamir	412.5	38.6	276.2	272.5	274.3
Mandarins						
6	Cleopatra (C. redhni)	413.7	55.9	236.2	323.7	325.0
7	Kinnow (Hybrid)	490.0	55.0	360.0	345.0	352.5
8	Calamondin	518.0	50.6	297.0	393.0	295.0
Lemon/rough lemon						
9	Lemon Meyor *(C. meyerii* Y. Tan)	234.0	23.5	196.6	190.0	193.3
10	Volkamer lemon *(C. Volkameriana)*	418.7	43.7	355.0	430.0	392.5
11	Galgal *(C. pseudlimon)*	365.5	36.2	292.5	256.6	274.5
12	Estes rough lemon	386.2	43.1	358.7	357.5	358.1
Trifoliate orange and its Hytbrids						
13	Troyer citrange	375.0	27.9	137.5	135.0	136.2
14	Citrangequate	415.0	42.1	270.0	250.2	250.1
15	Yuma citrange	385.0	29.2	145.0	155.0	150.0
16	Carrizo citrange	370.0	25.6	152.5	135.0	141.2
17	Trifoliate orange *(P.trifoliata)*	247.5	19.6	145.0	137.5	141.2
18	Citremon	485.0	35.0	220.0	265.0	242.5
Papeda Group						
19	Satkara *(C. mucrioetera)*	165.0	17.3	130.0	95.0	112.5
20	Soh Shykhoit *(C. latipes)*	480.0	48.0	302.0	290.0	296.2
Others						
21	Grapefruit	351.0	35.2	320.0	312.5	316.0
22	Sweet lime *(C. limiettiodies)*	441.0	44.0	355.0	321.0	338.0
23	Ada Jamir	352.5	37.0	250.0	232.5	241.2

acidity (5.1%) with minimum number of seeds (7.0) and segment (8.7) as well as juice content (19.2 ml) as compared to sweet orange types. Out of three mandarin species, Kinnow has least acidity and was the juicy fruit. However, the ascorbic acid content, number of seeds per fruit and rind thickness were observed to be more in Kinnow than other two types of mandarins. The variability in physico-chemical characteristics of different mandarins have also been reported by Singh and Lal (1982).

Among the lemon types, the fruits of galgal were found to be greater in weight (360.5g), size and juice (110.0 ml). Fruit size, weight, segments/fruits and juice content was recorded minimum in Estes rough lemon. However, the ascorbic acid was recorded more in the same fruit juice than the others. Among the trifoliate hybrids Citrangequat hybrid under mid hills conditions produced the bigger size, thicker skinned, least acidic fruits under mid hills conditions production the bigger size, thicker skinned, least acidic fruits with minimum number of segments as compared to other hybrids. The smallest size of fruit with least number of segments and juice content was recorded in trifoliate orange. However, number of seeds/fruit was found maximum in the same followed by Yuma and Carrizo citrange. The maximum TSS, acidity and ascorbic acid content was found in Troyer citrange follwed by Citremen and Carrizo citrange respectively

Out of two Papeda species, *Citrus latipes* and *C. macroptera*, a wide variation in morphological and

Table 2. Physico-chemical characteristics of citrus germplasm at Umiam, Meghalaya (Av. 4yrs).

No.	Name of Cultivars	Fruit Wt. (g)	Fruit size (cm) Length	Breadth	No of Segment/ Fruit	Rind Thickness ness (mm)	Number of seed/ fruit	Juice/ Fruit (ml)	TSS %	Acidity %	Ascorbic acid mg/100ml Fruit juice
Sweet orange											
(C. sinensis)											
1	Kamla Australia	123.6	5.75	6.12	11.2	4.50	11.8	41.2	10.1	0.90	66.0
2	Sohbitara	155.2	6.02	7.15	11.3	4.82	10.2	44.0	8.6	2.4	37.0
3	Sohnairiang	140.5	5.57	7.02	11.1	6.20	8.5	34.2	8.4	1.7	41.0
4	Dulcis malta	128.0	5.82	6.19	11.0	2.38	15.8	40.8	9.2	1.1	52.2
Sour Orange											
(C. aurantium)											
5	Karun Jamir	146.1	6.44	6.82	8.7	5.82	7.0	19.2	8.0	5.1	35.2
Mandarins											
6	Cleopatra mandarin *(C. redhni)*	36.3	3.34	4.12	11.4	1.55	8.2	17.5	8.4	2.7	32.5
7	Kinnow (Hybrid)	105.4	4.15	5.58	12.2	3.30	35.5	37.0	10.0	1.1	37.5
8	Calamondin	26.4	3.44	3.88	8.2	1.30	6.5	12.4	6.0	4.5	35.0
Lemon/rough lemon											
9	Lemon Meyor *(C. meyerii* Y. Tan)	260.5	11.08	6.53	10.2	6.50	42.0	34.5	6.5	5.7	31.5
10	Volkamer lemon *(C. Volkameriana)*	144.2	7.11	6.48	8.6	4.20	19.1	45.2	7.2	4.0	21.5
11	Galgal *(C. pseudlimon)*	360.5	9.98	8.85	8.4	6.00	5.2	110.0	6.4	4.1	30.0
12	Estes rough lemon *(C. jambhgiri)*	106.3	6.48	5.89	6.2	5.50	19.0	20.2	6.5	4.4	33.4
Trifoliate orange and its Hytbrids											
13	Troyer citrange	85.6	5.33	5.25	8.2	2.50	12.5	30.2	8.3	5.6	68.0
14	Citrangequate	125.6	5.84	5.76	10.8	3.72	8.5	40.3	7.0	1.5	52.2
15	Yuma citrange	71.5	4.62	5.54	9.2	3.51	18.5	27.4	6.5	4.1	52.2
16	Carrizo Citrange	80.2	5.54	5.32	9.0	2.62	14.2	25.4	7.0	4.6	55.0
17	Trifoliate orange *(P.trifoliata)*	35.4	3.94	4.12	6.4	2.48	22.8	16.4	7.1	5.28	47.6
18	Citremon	43.4	4.15	4.52	7.4	3.00	6.0	15.2	8.1	5.4	44.5
Papeda Group											
19	Satkara *(C. mucrioetera)*	169.5	6.09	7.12	14.0	6.40	10.5	35.2	7.9	8.2	27.0
20	Soh Shykhoit *(C. latipes)*	388.9	8.84	9.20	12.1	16.80	26.5	40.5	8.9	5.4	55.5
Others Group											
21	Grapefruit *(C. paradisi)*	362.5	8.25	9.13	12.0	6.62	56.5	95.20	7.2	2.0	41.2
22	Sweet lime *(C. limiettiodies)*	105.2	5.62	5.85	11.0	3.10	2.4	33.0	6.0	0.23	40.0
23	Adajamir	260.4	8.02	7.79	12.1	6.4	27.2	30.0	6.1	5.2	50.0

physico-chemical characters was observed. Single fruit weight (388.9 g), fruit size, rind thickness (16.8 mm) and ascorbic acid content (55.5 mg/100 ml juice) was recorded more in Soh Shyrkhoit than Satkara which contain maximum number of segments (14.4) and acidity. Similar observations were made by Verma and Ghosh (1979). In other three species viz. *C. paradisi*, *C. limettioides* and an indigenous species *C. assamensis*, the fruits of *C. paradisi* was recorded heavier in weight and bigger in size with thicker rind containing maximum juice and seeds followed by Adajamir. The TSS content was found in a range of 0.23 to 5.20% and 40 to 50 mg/ 100 ml juice with minimum in sweet lime and maximum in Adajamir respectively.

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Varietal and Species-Interrelationship between Cultivated and Wild Sesamum

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The relative distance between the five cultivated varieties of *Sesamum indicum* viz., *AVT-3, Rama, Krishna, B-67* and *Local* and the wild *S. mulayamum* was studied on the basis of similarities and dissimilarities of parameters as morphology, seed isozyme profiles and total protein profiles prior to undertaking a hybridization program. The dendrogram revealed that the varieties *AVT-3, Rama* and *Local* were distant from *S. mulayamum* but the grouping of the varieties Krishna and B-67 with *S. mulayamum* indicated greater chance of introgression of the desired insect resistance by hybridizing the wild with either *Krishna* or *B-67.*

Key words : Cultivated Varieties, Dendrogram, Relationship, *Sesamum*, Wild Species

Sesame (*Sesamum indicum* L.; family Pedaliaceae) is an important oil crop cultivated in several parts of India. The consumption of sesame oil is more advantageous than conventional mustard and rape oil with respect to polyunsaturated fatty acid composition (Brar and Ahuja, 1979). Cultivated sesame suffers considerable yield loss every year due to attack of the insect pest *Antigastra catanaulis,* although resitance to the latter is noted in its wild relatives : *S laciniatum* Klein and *S. mulayamum* Nair (Mitra and Biswas, 1983). A preliminary report of incorporation of this insect resistant trait from wild to cultivated sesame is available (Biswas and Mitra, 1990).

The objective of the present programme was to introgress *Antigastra* – resistance trait of *S. mulayamum (S. mul)* into a few cultivated high yielding but susceptible varieties of sesame, through hybridization and anther culture of F1 hybrids. A critical study of the genetic relationship between the wild species and the cultivated varieties is a prerequisite before undertaking such a breeding and biotechnological program. Hence, as an immediate objective we report here on the similarities and dissimilarities between the varieties of sesame and *S. mul* primarily on the basis of conventional seed parameters such as morphology, micro-morphology, isozyme profiles and total protein profiles. A dendrogram was computed to determine the relationship in order to make a successful breeding program.

Materials and Methods

Five varieties of *Sesamum indicum,* viz., *AVT-3, Rama, Krishna, B-67* and Local and the wild, *S. mulayamum* were used during the present investigation. The seeds were procured from the Experimental Farm of Bose Institute, Madhyamgram, West Bengal, India. The germplasms were initially collected from the Pulses and Oilseed Research Station, Berhampore, Government of West Bengal, India. Seeds of the wild species were collected from a population growing at the vicinity of the Experimental Farm of Bose Institute.

To study seed morphology, scanning electron microscopy (SEM) was done with dried seeds that were mounted on stub, sputtercoated with gold using the Edward S150 Sputter Coater, Scanned with Philips 500 SEM and photographed at an angle of 45°.

For the study of isozyme (esterase) and total protein, 2 g seeds of each variety/species were extracted separately with 5 ml of 0.05 M Tris-HCl buffer, pH 7.6 and centrifuged at 12,500 rpm for 20 min at 4°C (Das and Mukherjee, 1995). The clear supernatant was used as the source of enzyme/protein. Protein was quantified by the Folin-phenol method (Lowry *et al.*, 1951). Isozyme (esterase) and SDS-PAGE profiles of total protein were determined using native, non-denaturing polyacrylamide gel (8.5%) electrophoresis and denaturing SDS-PAGE (10%) respectively (Basu *et al.*, 1997). Electrophoretic runs were made for 3-4 h at 2 mA per lane basis at 4°C with gels loaded on an equivalent protein amount. The gels were developed following the procedures of Wetter and Dyck (1983) in case of isozyme profile and Hames (1981) in case of polypeptide profiles. Densitometric scans of the gels were carried out using the Biorad Gel Documentation System (Gel Doc 1000, version 1.5).

Pairing affinity values (PA) for different combinations of materials were calculated on the basis of morphological and biochemical parameters (Mitra *et al.*, 1998). In case

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of the electrophoretic band profile, PA values were calculated following the formula of Khan (1992). Three separate similarity matrices were derived from morphology, isozyme profiles and seed protein profiles and three separate dendrograms were computed accordingly using a statistical package SPSS-X release 3.1. For the sake of brevity, the combined similarity matrix and the dendrogram computed on the basis of these matrices is presented.

Results

The morphological features of flower and seed of the varieties of *Sesamum* and *S. mulayamum* are summarised in Table 1. In general, all varieties of *S. indicum* possess white flowers though there are tinges of pink in variable degrees in the inner corolla of *Rama, Krishna, Local* and *AVT-3*. The colour of the flower of *S. mulayamum* is, however strikingly violet. Moreover, it has a conspicous methyl violet marking along the longitudinal line of the anther (Table 1). The seed coat colour is variable. The seeds of *AVT-3* were differentiated from all others for its white colour. The seeds of *Krishna* are totally black while those of *Rama* and *Local* are brown. The seeds of *B-67* and *S. mulayamum* are blackish (Table 1). In general, the spermoderm is reticulate, reticulation is brought about by polymorphic, deeply concave cavities which are surrounded by straight anticlinal walls. The spermoderm of *Krishna, B-67* and *S. mulayamum* possessed ridges. The ridges are occasional in *Krishna* and *B-67* but very profuse and conspicuous in *S. mulayamum* (Table 1; Fig. 1 A-I).

With one exception, the esterase profiles of the seeds displayed three bands (band 1, rmf 0.53; band 2, rmf 0.57; and band 3, rmf 0.64). The variety *AVT-3* did not show band number 3 (Fig. 2). Similar to the isozymic profile, total seed protein profiles also exhibited general similarity in banding pattern and is represented by six

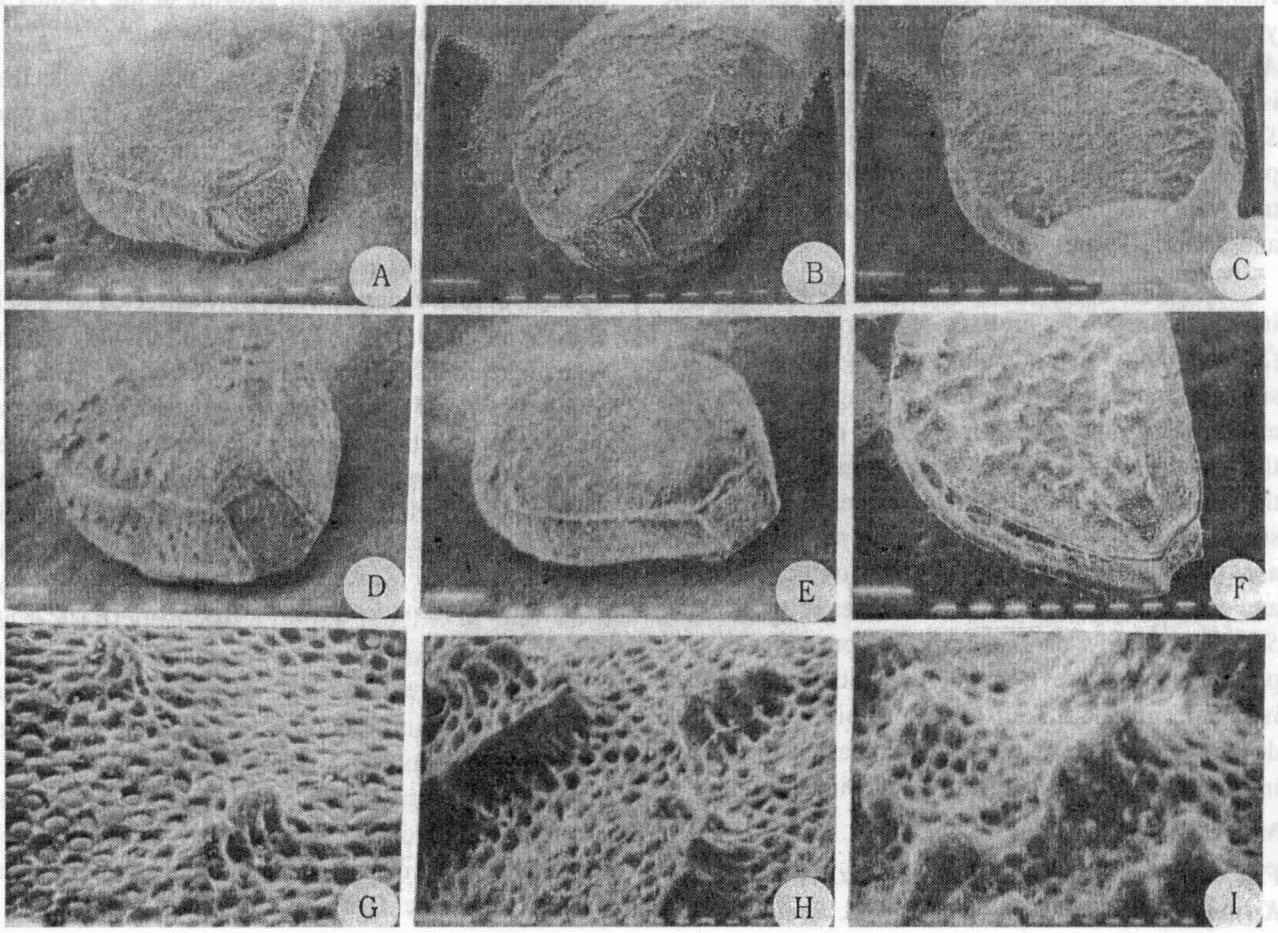

Fig. 1. SEM, seed surface morphology of Sesamum spp. Entire seeds (x50) of Sesamum indicum; (A-F) A, AVT-3, B, Rama, C, Krishna, D, B-67, E, Local; F : Sesamum mulayamum G-I : Seed surface showing ridges (x400), G, Krishna, H, B-67, I, Sesamum mulayamum

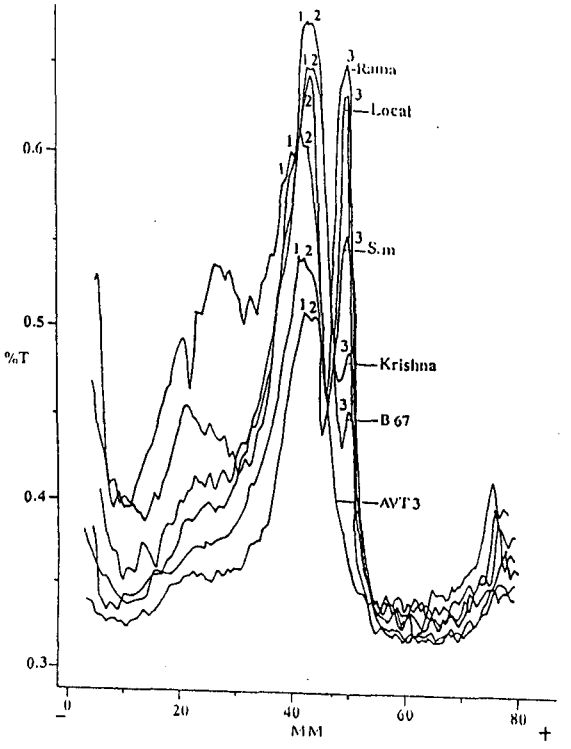

Fig. 2. Densitometric scan of esterase profiles of AVT-3, Rama, Krishna, B-67, Local (all Sesamum indicum) and S.m. (Sesamum mulayamum). Digits indicate band numbers. Migration direction : – → +

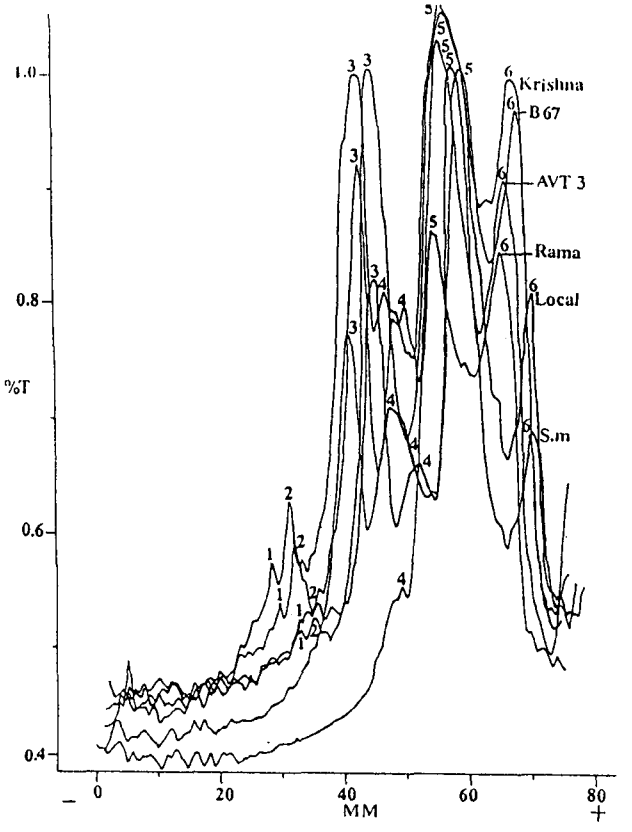

Fig. 3. Densitometric scan of total seed protein profiles of AVT-3, Rama, Krishna, B-67, Local and Sesamum mulayamum. Digits indicate band numbers. Migration direction: – → +

Table 1. Morphological parameters of *Sesamum*

Parameter	*S. indicum*					*S. mulayanum*
	AVT-3	*Rama*	*Krishna*	*B-67*	*Local*	
Flower colour						
Outer corolla	White	White	White	White	White	Violet
Inner corolla	Light Pinkish	Pinkish	Pinkish	White	Light pinkish	Violet
Colour marking along longitudinal line of anther	Pinkish	No marking	Pinkish	No marking	No Marking	Methyl violet
Seed coat						
Colour	White	Brown	Black	Blackish	Brown	Blackish
Spermoderm	Smooth	Smooth	Ridged	Ridged	Smooth	Ridged

bands (band 1, rmf 0.34; band 2, rmf 0.38; band 3, rmf 0.57; band 4, rmf 0.65; band 5, rmf 0.71; and band 6, rmf 0.93). The variety *AVT-3* is distinguishable form the others by the absence of bands 1-3 and in the variety *Rama* two slow migrating bands (1-2) could not be seen. All the six bands are present in *Krishna B-67, Local* and *S. mulayamum* (Fig. 3). Pairing affinity values ranged between 0.36-0.78 (Table 2). High pairing affinity values are shown by *Rama/local* (0.78); *Krishna/ B-67* ((0.78); and *Local/B-67* (0.78) followed by *Local/ Krishna* (0.71). *S.mulayamum* showed comparatively high pairing affinity values with *Krishna, B-67* and *Local* (0.64). However, the value is lowest between *S. mulayamum* and *AVT-3(0.36).* The combined dendrogram revealed two major groups : one comprising *Rama* and *Local,* similar at a distance of 2.2; the other comprising *Krishna* and *B-67,* similar at a distance of 1.8 and together with *S. mulayamum* similar at a distance of 3.1. Variety *AVT-3* at a distance of 4.6 is different (Fig. 4). The distances are Eucleidian but the pattern is similar to that computed following Mahalnobis distances, the dendrogram of which is not shown.

Discussion

Understanding the genetic relationship between the varieties and *S. mulayamum* is a rational approach prior to undertaking a breeding programme. The study of morphological, biochemical and molecular parameters was chosen to evaluate the closest neighbour(s) of interest. From the morphological observations of flower colour, the wild species *S. mulayamum* seemed to be totally different from the five cultivated varieties of *S. indicum* as the former was conspicuously violet while the latter were either white or white-based. The nature of spermoderm gave further differentiating observations as the varieties *AVT-3, Rama* and *Local* were devoid of ridge like structures which were characteristics of seeds of *Krishna* and *B-67* and particularly *S. mulayamum* the wild one. Thus, seed appears to be one of the distinctive features of the spermophytes. Variation in seed size, shape, colour and surface features are of prime importance in identification of seeds and distinction of varieties and species (Das and Mukherjee 1995; Mitra *et al.,* 1998).

Seed isozymes and protein profiles proved to be effective tools in testing varieties and species and their genetic relationships (Das and Mukherjee, 1995; 1997). The study indicated that variety *AVT-3* was different from others as it lacked a major fast migrating esterase and three slow migrating protein bands. The variety *Rama* also lacked two slow migrating bands in protein profile.

The dendrogram computed on the basis of combined pairing affinity values probably reflects a true picture of the relative distance between the five cultivated varieties and the wild species, *S. mulayamum.* The variety *AVT-3* was most distant from the others ruling out its consideration for a breeding programme. The grouping of *Rama* and *Local* in a cluster distant from *S. mulayanum*

Table 2. Combined pairing affinity values based on morphology, isozyme and protein profiles

	AVT-3	*Rama*	*Krishna*	*B-67*	*Local*	*S. mulayanum*
AVT-3	1.00					
Rama	0.64	1.00				
Krishna	0.50	0.64	1.00			
B-67	0.43	0.64	0.78	1.00		
Local	0.57	0.78	0.71	0.78	1.00	
S. mulayanum	0.36	0.50	0.64	0.64	0.64	1.00

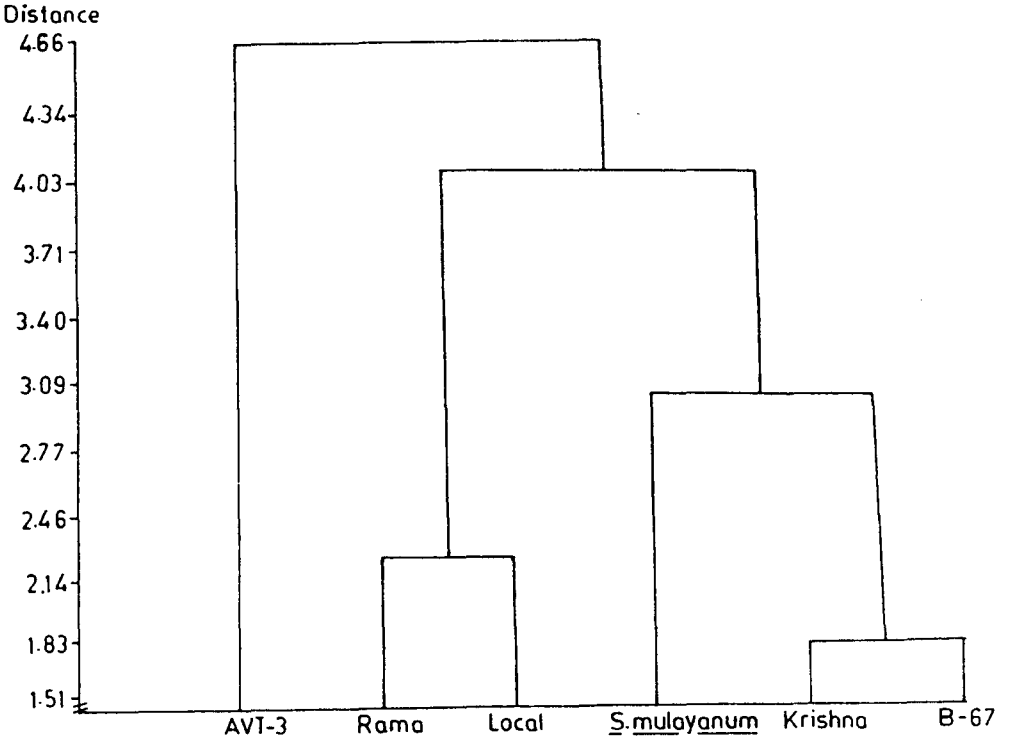

Fig. 4. Dendrogram computed on the compiled pairing affinity values derived from morphology, esterase and protein profiles showing the relative distance between five varieties of Sesamum indicum and the wild Sesamum mulayamum

also indicates their unsuitability for hybridization with *S. mulayamum*. The grouping of *S. mulayamum* with the two varieties *Krishna* and *B-67* strongly points out to the most successful chance of hybridization. These findings confirm the earlier report of hybridization of *S. mulayamum* with the high yielding variety, *B-67* (Biswas and Mitra, 1990).

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Evaluation of Peanut Genetic Resources for Nodule Count

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Six hundred and eighty groundnut germplasm accessions comprising four different habit groups were evaluated for nodule number per plant during rainy season. Rich variation was observed within the population as well as in each habit groups and would be an important gene pool for the breeder. While, the population was evaluated in two distinct environments, it showed two different types of distribution for nodule number per plant. Population registered higher mean nodule number per plant in post-rainy season under rice fallow in comparison to rainy season under red laterite soil. It seems that peddled soil of rice field would not be any constraint for nodulation in rice based groundnut crop and high nodule number per plant in post-rainy season in comparison to rainy season. This might be one reason for better productivity of rabi/summer groundnut under paddy fallow. Twenty five accessions out of 276 Spanish Bunch accessions showed promise as high nodulating genotypes in comparison to check variety, JL-24.

Key words : Augmented Design, Genetic Resources, Groundnut, Nodulation

Groundnut plays a vital role in edible oilseed production in India. Improvement of seed and oil yield in this crop to meet the increasing demand is foremost. There is a need to intensify efforts to search for appropriate new donors for different yield contributing traits to break yield plateau. In the present studies attempts have been made to evaluate the genetic resources of groundnut maintained at this centre to assess their potential use in developing high nodulating genotypes for rice based groundnut cropping system.

Materials and Methods

Working collections of 680 groundnut accessions comprising 416 Spanish Bunch (SB), 142 Valencia (VL), 86 Virginia Runner (VR) and 36 Virginia Bunch (VB) were evaluated in Augmented Design during rainy season at Out-reach Centre of National Research Centre for Groundnut, Bhubaneswar. The accessions were equally distributed in six different blocks having 113 test entries in each block along with six checks AK-12-24, JL-24, TAG-24, OG 52-1, Girnar-1 and ICGS-11. From these 680 accessions, 276 selected Spanish Bunch (SB) accessions out of 416 SB accessions, were re-evaluated again in Augmented Design during post-rainy season under residual moisture situation of paddy fallow. These accessions were distributed in six different blocks having 46 test entries in each block along with six checks as before.

Each accession was sown in three rows of five meter bed with plant to plant and row to row spacing of 10 x 5cm, respectively. N:P:K was applied @ 20:40:40 as basal dose at the time of sowing. Standard agronomic practices and plant protection measures were followed towards management of crop. Observations were recorded on 10 competitive randomly selected plants at 60 days after germination for scoring of nodule number per plant. Data was analyzed according to Agarwal and Sapra (1995).

Results and Discussion

Nodule number per plant was scored at 60 days after germination in 680 accessions of groundnut germplasm. Population distribution of four different habit groups (SB, VL, VR and VB) for nodule number per plant is shown in Fig. 1.

Spanish Bunch (SB) group

The 416 accessions of SB group distributed themselves in all five classes representing wide range of variation from 0 to 125 within the group. However, median class is II (26-50) since, nodule number per plant of majority SB accessions (more than 220) grouped in between 26-50. Frequency value of both class I and III are close to each other and is around 85, whereas frequency value of class IV and V are below 15.

Valencia (VL) group

Being the second largest group in the population (142 accessions), VL also revealed rich variation and distributed in all five classes. However, class III (51-75) showed highest frequency (around 50) for this group followed by class II and IV having frequency around 40 and 30 approximately. Class I and V have frequency value less than 15.

Virginia Runner (VR) group

Eighty six VB accessions also categorized in all five

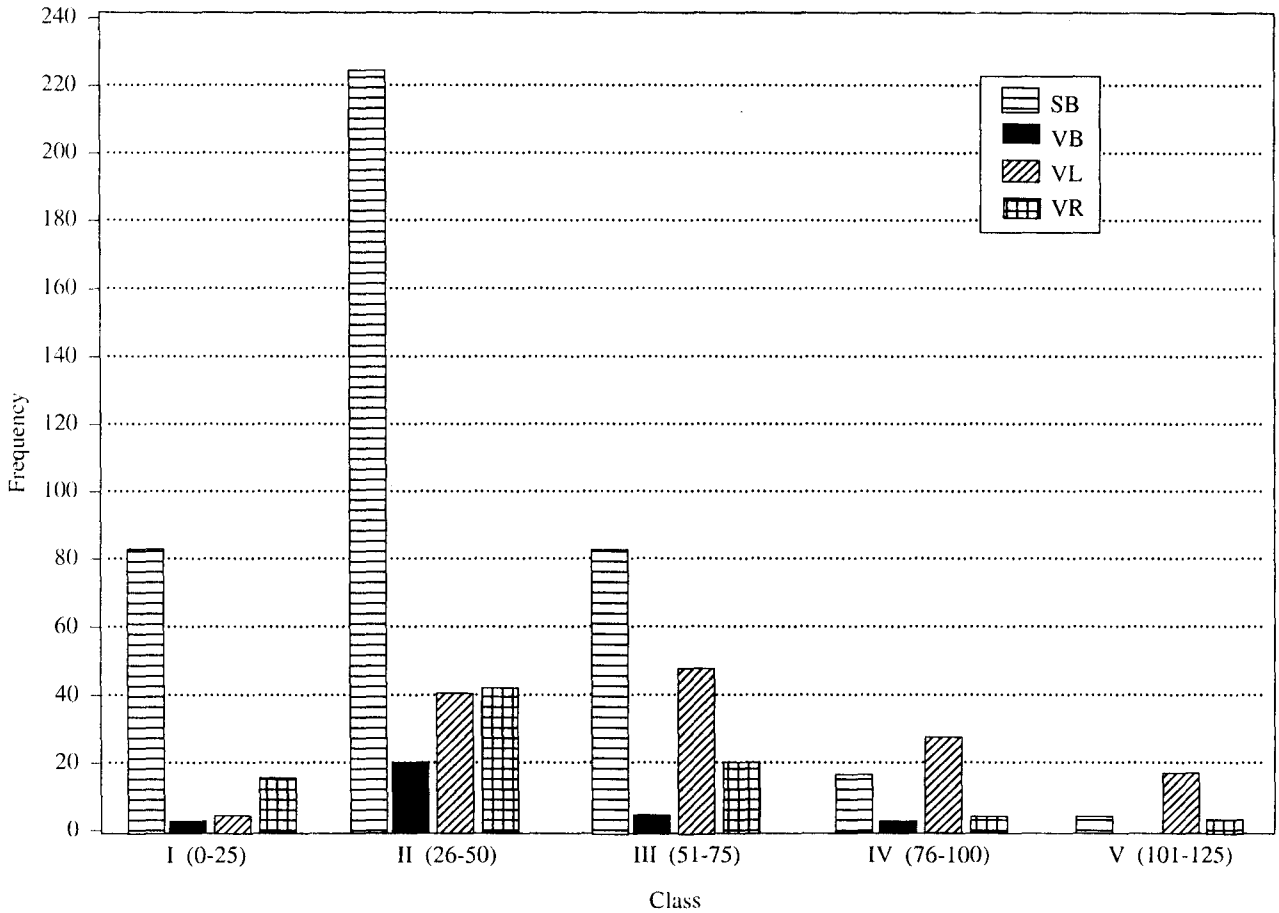

Fig. 1. Population distribution of 680 groundnut germplasm under four different habit groups for nodule number/plant during rainy season

classes. Maximum frequency value (approximate 40) was observed in class II. While other classes showed very less frequency value.

Virginia Bunch (VB) group

Thirty six VB accessions showed variation from 0 to 100, with class II the median class for this group having highest frequency value.

Combined

Maximum number of frequency was observed in class II for all habit groups except Valencia group. Though high frequency for Valencia comes under class III however, it is very close to the frequency of class II. Thus, nodule number per plant of the present population has been observed within the range from 26-50.

A total of 276 selected SB accessions were re-evaluated during *rabi*/summer season under paddy fallow. Population distribution of 276 SB accessions for nodule number/plant at 60 days after germination in rainy and post-rainy has been compared in Fig. 2. It is evident from the diagram that same population showed two different type of distribution for rainy and post-rainy seasons. Nodule number per plant during rainy season showed wide range of variation ranging from 0 to 125. However, highest number of frequency (225) was observed in class II with class value 25-50 followed by class III and I having frequency around 120, 70 and 60 respectively. These three classes represent the nodule number per plant of rainy season for majority genotypes of the population. However, picture is remarkably different in post-rainy season for the same population. In post-rainy season, nodule number per plant also exhibited rich variation starting from 0 to 150. Maximum frequency has been recorded in class IV with class value 76-100 followed by class III and V having frequency around 110, 75 and 50, respectively. Hence classes III, IV and V represent nodule number per plant of post-rainy season for majority accessions of the population.

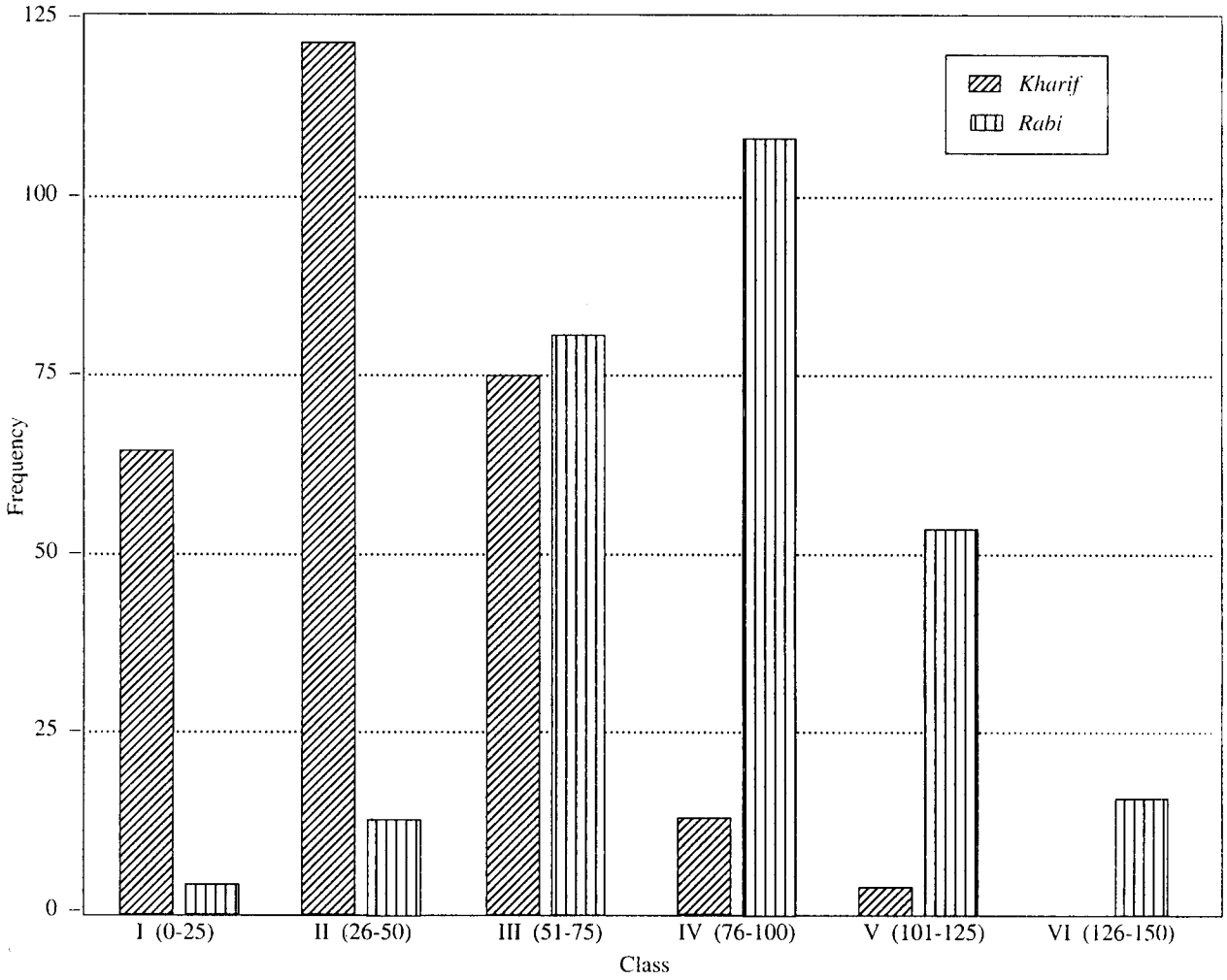

Fig. 2. Comparative population distribution of 276 Spanish Bunch groundnut germplasm for nodule number/plant over two seasons

It is evident from above that average nodule number per plant in groundnut during post-rainy season under paddy fallow situation is higher than rainy season under red lateritic soil. This maybe one reason for higher productivity of *rabi*/summer groundnut under paddy fallow in comparison to *kharif* groundnut.

Nodule number per plant of 276 SB accessions have been analyzed according to Agarwal and Sapra (1995).

Table 1. Mean nodule count per plant in six check varieties over blocks

Sl. No.	Check	No. of nodules/plant
1	AK-12-24	97
2	JL-24	112
3	TAG- 24	81
4	OG-52-1	110
5	GIRNAR-1	87
6	ICGS-11	89

Mean nodule number per plant of six checks varieties has been given has been given in Table 1. Variety, JL-24 produced highest mean nodule number per plant (112) followed by OG 52-1 (110) & AK 12-24 (97). ANOVA for nodule number per plant of six checks (Table 2) varieties revealed that both check and block showed significant variation at 5% and 1% level. Block effect was calculated due to significant variation among the blocks. Adjusted nodule number per plant of 276 SB test entries and different standard errors are presented in Table 3 and 4 to facilitate comparison among test

Table 2. ANOVA for check varieties

Source	D.F.	S.S.	M.S.S.	F Value
Block	5	3147.81	629.6	33.32**
Variety	5	4869.14	973.8	51.55**
Error	25	472.36	18.89	
Total	35	8489.31		

Table 3. Adjusted nodule number per plant of 276 test entries in six different blocks

Block1		Block 2		Block 3		Block 4		Block 5		Block 6	
ICG No	Nodule no.	ICG No	Nodule no.	ICG No	Nodule no.	ICG No	Nodule no.	ICG No	Nodule no.	ICG No	Nodule no.
45	106	1449	60	2028	53	3317	106	3723	97	4518	106
183	84	1451	73	2038	74	3327	100	3727	87	4549	108
317	105	1480	85	2055	64	3336	99	3740	104	4551	120
372	104	1487	57	2061	70	3345	96	3746	85	4563	98
387	122	1489	95	2067	110	3354	111	3755	113	4565	101
1064	107	1491	86	2077	86	3369	102	3762	113	4570	86
1102	89	1496	100	2080	67	3380	89	3765	71	4571	90
1103	157	1507	68	2081	70	3383	69	3772	124	4588	157
1135	81	1509	113	2087	71	3388	149	3773	109	4593	71
1204	125	1510	94	2089	70	3409	121	3774	47	4594	82
1212	80	1511	85	2099	64	3438	102	3785	71	4600	118
1214	89	1512	94	2107	54	3463	77	3823	73	4603	66
1125	116	1513	68	2119	79	3469	86	4038	86	4604	95
1235	76	1517	60	2132	51	3491	66	4043	90	4606	73
1259	104	1537	110	2152	74	3495	81	4044	109	4607	71
1315	79	1538	61	2176	85	3500	61	4069	97	4612	77
1330	78	1571	118	2179	92	3537	31	4071	99	4626	69
1331	90	1572	117	2193	76	3555	111	4075	86	4635	94
1338	101	1750	82	2194	41	3569	37	4078	82	4636	139
1347	84	1785	100	2196	88	3572	83	4083	120	4637	50
1353	71	1826	81	2210	107	3575	72	4084	85	4642	87
1354	77	1834	61	2220	108	3606	107	4086	101	4660	95
1335	83	1837	78	2221	57	3613	89	4091	75	4661	83
1358	89	1839	98	2395	45	3616	159	4102	60	4674	101
1361	67	1856	80	2499	64	3617	91	4004	94	4686	79
1365	107	1859	57	3028	57	3618	111	4107	61	4690	103
1391	81	1873	76	3098	69	3661	132	4112	84	4691	119
1404	105	1880	98	3100	52	3622	107	4114	89	4702	117
1407	63	1912	121	3106	58	3625	116	4117	63	4708	74
1424	75	1916	112	3158	79	3627	98	4118	83	4710	67
1427	71	1917	137	3242	87	3630	70	4226	89	12305	116
1437	92	1922	106	3260	115	3653	75	407	78	12312	95
4893	49	1923	104	3264	40	3660	88	7015	102	2044	99
6027	150	1930	86	3272	94	3674	146	7022	98	2112	79
6028	112	1931	70	3273	75	3698	113	7029	97	6497	109
6030	58	1967	42	3283	57	3721	71	7036	81	6499	111
6035	121	1982	85	3287	44	6617	61	7037	106	6529	89
6038	86	6069	39	3298	24	6625	78	7141	76	6540	37
6039	90	6104	60	6320	16	6630	61	7044	60	6545	70
6040	11	6105	63	6362	67	6667	88	11618	97	6573	36
6042	76	6166	71	6380	5	6677	61	11645	77	6595	37
6058	77	6168	56	6473	92	6679	63	11663	120	6658	86
6178	66	6172	65	6474	52	6710	49	11684	68	11953	28
6217	92	6174	64	6486	57	6769	66	11748	32	12115	73
6238	97	6176	69	6503	26	6823	121	11749	75	12121	70
6270	48	7177	42	6508	41	6906	95	11948	65	12126	199

Table 4. Standard error between components

Sl. No.	Components	S.E. Value
1	Between two check means	1.17
2	Between variety yield and check mean	2.36
3	Between yield of two varieties	2.87

Table 5. Promising genotypes against best check (JL – 24)

Sl. No.	ICG No.	Nodule no.
1	387	122
2	1103	157
3	1204	125
4	1571	118
5	1572	117
6	1912	121
7	1917	137
8	3388	149
9	3409	121
10	3616	159
11	3621	132
12	3674	146
13	3772	124
14	4083	120
15	4551	120
16	4588	157
17	4600	118
18	4636	139
19	4691	119
20	4702	117
21	6027	150
22	6035	121
23	6823	121
24	11663	120
25	12126	199
Best check	JL-24	112 ± 5.07

entries within a particular block, among entries between blocks and between checks and test entries. Accordingly, promising genotypes against best check variety (JL-24) have been identified and listed in Table 5. As many as 25 five test entries from six different blocks registered higher nodule number per plant than best check, JL-24. These high nodulating promising genotypes may be used as parents in breeding programme.

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Performance of Exotic Guava (*Psidium guajava* L.) Germplasm in Humid Sub-Tropics of Meghalaya, India.

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Nine exotic accessions (USA) and two standard varieties of guava (Psidum guajava L.) from India were evaluated together for growth, yield and quality attributes under hilly land conditions (30-35% slope) in mid altitudes (1000m) of Meghalaya. Very high degree of variability (CV%) was recorded in respect to number of fruits and fruit yield/ tree. Acidity and fruit density followed by fruit weight and tree volume. Number of trees, fruit density, stem girth and tree volume and spread showed positive and significant correlation with yield/tree. All the 16 characters studied had significant differences among genotypes. Accessions No. EC-313009 and EC-313010, were found to be significantly high yielding accessions, with pink pulp and sour taste but showed poor quality. However, the yield performance of EC-313012 and EC-313013 was moderate but quality wise superior among all genotypes, thus identified as promising for mid altitude of Meghalaya.

Key Words : Ascorbic Acid, Correlation and Variability, Exotic Germplasm, Germplasm Evaluation, Growth and Yield, *Psidum guajava* L.

Guava (*Psidum guajava* L.) is one of the important fruit crops of North India. It is gaining popularity in hilly areas of North-Eastern Region, through productivity is lower in comparison with the Northern plains (Chandra and Govind, 1995). In low hilly situation of Meghalaya, it has been observed that fruit ripening during rainy season is delayed owing to cool temperature, causing fruits to ripen in October and November, which may be off season crop for Northern plains (Chandra and Govind, 1991; Chandra 1993). As far as the recommendation of varieties is concerned, very little efforts were made in Meghalaya (Chandra and Govind, 1991) and in Sikkim (Gurang and Sing, 1980.) among North eastern states. Considering the scope of guava in this region, the introduction of suitable genotypes and their evaluation programme was undertaken.

Materials and Methods

Nine exotic accessions received from USA were introduced during 1992 at the experimental farm of Regional Station of National Bureau of Plant Genetic Resources (NBPGR), Barapani. These were planted in a randomized block design with two checks namely Allahabad Safeda and Lucknow – 49, and replicated thrice . The experiment was laid on sloppy land (30-35% slope) at 1000m altitude above the sea level. Plantation was carried out on half moon terraces made along the contour lines with a distance of 5m between each plant. The soil consisted of loam (Typic Paleudolfs) with a pH of 4.6. The total rainfall ranged from 199.3-286.0 cm, temperature from 5.2-28.5 °C, humidity from 53.0-92.0% and sunshine duration from 2.04-8.47 hours during the period 1992-1996. Observations were recorded for different growth, yield and quality parameters.

Five ripe fruits from each tree were harvested for qualitative studies during first week of November 1996. Acidity and ascorbic acid in fruits were analyzed by standard procedures (Ranganna, 1997). The tree volume was calculated based on formula of Westwood *et al.*, (1963). Mean range of variation, coefficient of variation (CV%), standard deviation (SD) and correlation were also computed for various attributes.

Results and Discussion

Evaluation of guava genotypes showed considerable degree of variation in respect to their growth, yield and quality attributes (Table 1). The highest coefficient of variation (CV) was observed for number of fruits/tree (96.76%) followed by fruit yield/tree (86.66%), acidity (75.25%) and fruit density (71.87%) but it was lowest for TSS (9.01%). Since these characters have wider variability, they can be used to make selections in guava. Positive correlation of fruit yield/tree with number of fruits/tree (r-0.92) and fruit density (r-0.84) was observed to be highly significant (P/-0.01) whereas stem girth, tree spread and volume with fruit yield/tree showed positive correlation at 5% level of significance. Thus, these traits may be suitable entries while making selection from the population for higher yield.

The analysis of variance showed significant difference (P/-0.05) among genotypes for all the 16 characters studied (Table 2, 3 and 4). Plant height was 2.26-4.38 m

Table 1. Mean range, coefficient of variation (CV) and correlation for growth, yield and quality characters in guava germplasms (1996).

Character	Range	Mean	S.D.	CV%	r'
Plant height (m)	2.26-4.38	2.91	0.69	23.71	0.23
Stem girth (cm)	12.66-25.66	19.64	3.64	18.53	0.66*
Tree spread (m)	2.59-4.59	3.67	0.58	15.80	0.60*
Tree volume (m^3)	3.37-7.22	5.08	1.32	25.98	0.62*
Leaf length (cm)	8.23-12.06	10.03	1.27	12.66	0.06
Leaf width (cm)	3.50-5.60	4.67	0.62	13.28	0.57
No. of fruits/tree	12.01-342.0	104.09	98.08	96.76	0.92**
Fruit weight (g)	100.00-283.30	158.14	56.79	35.91	0.06
Fruit length (cm)	6.20-8.53	7.26	0.69	9.50	0.49
Fruit diameter (cm)	5.68-7.74	6.46	0.67	10.37	-0.10
Fruit density (No. of fruits/m^3 tree volume)	6.60-47.40	18.97	13.08	71.87	0.84**
Days to fruit maturity	104.30-190.0	156.90	26.60	16.95	0.02
Fruit yield/tree (kg)	5.80-57.23	18.14	15.72	86.66	-
T.S.S. (%)	8.10-11.10	9.43	0.85	9.01	-0.18
Acidity (%)	0.37-2.85	1.01	0.76	75.25	0.13
Ascorbic acid (mg/100g fruit pulp)	272.0-424.9	328.91	54.36	16.53	0.12

* Significant at 5 per cent;
** Significant at 1 per cent;
r correlation coefficient between fruit yield/tree and other characters.

Table 2. Morphological growth parameters of exotic guava accessions studied

Accession No./ Variety	Plant height (m)	Stem girth (cm)	Tree spread (m)	Tree volume (m^3)	Leaf length (cm)	Leaf width (cm)
EC-313009	3.51	25.66	4.59	7.22	9.30	5.10
EC-313010	3.31	24.00	4.25	6.36	11.73	5.60
EC-313012	2.48	20.50	2.59	3.49	9.93	4.80
EC-313013	2.48	12.66	2.90	3.56	8.23	4.30
EC-323712	3.60	17.16	3.76	5.55	9.10	3.50
EC-323713	2.86	22.53	4.23	5.96	12.06	5.33
EC-323714	2.26	17.93	3.52	4.40	10.20	4.50
EC-323715	4.38	20.00	3.72	6.33	10.93	4.73
EC-323716	2.33	17.16	3.38	5.16	8.50	3.96
Allahabad Safeda	2.35	20.55	3.73	4.50	11.00	4.73
Lucknow-49	2.47	17.93	3.76	3.37	9.43	4.56
C.D. (P=0.05)	0.43	6.80	0.43	0.59	1.91	0.22

in different genotypes with highest value of 4.38m in EC-323715. Plant spread was higher in EC-313009, EC-31310 and EC-323713. Their values ranged between 4.23-4.5 m, which indicates these genotypes are spreading type with semi-tall to tall growing in nature. Besides, their tree volume (5.96-7.22m) and stem girth (22.53=25.66m) were also higher. Leaf length and width of different genotypes varied between 8.23-12.06 cm and 3.50-5.60 cm respectively.

Fruiting was noticed in all the genotypes from 3rd year onwards after planting. Though number of fruits/ tree in 1995 was less (11.0-60) but in the subsequent year it was higher (36.7-342.0). EC-313009 (342.0) and EC-313010 (233.3) accessions recorded more number of fruits per tree during 1996. Heavy fruiting in guava after 2 year of planting was also recorded by Yadava (1996) in Fort Valley of Georgia. EC-313013 and EC-313022 were at par with each other and significantly superior to other genotypes in respect of their fruit weight and size. Average fruit weight ranged between 100.0-283g in different genotypes. Maximum fruit weight (283.3g) was noted in EC-313013, followed by EC-313012 (250.0g), while the fruit density was significantly highest in EC-313009 (47.4) followed by EC-313010 (36.7) and Lucknow-49 (21.9). It was lowest in EC-323712 (6.6).

In general, flowering started from April to May and depending upon the genotype, the fruit started ripening from August and continued till the last week of November. Moreover, the fruits in most of the genotypes were ready for harvest in between second week of October to first week of November. EC-323712 was the earliest genotype where fruit matures in about 100 day after flowering while in EC-323714 it took 190-198 days to mature (Table 3). Rathore (1976) and

Table 3. Yield attributing characters of exotic guava accessions

Accession/variety	No of Fruits/tree		Average fruit weight (g)	Fruit size (cm)		Fruit density (No. of fruits/ tree volume)	Days to maturity	
	1995	1996	1996	Length 1996	Diameter 1996	1996	1995	1996
EC-313009	33.0	342.0	145.0	7.8	6.2	47.4	153.3	154.7
EC-313010	60.0	233.3	146.7	7.4	6.3	36.7	130.3	138.7
EC-313012	35.3	44.0	250.0	8.1	7.7	12.6	160.0	155.3
EC-313013	27.3	42.0	283.3	8.5	7.7	11.8	168.3	165.3
EC-323712	26.3	36.7	143.3	6.3	6.1	6.6	101.7	104.3
EC-323713	11.0	91.0	149.3	7.8	5.9	15.3	184.7	184.3
EC-323714	20.3	51.3	140.0	6.9	6.2	11.7	198.3	190.0
EC-323715	22.7	64.0	102.0	6.2	5.7	10.1	160.0	153.3
EC-323716	31.0	86.3	136.7	6.7	6.3	16.7	181.0	193.7
Allahabad Safeda	36.7	80.3	143.3	6.7	6.6	17.9	129.6	130.7
Lucknow-49	25.6	73.7	100.0	7.1	6.4	21.9	153.0	155.7
CD (P=0.05)	19.2	23.5	51.6	0.5	1.0	6.4	10.3	18.4

Samson (1986) also reported that guava can take 100-150 days from bloom to fruit harvest depending upon its cultivar or type and ecological conditions. Fruit maturation periods in different genotypes were not much influenced by climatic conditions during 1995 and 1996 period.

Among the quality parameters, acidity was the variable character which could range from 0.37-2.85% in different genotypes (Table 4). The fruit of EC-323712 was the most sour in taste and had 2.85% acidity. In contrast EC-313013 was the sweetest genotype and had significantly higher TSS (11.1%) followed by Lucknow-49 (10.06%). Genotypes EC-313012 (409.43mg/100 g of pulp) and EC-313013 (424.93mg/100 g pulp) were significantly superior in ascorbic acid content. The ascorbic acid in fruits of different genotypes ranged between 272.00-424.93 mg/100 g of pulp. Yield performance of the accession EC-313009 was significantly superior followed by EC-313010 in both the years. The fruit yield varied from 3.16 to 23.46 kg/tree in 1995 and 5.80 to 57.23 kg/tree in 1996.

Out of 9 exotic germplasm, the flesh colour of fruits of 6 genotypes were pink and they were sour in taste with moderate to high yield performance. Thus, EC-313009 and EC-313010, having higher yield and pink colour, can be exploited for crop improvement and also for preparation of value added products. Although yield efficiency per unit volume of tree of EC-313012 and EC-313013 was comparatively lower to the standard varieties Allahabad Safeda and Lucknow-49) but their fruit weight and quality was superior to them. Besides the plant canopy stature was dwarf which proves better scope for high density planting in mid hills of Meghalaya.

Table 4. Fruit yield and quality characters of exotic guava gentoyses

Accession/ Variety	T.S.S. (%)	Acidity (%)	Ascorbic acid (mg/ 100g of pulp	Fruit yield/ tree (kg)		Flesh colour	Taste
	1996	1996	1996	1995	1996		
EC-313009	9.46	1.18	282.60	23.46	57.23	pink	sour
EC-313010	8.06	1.16	314.63	15.40	36.05	pink	sour
EC-313012	9.86	0.41	409.43	10.86	11.55	white	sweet
EC-313013	11.1	0.49	424.93	3.46	18.70	white	sweet
EC-323712	9.66	2.85	333.33	4.66	8.33	pink	sour
EC-323713	8,83	1.40	361.83	3.16	23.20	pink	sour
EC-323714	8.26	0.63	358.83	13,66	8,80	pink	sour
EC-323715	9.10	0.53	272.03	8.21	5.80	white	sweet
EC-323716	9.80	1.69	272.73	8.55	13.33	pink	sour
Allahabad Safeda	9,50	0.37	275.76	6.13	8.13	white	sweet
Lucknow-49	10.06	0.42	312.06	5.53	8.13	white	sweet
CD (P=O.05)	0.69	0.15	44.15	3.23	11.36	-	-

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Genetic Variability and Heritability Studies in *Cuphea procumbens*

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The extent of variability, heritability and genetic advance for days to flowering, plant height, yield traits and yield were determined in 15 germplasm lines of *Cuphea procumbens*. Sufficient variability existed for number of branches/plant, yield/plant, number of fruits/plant and number of seeds/fruit indicating that selection for these traits between germplasm lines may be fruitful. Among 15 germplasm lines NBC 58, NBC61 and NBC 60 were found to be better for yield and yield traits. Heritability in broad sense was high for all the characters and ranged from 64.56 to 98.83%. High heritability coupled with high genetic advance and high coefficient of variability for yield/plant, number of fruits/plant, number of seeds/fruits and number of branches/plant indicates the governance of these characters by additive gene effects thereby implying that simple selection may be effective.

Key Words : *Cuphea procumbens*, Genetic Advance, Heritability, Medium-Chain Triglycerides, Variability

The genus *Cuphea,* consisting of herbaceous annuals and perennials, is the largest in the family Lythraceae having more than 260 species. The seed oil of *Cuphea* has unparallel diversity of fatty acid patterns that range from C_8-C_{18} with Medium-Chain Triglycerides (C_8-C_{14}) predominating, which is unique in plant kingdom (Graham, *et al.,* 1981; Hirsinger, 1985; Khanna and Singh, 1991). The Medium-Chain Triglycerids has wide applications in industries, medicine and nutrition and dietetics (Thompson, 1984; Knapp, 1990). *Cuphea* is native of sub-tropical Brazil and Mexico, and has been introduced in India for exploitation as oil seed crop (Singh *et al.,* 1998).

Preliminary investigation made at National Botanical Research Institute, Lucknow, India revealed that four species (*C. procumbens. C. lanceolata, C. viscosissima* and *C. wrightii)* are promising under Indian conditions. Among these *C. procumbens* was found to be the best. So the present study was conducted to study the genetic variability among *C. procumbens* germplasm lines and also to study the heritability and genetic advance of yield and yield contributing traits.

Materials and Methods

The exotic germplasm of *Cuphea procumbens* obtained from Unitied States Department of Agriculture (USDA), Plant Introduction Center, Ames, USA, were subjected to selection for pure lines and inbred lines during 1998-99. Among these the selfed seeds of 15 genotypes were raised in a randomized block design with three replications during 1999-2000, at National Botanical Research Institute, Lucknow, India, situated between 26^0 *40'N* latitude and 80^0 *45'E* longitude and at an altitude of 129 m above sea level. The rows were 3 m long while the spacing between the rows and within the rows were 65 cm and 30 cm respectively. Basal dose of NPK @ 45 kg, 40 kg and 40 kg per hectare was applied at the time of planting and remaining 45 kg of N was applied in two splits as top dressing. Ten plants were selected at random in each plot/replication and observations on days of flowering, plant height (cm), number of branches/plant, number of fruits/plant, number of seeds/fruits, test weight (g) and seed yield/plant (g) were taken.

The Analysis of Variance (ANOVA) for the design of experiment was performed according to Panse and Sukhatme (1967). The genotypic and phenotypic coefficient of variation and heritability in broad sense were computed according to method suggested by Johnson *et al.* (1955). Genetic advance was estimated according to Allard, 1960.

Results and Discussion

ANOVA for the design of experiment revealed that genotypes differed significantly for all the characters. Mean values, range and co-efficient of variation estimates reflected the presence of ample exploitable variability for all the characters under study (Table 1-3).

Mean performances of 15 germplasm lines for different characteristics (Table 1) revealed that days to flowering was variable between 76.75 (NBC 51) to 109.50 days (NBC 53) with an average of 84.76 $\pm$ 0.68 days. The low Genotypic Coefficient of Variation (GCV) (9.13%) for this character (Table 3) indicates that sufficient variability doesn't exist, so selection will not be effective.

Regarding plant height NBC55 was the shortest (39.75cm) and NBC 58 was the tallest (53.25 cm) among

Table 1. Mean values for days to flowering, plant height, yield traits and yield in different *C. procumbens* germplasm lines

Germplasm Lines	Days to Flowering	Plant Height (cm)	No. of Branches/ Plant	No. of Fruits/ Plant	No. of Seeds/ Fruit	Test Weight (g)	Seed Yield/ Plant (g)
NBC51	76.75	54.75	83.25	155.67	25.25	3.320	12.95
NBC52	82.00	46.50	74.25	163.67	19.50	3.910	12.50
NBC53	109.50	48.25	122.00	208.50	21.50	2.712	12.15
NBC54	82.00	50.50	109.75	202.50	15.75	3.020	9.61
NBC55	81.00	39.75	96.75	177.50	18.50	2.803	9.24
NBC56	82.00	52.75	52.75	146.13	23.75	3.144	10.85
NBC57	81.00	49.75	59.75	133.38	31.00	2.514	10.39
NBC58	82.50	53.25	123.00	197.50	29.25	3.026	17.40
NBC59	81.50	44.50	73.50	127.00	31.75	3.178	12.82
NBC60	87.50	41.25	78.25	125.50	31.75	2.860	15.23
NBC61	90.25	42.25	82.25	164.38	27.25	3.556	15.84
NBC62	90.50	47.75	58.00	121.88	27.25	2.712	8.95
NBC63	81.75	50.25	86.25	147.63	27.75	2.938	12.06
NBC64	82.25	50.75	63.25	102.50	27.00	2.874	7.95
NBC65	81.00	48.25	62.00	129.38	34.75	2.914	13.09
$\bar{x}$	84.76	47.43	81.66	153.53	26.12	3.098	12.06
SE	0.68	2.27	9.56	11.33	12.06	0.077	0.94
CV(%)	0.99	5.86	14.33	9.03	9.70	3.11	9.54
CD(5%)	1.41	4.65	19.58	23.21	4.24	0.16	1.92

the germplasm lines. The average was 47.43 ± 2.27 cm. GCV was low (7.91%) indicating lack of variability for this trait too (Table 3).

Among the yield traits number of branches/plant showed highest GCV (26.32%) followed by number of fruits/plant (20.17%), number of seeds/fruits (20.03%) and test weight (13.11%). The mean value for number of branches/plant ranged from 52.75 to 123.00 with an average of 81.66 ± 9.56. NBC58 (123.00) had the highest number of branches/plant followed by NBC53 (122.00) and NBC54 (109.75). The GCV is very high indicating the presence of rich exploitable variability for this character.

Among 15 germplasm lines NBC 65 had the highest number of seeds/fruit (34.75) and NBC53 had the highest number of fruits/plant (208.50). The magnitude of variability for both the characters are high, so selection for these characters between genotypes is effective. Maximum test weight was found in NBC52 (3.910 g), however the GCV for this trait is low indicating narrow variability.

The seed yield/plant ranged from 7.95 g to 17.40 g with an average of 12.06 ± 0.94. NBC58 had the highest yield/plant (17.40 g) followed by NBC61 (15.84 g) and NBC60 (15.23 g). The GCV for yield/ plant (21.47%) was high indicating existence of sufficient variability among germplasm lines. NBC58 that had the highest yield/plant also had the highest number of branches/plant. Other yield traits such as number of fruits/plant (197.50), numbers of seeds/fruit (29.25) and test weight (3.026 g) are also high for this germplasm line indicating the contribution of these characters towards yield. However the relationship between these characters and yield has to be further studied by correlation and path analysis.

Comparison of individual mean value of germplasm lines for seed yield/plant with arithmetic mean ($\bar{x}$12.06 ± 0.94 g) indicated 8 germplasm lines to be superior. Further test for significant difference among germplasm lines for seed yield/plant using CD (Table 2) revealed that NBC58 was on par with NBC61 and significantly different from other strains. NBC61 and NBC60 were on par with each other for this trait. Among 15 germplasm lines performance of three lines (NBC58, NBC61 and NBC60) in terms of yield was significantly better than other lines. So these three strains can be subjected for genetic improvement to be developed as varieties or can be used as parents in hybridization programmes. The coefficient of variation does not offer full scope to estimate the heritable variation. The relative proportion of heritable variation assessed with the help of heritability estimates and genetic advance expressed as percentage of mean are presented in Table 3.

Table 2. Comparison of mean seed yield/plant (g) of germplasm lines using Critial Difference (CD)

S.No.	Germplasm Lines	Seed Yield/ Plant (g)
1	NBC58	17.40
2	NBC61	15.84
3	NBC60	15.23
4	NBC65	13.09
5	NBC51	12.95
6	NBC59	12.82
7	NBC52	12.50
8	NBC53	12.15
9	NBC63	12.06
10	NBC56	10.85
11	NBC57	10.39
12	NBC54	9.61
13	NBC55	9.24
14	NBC62	8.95
15	NBC64	7.95
	$\bar{x}$	12.06
	CD (5%)	1.92

Note : Germplasm lines covered by same line are on par with each other

Heritability denotes the proportion of phenotypic variance that is due to genotypic control. This genotypic variance is important in crop improvement, since this component is transmitted to next generation. In general heritability was high for all the characters. Broad sense heritability was found to be maximum for days to flowering (98.83%) followed by test weight (94.56%) and yield/plant (83.49%). Plant height had lowest heritability (64.56%).

Heritability estimates along with genetic advance are normally more helpful in predicting the gain under selection than heritability estimates alone (Singh and Narayanan, 1993). Johnson *et al.* (1995) pointed out that without genetic advance, the estimates of heritability would not be practically important in selection based on phenotypic appearance. Genetic advance among component traits were high for number of branches/ plant (47.62%), yield/plant (40.41%) and number of fruits/plant (37.92%). High heritability coupled with high genetic advance and high coefficient of variability for yield/plant, number of fruits/plant, number of seeds/fruit and number of brances/plant indicates that most likely

Table 3. Genetic parameters of different traits in *C. procumbens*

Plant Character	F Value	Range	Variance			Variability (%)		h^2 (%)	Genetic Advance (%)
			δ^2p	δ^2p	δ^2e	GCV	PCV		
Days to Flowering	253.00**	76.75-109.50	60.70	59.98	0.71	9.13	9.19	98.83	18.71
Plant Height (cm)	6.46**	39.75-53.25	21.85	14.10	7.74	7.91	9.85	64.56	13.10
No. of Branches/ Plant	11.11**	52.75-123.00	599.35	462.23	137.11	26.32	29.97	77.12	47.62
No. of Fruits/Plant	15.94**	102.50-208.50	1151.75	959.19	192.55	20.17	22.10	83.28	37.92
No. of Seeds/Fruit	13.79**	15.75-34.75	33.83	27.40	6.42	20.03	22.26	81.00	37.14
Test Weight (g)	54.11**	2.514-3.910	0.17	0.16	0.009	13.11	13.47	94.65	26.27
Seed Yield/ Plant (g)	16.17**	7.95-17.39	8.04	6.71	1.32	21.47	23.50	83.49	40.41

Note :
** Singnificant at 1% probability level.
δ^2p - Phenotypic Variance
δ^2g - Genotypic Variance
δ^2e - Environmental Variance
GCV - Genotypic Coefficient of Variation
PCG - Phenotypic Coefficient of Variation
h^2 - Heritability (Broad Sense)

heritability for these characters is due to additive gene effects and hence direct selection may be highly effective. Characters showing high heritability and low genetic advance indicate that these characters were governed by non-additive gene action (dominance and epistasis) and presence of gxe interaction. The heritability is being exhibited due to favourable influence of the environment rather than genotype and hence simple selection may not be rewarding. As such progeny of family testing is to be practiced for improvement of these traits. This implies that breeders can go for selection over several successive generations and locations following hybridization of desirable transgressive segregants. Test weight showed high heritability (94.65%) and moderately high advance (26.27%) and moderately high genetic advance (26.26%), so this trait can be included in the breeding system of component characters.

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Characterization of Potato (*Solanum tuberosum* ssp. *tuberosum*) Germplasm Based on Genetic Divergence and Processing Attributes

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Non-hierarchical Euclidean cluster analysis based on principal component scores of yield and processing traits was used for characterization of 108 potato germplasm accessions of world collection under short day (9.75-11.5 h photoperiod) conditions in the North Indian plains. Moderate to high coefficient of variability was observed for tuber yield, average tuber number, average tuber weight, reducing sugars, sucrose, total phenols, free amino acids and chip colour score, which could be harnessed in future improvement programmes. Based on genetic divergence, determined by Euclidean distances, the accessions were classified into six well-characterized clusters with variable number of genotypes. Each cluster has germplasm accessions of heterogeneous origin, suggesting that geographical distribution has no significant bearing on genetic divergence. Inter-cluster distances were higher than the intra-cluster distances, indicating high diversity among clusters. Based on mean performance for processing attributes, six germplasm accessions, namely 316.1 (CP 1798), B 6532-3 (CP 1907), K 85-6 (CP 1940) and K 194-3 (CP 1945) obtained from USA, Tombola (CP 1780) from the Netherlands and Tunika (CP 1806) from Germany are recommended as parents in developing varieties suitable for processing. Adaptability evaluation for yield traits led to the identification of five high yielding accessions, namely, B 4829-7 (CP 1564) from USA and HYB. No. 20089 (CP 1813), 62.66/1 (CP 1824), 57.1775.110 (CP 1826) and Giewont (CP 1868) from Germany. The tuber traits of these accessions ranged from round to oblong shape, shallow to low deep eyes, white to yellow skin color and white to yellow cream tuber flesh color. This classification should aid the utilization of potato germplasm to develop cultivars with specific adaptation features.

Key words : Cluster Analysis, Intra and Inter-Cluster Distances, Processing Characteristics, *Solanum tuberosum*

Potato is a crop of great importance in the world food production and is the most extensively grown horticultural crop in India (Sikka, 1996; Rao, 1998). It is one of the most productive crop which can play a significant role in ensuring food security and is a versatile food which can be cooked in many ways, can be processed into a number of products and can fit in any meal. On an industrial scale, potato processing is largely confined to the developed countries, but fast growth in processing is also expected in developing countries. In India, there is a spurt in processing activity due to increased urbanization growth, preference of new generation for fast foods, rise in per capita income, increase in number of working women preferring ready-cooked foods and expanding tourist trade (Marwaha, 1997). Recently, a large number of companies including multinationals have stepped into the field of potato processing. These processing industries need varieties with above 20% tuber dry matter and low reducing sugars and total phenols (Gaur *et al.*, 1999). The north-western plains is a major potato producing zone of India where the crop is grown during winter season under short day conditions, planted mainly in October and harvested in January/February. During maturity period, the crop is exposed to average minimum temperature of 4.5^{0}C or even lower leading to the accumulation of low dry matter and high content of reducing sugars in potatoes which make this zone unsuitable for producing potatoes for processing (Ezekiel *et al.*, 1999). Conversely, the major potato processing industries are located in the north-western plains of India, which procure potato from Central plains of Uttar Pradesh and Malwa region of Madhya Pradesh. The cost of the raw material arriving at the factory premises becomes very high due to heavy transportation charges. Thus, there is an urgent need to breed suitable processing varieties for this region. Although, two processing varieties, Kufir Chipsona-1 and Kufri Chipsona-2, have been released for commercial cultivation for the Indo-gangetic plains during 1998 (Gaur *et* al., 1998; Gaur *et al.*, 1999), there is still a need to develop more processing varieties to meet the increasing demand of processing industries and to provide wider choice to the growers. The germplasm is the reservoir of genetic diversity which is often exploited to meet the changing needs for developing improved varieties of a crop. While formulating any breeding programme, understanding about the nature and the degree of genetic divergence for desirable traits available in the germplasm

plays a pivotal role as it helps in judicious selection of parents to generate superior and desirable recombinants. The present investigation was, therefore, undertaken to determine the magnitude of variability among genotypes for yield and processing traits; to determine the distribution pattern of genotypes in diverse clusters and, to identify genetically diverse and processing superior germplasm accessions for use as parents in developing potato varieties suitable for processing.

Materials and Methods

Germplasm material

The material comprised 108 potato germplasm accessions (*Solanum tuberosum* ssp. *tuberosum)* along with two Indian varieties viz., Kufri Chandramukhi and Kufri Jyoti and three processing popular exotic cultivars, viz., Atlantic, FL 1533 and FL 1625 taken as controls. The germplasm material has been collected from nine different countries and was being maintained vegetatively under field conditions. The germplasm accessions along with controls were evaluated for yield and important processing attributes viz., dry matter content, reducing sugars, free amino acids, total phenols and chip colour under short day conditions at the Central Potato Research Stations Jalandhar, located in the north-western plains (30^0N 75^0E; 237 m above msl). The trial was laid during 1998-1999 and 1999-2000 in two replications. Twelve plants of each genotype in a single row planted at inter and intra-row distances fo 60 cm and 20 cm, respectively, represented each replication. All the recommended agronomical practices were followed. The crop was dehaulmed on 90 days after planting and the tubers were cured for 20 days before harvest. The characters studied were tuber yield per plant (TY), average tuber number per plant (ATN), and average tuber weight (ATW). Important physico-chemcial characters of tubers were studied simultaneously in uniform size tubers (70-80g) of each culture. For the determination of dry matter (DM), tubers were cut into small pieces and over dried at 70^0C to a constant weight. The reducing sugars (RS) were detemined by the Nelson-Somogyi method (Pearson, 1976), while sucrose (S) was estimated by the method of Van Handel (1968). Free amino acids (FAA) and total phenols (TP) were determined by the methods of Moore (1968) and Swain and Hills (1959), respectively. The fresh chips were subjectively scored for colour and assigned a value from 1 to 10 (lower number-better colour). Chip colour score (CCS) up to 3 was acceptable.

Analytical procedures

The mean, range, phenotypic coefficient of variation (PVC) and correlation coefficient were calculated. Mean values were used for principal component analysis to transfer the inter dependent variables into a set of independent variables (Mardia, 1971). Different clusters were generated through a non-hierarchical method of cluster analysis using the principal component analysis as proposed by Singh and Roy (1997).

Results and Discussion

The results of present investigation showed considerable diversity in the germplasm as exhibited by wide ranges and moderate to high variability for all the traits. The data presented in Table 1 shows that the relative contribution of reducing sugars towards variability was very high. This was followed by average number, sucrose, average tuber weight and tuber yield. Moderate coefficient of variation was observed for total phenols, free amino acids and chip colour score, while dry matter content exhibited the lowest coefficient of variability. Since chip colour is the most important visual criterion to assess the consumer acceptability of the finished product, its relationship with other traits was worked out (Table 1).

Table 1. Estimates of variability parameters for important traits

Parameter	Mean	Range	Coefficient of Variability (%)	Correlation coefficient (r) of chip colour score with other traits
Yield/plant (g)	369	130-654	30.9	NS
Tuber weight (g)	48.0	19.0-96.5	31.3	NS
Tuber number/plant	8.19	4.0-18.2	33.2	NS
Dry matter (%)	30.11	16.0-24.0	8.9	NS
Reducing sugar (mg/100g fresh wt)	231	30-811	66.8	0.505*
Sucrose (mg/100g fresh wt)	132	51-263	31.9	NS
Total phenol (mg/100g fresh wt)	47.0	17-92	29.9	NS
Free amino acid (mg/100g fresh wt)	59.0	24-104	27.9	NS
Chip colour score	6.35	1-10	25.8	-

Correlation matrix was used to transform all the metric traits into a single index of similarity in the form of principal components, which yielded nine eigen vectors and eigen roots. Only eight vectors were used for further analysis as these accounted for 99.44 per cent of the variation (per cent variation explained by

these roots, was 24.04, 18.35, 15.0, 11.35, 10.58, 8.76, 6.68 and 4.59 respectively). The first component was a measure of tuber yield(g); the second component of average tuber weight and the third component was measure of chip colour score as the coefficients associated with these traits have the largest magnitude. Similarly, the dry matter and sucrose were presented by fourth; free amino acids by fifth, reducing sugar content by sixth, average tuber number by seventh and total phenol by eighth component.

Non-hierarchical Euclidean cluster analysis based on these eight principal components grouped 108 germplasm accessions and five controls into six well characterised groups (Table 2), suggesting the presence of considerable genetic diversity in the germplasm. The genotypes were distributed as 29 in cluster I, 13 in II, 23 in III, 11 in IV, 21 in V and 11 in VI (Table 2). The five controls were grouped into cluster V. The intra-cluster distance in cluster VI was the highest (2.595) follwed in the descending order by V, II, IV, I and II (Table 3). The inter-cluster distance between IV and V was 4.019 followed by II and VI (3.702) indicating that the genotypes of these clusters were highly diverse from those in other clusters. The cluster wise mean values are given in (Table 4). The data on inter-cluster distances and the mean performance of genotypes were used to select genetically diverse and superior accessions out of 108 accessions. The cluster III, having 23 genotypes, with the highest mean DM (21.2%), the lowest mean RS (149.69mg/100 g fresh wt) and the lowest and acceptable chip colour score (4.42) was considered desirable group for processing. Similarly, 26 genotypes of cluster V possessed reasonably good processing qu lity having 20.4% DM, 167.94 mg/100 g fresh wt RS and 5.09 CCS. The genotypes of cluster IV had high ATN (11.52), the highest RS content (519mg/100 g fresh wt) and high CCS (8.18), and were considered unsuitable for processing (Table 4). The cluster VI comprised of genotypes producing high tuber yield (516 g/plant) and high ATW (74.2 g) with moderate

Table 2. Cluster-wise distribution of 108 germplasm accessions and five controls

Cluster No.	No. of genotypes	Accession number
I	29	CP 1151, 1157, 1197, 1783, 1810, 1884, 1854, 1859, 1871, 1873, 1875, 1876, 1879, 1881, 1890, 1891, 1896, 1911, 1915, 1917, 1918, 1933, 1936, 1945, 1945, 3194, 3195, 3196.
II	13	CP 1779, 1817, 1846, 1850, 1889, 1893, 1895, 1897, 1906, 1922, 1923, 1927, 1937.
III	23	CP 1175, 1178 1214, 1401, 1424, 1428, 1493, 1770, 1771, 1776, 1780, 1782, 1785, 1788, 1798, 1802, 1806, 1809, 1812, 1815, 1818, 1880, 1912.
IV	11	CP 1787, 1835, 1835, 1836, 1843, 1857, 1860, 1868, 1869, 1878, 1919, 1931.
V	26	CP 1523, 1524, 1771, 1775, 1777, 1778, 1781, 1796, 1800, 1804, 1811, 1825, 1907, 1908, 1914, 1921, 1924, 1935, 1940, 2184, 2271, Atlantic, FL 1533, FL 1625, Kufri Jyoti, Kufri Chandramukhi.
VI	11	CP 1143, 1207, 1231, 1564, 1784, 1813, 1822, 1824, 1826, 1827, 1832.

Table 3. Estimates of average intra and inter cluster distances based on non-hierarchical Euclidean cluster analysis

Cluster Number	I	II	III	IV	V	VI
I	**2.124**	2.372	2.476	3.639	2.149	3.471
II		**2.094**	2.462	2.545	2.682	2.275
III			**2.368**	3.459	2.485	3.702
IV				**2.364**	4.019	3.477
V					**2.468**	2.685
VI						**2.595**

Diagonal (bold face) values are average intra-cluster distances, and underlined values are the highest (4.019) and the lowest (2.149) inter-cluster distances.

Table 4. Cluster wise mean values for yield and processing traits

Cluster No.	Chip colour Score	Reducing sugar (mg/100 g Fresh wt)	Dry matter (%)	Total phenol (mg/100 g fresh wt)	Free amino acid (mg N/100 g Fresh wt)	Tuber yield/ plant (g)	Average tuber weight (g)	Average tuber number/ plant
I	6.04	187.63	20.24	29.55	42.76	272.75	41.91	6.86
II	6.92	351.31	18.57	42.54	43.34	430.95	57.11	7.74
III	4.42	149.69	3\21.20	55.03	63.08	336.67	33.62	10.35
IV	8.18	519.95	18.99	43.65	48.17	453.57	40.33	11.52
V	5.09	167.94	20.40	53.35	69.82	377.80	55.56	7.03
VI	7.82	230.15	19.80	48.23	54.74	515.83	74.18	7.06
CD (0.05)	0.56	19.5	0.12	0.98	0.27	37.8	1.93	0.02

DM (19.8%) and high reducing sugars (230 mg/100 g fresh wt). The genotypes grouped in cluster, I, II, IV and VI were not suitable for processing on the basis of their cluster mean values, whereas cluster III followed by Cluster V were deemed good for selecting genetically diverse and processing superior genotypes.

In this study, some genotypes which performed exceptionally good in respect to one and/or more yield and quality traits in comparison to the controls, were selected on the basis of individual genotypic performance out of 108 accessions (Table 5). Irrespective of the clustering, seventeen accessions were identified, which had reducing sugars <0.1% on fresh wt basis, an acceptable limit for producing good quality fired chips, Colour, the most important visual criterion for evaluating the quality of fried products, was mainly dependent upon Maillard reaction between reducing sugars and amino acids present in the tubers (Roe *et al.*, 1990; Marwaha, 1999). The presence of high reducing sugars make fried potato products unacceptable for consumers due to excessive darkening and development of off-flavours (Pritchard and Adam, 1994).

Six accessions were identified for having chip colour score up to 3 (acceptable). Out of these 6, four were such which also converged in the class of genetypes having low reducing sugar content (<0.1% on fresh wt basis), indicating the key role of reducing sugars in determining the colour of processed product. The correlation studies also revealed that chip colour was mainly dependent upon reducing sugar content of tuber (r=0.555**). Similar observations were also reported by Mizza (1983).

Six accessions were identified for having very high dry matter content (23.1-24.1%). Since, high dry

Table 5. Elite accession with desirable processing quality traits selected from each cluster

Cluster No.	Chip colour Score (≤3)	Reducing sugar (<100 mg/100 g fresh wt)	Dry matter (>23%)	Total phenol (<24 mg/100 g fresh wt)	Free amino acid (<30 mg N/100 g fresh	Sucrose content (≤ 60 mg/100 g fresh wt)	Tuber yield/ Plant (>600g)	Average tuber weight (>70g)	Average tuber number (>15)
I	1945 (3)	1810(62.9) 1896(69.0) 1945 (78.0)	1873 (24.1)	1891 (22.)	1873 (24.0)	1859(54) 1918 (29.0)		1850 (71.6)	 1175 (15.4) 1780 (16.9) 1912 (18.2)
II				1817 (17.6)	1937 (29.0)				
III	1780 (3) 1798 (3) 1806 (3)	1175 (86.3) 1214 (49.8) 1770 (68.3) 1798 (29.0) 1806 (78.0) 1818 (72.1) 1880 (58.0)	1178 (23.3) 1776 (23.4) 1785 (23.1)			1175 (56)		 1924 (73.4)	 1868 (18.0)
IV		1843 (69.2)		1868 (21.1) 1878 (23.1)		1860 (57) 1868 (51) 1869 (60)	1868 (620)	 1143 (75.0)	
V	1907 (3) 1940 (1)	1800 (80.9) 1921 (88.0) 1940 (67.0)	1777 (24.0) 1940 (23.1)					1207 (79.2) 1813 (80.5) 1822 (76.8) 1826 (70.0)	
VI		1143 (69.3) 1813 (71.2) 1873 (71.2)				1207 (55) 1564 (56)	1564 (623) 1813 (686) 1824 (654) 1826 (650)	1832 (96.5)	
Control									
KCM	5	112.0	17.8	32.4	101.3	197	329	48.9	9.7
K. Jyoti	5	101.7	19.9	40.2	104.1	193	472	37.8	8.7
Atlantic	3	82.0	21.2	17.4	76.4	263	425	60.2	7.1
FL 1533	3	77.5	19.6	25.4	81.3	176	385	50.3	7.7
FL 1625	3	33.0	21.6	23.4	92.1	170	334	48.7	6.8
CD (5%)	0.2	8.1	1.1	2.6	4.7	11.3	18.9	3.6	1.8

matter was associated with low oil absorption, high product yield and better process efficiency (Storey and Davis, 1992), these accessions were acclaimed suitable for processing. A wide variation in the sucrose content (51-263 mg/100 g fresh wt) was observed in the germplasm, but this parameter showed no specific influence on the processing quality of fried products as reported earlier (Marwaha, 1998).

Potatoes used for different forms of processing have stringent size and shape requirement (Krikman, 1986). Large size tubers are preferred for processing into fried and dehydrated products, as the peeling loss is proportionally greater for small tubers (Marwaha, 1997). In the present investigation, eight genotypes, viz., CP 1143, 1207, 1822, 1826, 1832, 1850, 1873 and 1924 were identified for having large tuber size (>70g) and were considered most suitable, as these will show less peeling losses ultimately leading to high product yield. Four accessions namely, CP 1175, 1780, 1832 and 1912 produced small sized tubers (19.1-28.7 g), but in large numbers (ATN>15) and were designated ideal for canning which required small size tubers with low dry matter content (Kadam *et al.*, 1991). CP 1832 with high ATN (18.3) and low dry matter (17.0%) was found to be most suitable for canning.

Five high yielding accessions viz., CP 1564, 1813, 1824, 1826 and 1868 were identified having dry matter content between 16.0 to 21.3 per cent, Since, the yield recovery of processed products was directly related to the tuber dry mater content and tuber yield per unit area of a particular genotype (Marwaha and Kang, 1994), these accessions were expected to give high product yield. CP 1813, an accession, besides producing high yield (686g/plant), also possessed high ATW (80.4 g), high dry matter content (21.0%), low free amino acids (33.7 mg N/100g fresh wt), low total phenols (32.2mg/100g fresh wt) and low reducing sugars (71.2mg/100g fresh wt). This high yielding accession with desirable processing attributes can be successfully exploited to generate useful segregates in breeding programme for processing quality.

Three accessions, viz., CP 1873, 1918 and 1937 were found to have low FAA content (<30 mg N/100g fresh wt). Free amino acids have been reported to participate in the development of colour of the fried products (Cobb *et al.*, 1990), however in the present study no such relationship was observed (r=-0.136). This was in confirmation with the findings reported by several workers (Herrman *et al.*, 1996; Marwaha, 1999).

Phenolic compounds have been associated with enzyme discoloration (Marwaha, 2001) and cooking quality of potato (Mondy and Munshi, 1988). Four accessions, viz., CP 1817, 1868, 1878 and 1891 contained low total phenol content (<24mg/100 g fresh wt) and were expected to show better cooking quality.

On simultaneous consideration of all the factors, an accession CP 1940 from USA, was marked excellent for having the best chip colour (chip colour score 1), low reducing sugars (<0.1%), high dry matter (23.1%) and low total phenol (26.0 mg/100 g fresh wt). It has oval shaped tubers having shallow eyes with a good average tuber weight (63.9 g). Six germplasm accessions, viz. CP 1780, 1898, 1806, 1907, 1940 and 1945 were found to possess all the desirable processing traits. These accessions can serve as parents to generate desirable segregates in breeding programmes aimed to develop potato varieties suitable for processing in the north-western plains of India.

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AFLP Diversity Among Selected Foliar Diseases Resistant Groundnut (*Arachis hypogaea* L.) Germplasm

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Knowledge of genetic diversity facilitiates the judicious use of germplasm in crop improvement programs. The amplified fragment length polymorphism (AFLP) technique was employed to identify foliar diseases resistant accessions with distinct DNA profiles for mapping and genetic enhancement in groundnut (*Arachis hypogaea* L.). This study revealed 93.3% polymorphic AFLP fragments and 7.2 unique AFLP markers per primer pair. Primer pairs E-ACA + M-CAG, E-AAC + M-CAT, E-ACA + M-CTG, E-AAC + M-CTT, and E-ACC + M–CTC detected between 11-12 unique markers. Accessions with distinct DNA profiles (ICG 6284 with ICGV 99001; TMV 2 with ICG 405, ICGV 1705, ICG 6284, ICGV 99004, and ICGV 99005) and with more number of unique markers (ICG 405, ICG 1705, ICG 6284, ICGV 9904, and ICGV 99005) were identified to diversify breeding populations and identify AFLP markers/quantitative trait loci linked with resistance to ELS, LLS, and rust in groundnut.

Key Words : AFLP Markers, Genetic Diversity, Leaf Spots, Peanut, Rust

Knowledge of genetic diversity, identification of molecular markers linked with specific traits, and availability of genetic linkage map are pre-requisite to marker-assisted genetic enhancement. Amplified fragment length polymorhism (AFLP) has been recently used to study genetic diversity and phylogentic relationships in a wide range of crop species (Sharma *et al.*, 1996; Tohme *et al.*, 1996; Maugham *et al.*, 1996; Singh *et al.*, 1998; Aggarwal *et al.*, 1999; Caidedo *et al.*, 1999; Sanchez *et al.*, 1999). AFLP analysis required no prior sequence knowledge of the target genome, detects greater polymorphisms, and the markers are robust, reliable, and reproducible (Vos *et al.*, 1995; Maughan *et al.*, 1996; Tohme *et al.*, 1996). Recent studies, using DNA amplification fingerprinting (DAF) and AFLP (He and Prakash, 1997), random amplified polymorphic DNA (RAPD) (Bhagawat *et al.*, 1997; Subramanian et al., 2000; Dwivedi *et al.*, 2001), and simple sequence repeats (SSRs) (Hopkins *et al.*, 1999) assays revealed polymorphism in cultivated groundnut (*A. hypogaea* L.).

Rust (*Puccinia arachidis* Speg.), late leaf spot (LLS) (*Phaeoisariopsis personata*) (Berk. & Curt.) v. Arx), and early leaf spot (ELS) (*Cercospora arachidicola* Hori) are widely distributed foliar fungal diseases of groundnut in the semi-arid tropic regions. They cause yield losses in excess of 50per cent to groundnut production (Subrahmanyam *et al.*, 1984, 1985; Waliyar, 1991), and reduce seed quality (Dwivedi *et al.*, 1993). Research at ICRISAT led to the identification of several sources of resistance to rust, LLS, and ELS (Singh *et al.*, 1997), however, the extent of genetic diversity among these accessions is not known. There is a need to identify genetically distinct accessions for diversification of breeding populations with enhanced resistance to rust, ELS, and LLS in groundnut.

The present study was initiated to determine molecular diversity among selected foliar diseases resistant and susceptible accessions to identify those with distinct DNA profiles and unique AFLP markers for mapping and genetic enhancement in groundnut.

Materials and Methods

Eleven accessions were selected for the study. ICG 10881 and ICG 10890 are resistant to rust and ICG 405, ICG 1705, ICG 6284, and ICG 6886 to ELS. They are land races and native of South America. Except ICG 6284, they belong to subsps *fastigiata*. ICG 6284 belongs to subsps hypogaea. ICGV 99001, ICGV 99002, ICGV 99004 and ICGV 99005 are interspecific derivatives originating from crosses between *A hypogaea* and foliar diseases resistant wild *Arachis* species, and are resistant to rust and/or LLS. TMV 2 is highly susceptible to ELS, LLS, and rust. Prior to study, these accessions were grown under field conditions for two seasons to

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detect for any phenotypic variation within each accession. All the accessions included in the study, were phenotypically uniform.

Young unfolded leaves from two week greenhouse grown old plants were bulk harvested for each accession and immediately placed in liquid nitrogen to extract DNA using CTAB method (Saghai-Maroof *et al.*, 1984). The quality and concentration of DNA was assessed by spectrophotometer and also by gel electrophoresis using 0.8% agarose with known concentration of uncut lamda DNA.

Seventeen AFLP assays, using primer pairs E-ACT with M-CAT; E-ACC with M-CAC and M-CTC; E-ACA with M-CAG, M-CTC, and M-CTG; E-AGC with M-CCA; E-AAC with M-CAT, M-CAA, M-CAC, M-CTG, M-CTA, and M-CTT; and E-AGG with M-CAA, M-CTT, M-CAG, and M-CTA, were conducted on 11 accessions following Vos *et al.* (1995) with minor modification. *Genomic DNA (500 ng) was double digested* with 1μl *EcoR* 1/*Mse* 1,5 μl of 5X reaction buffer and AFLP grade water added to a total reaction volume of 15 μl. The reactions were incubated for 3 h at 37°C and then denatured to inactivate the restriction endonucleases at 70°C for 15m. The digested DNA fragments were ligated using 0.5 μl of T4 DNA ligase and 12 μl of adapter ligation solution containing *EcoR* 1 and *Mse* 1 adapters at 20°C for 2 h, The adapter ligated DNA was diluted 10-fold with TE buffer and used as template DNA for pre-amplification. The pre-amplification reaction mixture consisted of 5 μl of template DNA (1:10 diluted ligation mixture), 40 μl of pre-amp primer mix, 5 μl of 10 X PCR buffer containing Mg^{2+}, and 1 μl of Taq DNA polymerase (1 unit/μl). Twenty cycle PCR programme was performed at 94°C for 30s, 56°C for 60s, and 72°C for 60s. The pre-amplified DNA was diluted in a ratio of 1:50 in TE buffer and used as template for selective amplification with *EcoR* 1 and *Mse* 1 primers, each having three selective nucleotides at their 3' ends. Prior to selective amplification, the *EcoR* 1 primer was end labelled with [y^{33}P] ATP (2000Ci/mmol). 10μl of labelled primer along with 10μl of 5 X kinase buffer and 2 μl of T4 kinase were made to 50 μl with AFLP grade water. The reactions were incubated at 37°C for 1 h and inactivated at 70°C for 10m. The 20μl PCR reaction for selective amplification contained 5 μl of 1:50 diluted pre-amplification products, 0.5 μl of labelled *EcoR* I primer, 4.5 μl of *Mse* 1 primer (containing dNTPs), 2.0 μl of 10 X PCR buffer, 0.1 μl of Taq DNA polymerase (5 units μl) and 7.9 μl of AFLP grade water. The cycling profile for selective amplification was one cycle of 30s at 94°C, 30s at 65°C, and 60s for 72°C. The annealing temperature was lowered by 0.7°C per cycle during the first 12 cycles. This gave touch down phase of 13 cycles. The remaining 23 cycles were performed at 94°C for 30s, 56°C for 30s, and 70°C for 60s. PCR reaction was stopped by adding 20μl of formamide dye (98% formamide, 10mM EDTA, 0.025% bromophenol blue, and 0.025% of xylene cyanol). The reaction mixtures were then incubated for 3m at 90°C and placed immediately on ice. 3μl of sample was loaded on a 6% polyacrylamide gel. Electrophoresis was performed on Sequi Gen sequencing unit of BIORAD at constant power of 1500 volts for 3h. After electrophoresis, the gels were covered with Saran wrap and Whatmann # 3 paper and dried in vacuum on a gel drier (Model 583 biorad) for 2h. The dried gels were than exposed to X-ray films for 6 to 10 days, depending upon the intensity of the radiation signal, for developing good autoradiographs.

The amplified fragments on the autoradiographs were manually scored as '1' for the presense and '0' for the absence of band from higher to lower molecular weight products. Pair-wise genetic similarities (S_{ij}) between accessions I and j were estimated using the similarity coefficient of Nei and Li (1979) as Sij = 2 Nij/(Ni +N_j), where N_{ij} is the number of bands in common in accessions i and j, and N_i and N_j are the totals of bands in accessions i and j, respectively, S_{ij} represents the proportion of bands in common between any two accessions and may range from '0' (no common bands) to '1' (identical band profile for the two accessions). S_{ij} values were used to estimate genetic dissimilarity, as $D_{ij} = 1 - S_{ij}$, and D_{ij} values were used to determine the relationships among accessions using principal co-ordinate analysis (PCoA) (Sneath and Sokal, 1973). All computations were performed using statistical computing package Genstat 5 Release 4.1. A band is identified as a unique molcular marker if present in one accession at specific molecular weight but absent in the remaining accessions studied together for a given AFLP primer pair.

Results and Discussion

Seventeen AFLP assays, performed on 11 accessions, produced 8656 fragments of which 8074 (93.3%) were polymorphic (Table 1). Polymorphism ranged between

Table 1. Analysis of polymorphism(%) and unique markers in foliar diseases resistant and susceptible accessions as revealed by AFLP analysis in groundnut

Primer pair*	#amplified Bands+	# polymorphic bands	Polymorphism (%)	# of bands per primer Pair++	# of unique markers per primer pair	Accessions with unique AFLP markers
E-ACT+M-CAT	399	323	80.9	36.3	5	1 each in ICG#6284 and 10881, and ICGV# 99001, 99002, and 99005
E-ACC+M-CAC	285	259	90.8	25.9	5	1 each in ICG#6284 and 10881, and ICGV# 99001, 99002, and 99005
E-ACC+M-CTC	518	518	100.0	47.1	22	12 in ICG 1705, 6 in ICG 6284, and I each in ICGV# 99002, 99004, and 99005 and ICG 10881
E-ACA+M-CAG	474	434	91.6	43.1	11	5 each in ICG 6284 and ICGV 99005 and I in ICGV 99004
E-ACA+M-CTC	604	604	100.0	54.9	3	1 each in ICGV# 99001, 99002, and 99005
E-ACA+M-CTG	593	593	100.0	53.9	12	11 in ICG 1705 and I I ICG 6284
E-AGC+M-CAA	479	383	79.9	43.5	1	1 in ICG 10881
E-ACC+M-CAT	598	598	100.0	54.4	11	7 in ICG 405, 2 in ICGV 99001, and I each in ICGV 99004 and ICG 1705
E-AAC+M-CAA	615	577	93.8	55.9	4	2 in ICG 405 and 1 each in ICGV 99005 and ICG 6284
E-AAC+M-CAC	539	494	91.6	49.0	3	2 in ICG 405 and 1 in ICG 10890
E-Aac+M-CTG	524	462	88.2	47.6	1	1 in ICG 405
E-AAC+M-CTA	689	689	100.0	62.6	4	2 each in ICG# 405 and 10881
E-AAC+M-CTT	682	682	100.0	62.0	17	7 in ICGV 99001, 6 in ICG 405, 3 in ICGV 99004, and 1 in ICG 10890
E-AGG+M-CTT	453	413	91.2	41.2	5	3 in ICG 405, amd 1 each in ICG 6886 and IMV 2
E-AGG+M-CTT	447	405	90.6	40.6	4	3 in ICG 405 and 1 in ICG 1705
E-AGG+M-CAG	275	206	74.9	25.0	8	7 in ICG 405 and 1 in ICGV 99004
E-AGG+M-CTA	483	434	89.8	43.9	7	3 in ICG 405 and 2 each in ICG 10881 and ICGV 99001

*E= *EcoR*1 primer and M = *MSE*1 primer; +Total number of bands recorded in 11 accessions; ++Average number of bands per primer per accession

74.9% with primer pair E-AGG+M-CAG to 100.0% with primer pairs E-ACC+M-CTC, E-ACA+M-CTC, E-ACA+M-CTG, E-ACC+M-CAT, E-AAC+M-CTA, and E-AAC+M-CTT. The amplified fragments ranged from 25.0 to 62.6, with an average of 46.3 per primer pair. The AFLP analysis of 17 primer pairs on 11 accessions identified 123 unique molecular markers. With an average of 7.2 markers per primer pair (Table 1). The unique markers detected in each accessions were 1 each in ICG 6886 and TMV 2; 2 in ICG 10890; 4 in ICGV 99002; 7 in ICGV 99004; 8 in ICG 10881; 10 in ICGV 99005; 14 in ICGV 99001; 15 in ICG 6284; 25 in ICG 1705; and 36 in ICG 405. All the 11 accessions could be differentiated based on the presence of unique makrer(s) at specific molecular weight DNA fragments. The AFLP primer pairs E-ACA+M-CAG, E-AAC+M-CAT, E-ACA+M-CTG, E-AAC+M-CTT, and E-ACC+ M-CTC detected between 11-22 markers.

The genetic dissimilarity (D_{ij}) ranged from 0.0632 to 0.2844 with an average of 0.1703 (Table 2). The D_{ij} matrice was used to determine the genetic relationships among accessions using principla co-ordinate analysis (PCoA). Accessions TMV 2 (quadrant II), ICG 6284 (quadrant III), and ICGV 99004 (quadrant IV) were well separated from each other, and the remaining formed two distinct clusters: ICG 6889, ICG 10881, ICG 10890, and ICGV 99002 in cluster 1 and ICG 405, ICG 1705, ICGV 99001,

Table 2. AFLP dissimilarity matrix for foliar diseases resistant and susceptible accessions as revealed by AFLP analysis in groundnut

	ICG 10890	ICG 10881	ICGV 99001	ICGV 99002	ICGV 99004	ICGV 99005	ICG 1705	ICG 405	ICG 6284	ICG 6886	TMV 2
ICG 10890	0.0000										
ICG 10881	0.0692	0.0000									
ICGG 99001	0.1674	0.1208	0.0000								
ICGG 99002	0.1202	0.0850	0.1310	0.0000							
ICGG 99004	0.2032	0.1763	0.1693	0.1813	0.0000						
ICGG 99005	0.1748	0.1687	0.2194	0.1368	0.21909	0.0000					
ICG 1705	0.1970	0.1745	0.2210	0.1839	0.2429	0.1278	0.000				
ICG 405	0.1644	0.1374	0.1944	0.1294	0.1960	0.1366	0.1743	0.0000			
ICG 6284	0.2442	0.2214	0.2265	0.2399	0.2844	0.2335	0.2621	0.2315	0.0000		
ICG 6886	0.0991	0.0632	0.1351	0.0845	0.1745	0.1622	0.1740	0.1286	0.2055	0.0000	
TMV 2	0.1532	0.1093	0.1934	0.1296	0.2024	0.1980	0.2024	0.1531	0.1852	0.0687	0.0000

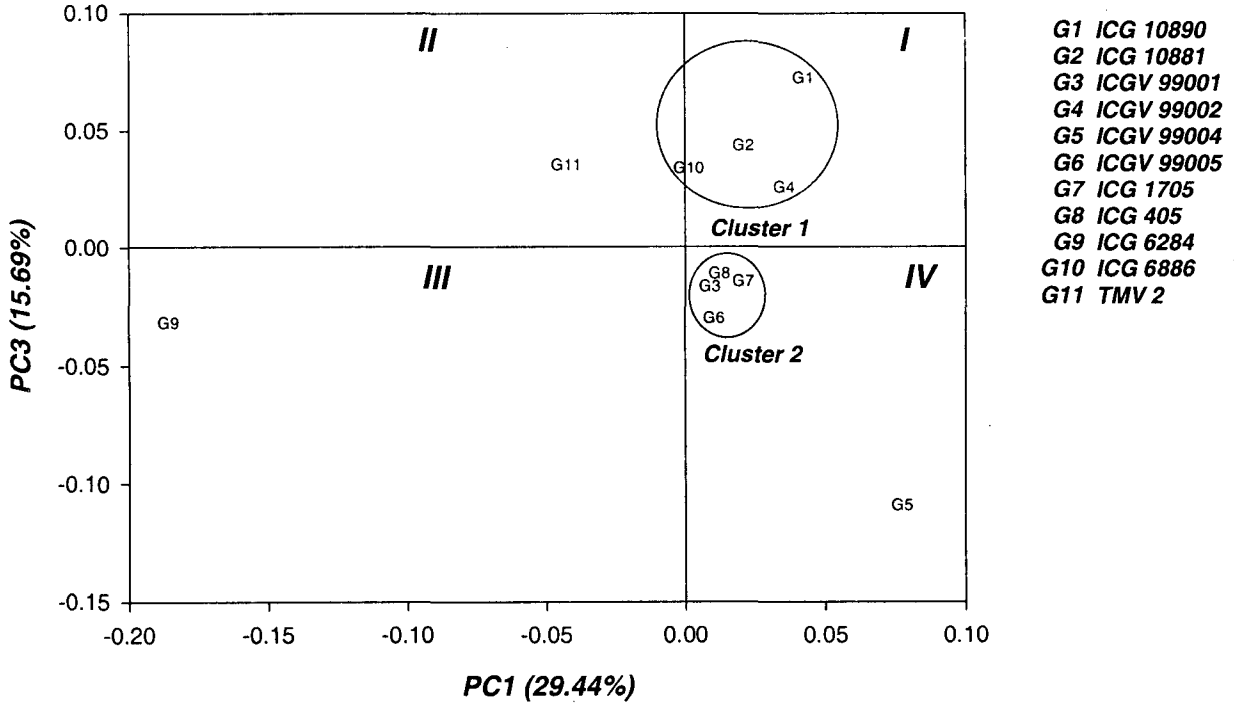

Fig.1. Relationships among 11 accessions as visualized by principal co-ordinate analysis (PCoA) using AFLP based dissimilarity values in groundnut

and ICGV 99005 in cluster 2 (Fig. 1). ICG 6284 and ICGV 99004 are the ideal accessions, as they showed maximum dissimilarity, to develop diverse breeding populations with combined resistance to ELS, LLS and rust, Accessions ICG 405, ICG 1705, ICG 6284, ICGV 99001, and ICGV 99005 with TMV 2 would be the better cross combinations to develop recombinant inbred lines (RILs) for mapping quantitive trait loci (QTL) associated with resistance to ELS, LLS, and rust in groundnut. These accessions possess a large number of unique markers that are absent in TMV 2.

With the use of DNA profiles, the genetic uniqueness of each accession relative to all other accessions can be determined and quantified. Accessions with DNA profiles most distinct are likely to contain the greatest number of novel alleles. It is in these accessions that one is most likely to uncover the largest number of unique and potentially agronomically useful alleles. This strategy has resulted in high proportion (~50%) of new and useful QTL alleles in rice and tomato (Tanksley and McCouch, 1997). With similar studies initiated in groundnut, it is proposed to determine the chromosomal position of the key loci and allelic variants at these loci controlling resistance to ELS, LLS, and rust and yield enhancing QTL for targeted genetic enhancement in groundnut. Few accessions with high genetic

dissimilarity and with greater number of unique molecular markers have been crossed for mapping and genetic enhancement in groundnut at ICRISAT. The enhanced breeding populations and RILs will be freely accessible to researchers for further studies in groundnut.

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Bio-Diversity of Wild Fruits in Chamba District of Himachal Pradesh

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Wild fruits were the valuable source of food for the prehistoric man, who nestled in caves. As the civilization flourished, they gathered and passed on important information on the use of these fruits from generation to generations. Consequently, the present day horticulture came into existence. The wild species of these fruit plants yield edible fruits and grow throughout the Chamba district of Himachal Pradesh, contributed a lot directly or indirectly to cultural heritage of the state (Table-1). These fruits are consumed in abundance by the local people, residing in the remote areas of the district, as these are in plenty in their natural habitat (CSIR 1950; Parmar and Kaushal, 1982). Some of these wild fruit species produce small, juicy fruit with excellent taste and can be used in processing industries. Some of these fruits are of therapeutic use and have proven useful to cure many ailments. These fruits not only have nutritional and medicinal value assault (Table 2), but also provide stable income to the tribal people living in very remote areas. Fruit growing in present days has become a challenging job because of their susceptibility to insect-pests and disease as well as overriding need to manage them through chemicals. Besides these factors, the ever changing climatic conditions adversely affect the growth as well as the fruit yield.

Table 1. Wild fruit diversity of Chamba District of Himachal Pradesh

Species	English Name	Local Name	Name of Village	Latitude and Longitude	Altitude (m above sea level)	Frequency of occurrence
Punica granatum L.	Wild Pomegranate	Daru	Chamba, Saru Chaned, Pukhri, Koti	N 32° 32' and 32° 43' E 75° 59' and 76° 21'	(700-900)	Abundant
			Tissa, Tikaregarh	N 32° 1' and 32° 35' E 75° 59' and 76° 26'	(1800-2000)	Frequent
			Garola	N 32° 11' and 32° 41' E 76° 22' and 76° 33'	(2300)	Frequent
Prunus padam L.	Wild Cherry	Paja	Chamba, Gajnoi	N 32° 32' and 32° 43' E 75° 59' and 76° 21'	(900-1600)	Occasional
			Lahru, Kakira Tunuhatti	N 32° 15' and 32° 38' E 75° 50' and 76° 10'		Occasional
			Salooni	N 32° 15' and 75° 38' E 75° 50' and 76° 10'	(1000-4600)	Occasional
			Tissa	N 32° 1' and 32° 35' E 75° 59' and 76° 26'	(1800-2000)	Occasional
Rubus ellipticus Smith	Wild raspberry	Aakhren	Chamba, Saru Kiani, Chaner	N 32° 32' and 32° 43' E 75° 59' and 76° 21'	(900)	Frequent
			Chawari, Lahru	N 32° 15' and 32° 38' E 75° 50' and 76° 10'	(600-800)	Frequent

Species	English Name	Local Name	Name of Village	Latitude and Longitude	Altitude (m above sea level)	Frequency of occurrence
			Salooni	N 32° 15' and 75° 38' E 75° 59' and 76° 26'	(1700-1900)	Frequent
			Tissa	N 32° 1' and 32° 35' E 75° 59' and 76° 26'		Frequent
Carissa spinarum L.		Garna, Kara unda	Laharu, Chawari Sinhunta, Kakira Kamla	N 32° 15' and 32° 38' E 75° 50' and 76° 10'	(600-2000)	Frequent
			Chamba, Sarol, Kiani Sundla	N 32° 32' and 32° 43' E 75° 59' and 76° 21'		Frequent
			Tissa	N 32° 1' and 32° 35' E 75° 59' and 76° 26'		Occasional
Emblica officinalis Gaertn.	Indian gooseberry	Amla, Aonla	Chamba, Rajnagar, Parihar	N 32° 32' and 32° 43' E 75° 59' and 76° 21'	(700-900)	Frequent
Murraya koenigii L.	Curry leaf plant	Kurry Patta	Laharu, Chawari Sinhunta, Kakira	N 32° 15' and 32° 38' E 75° 50' and 76° 10'	(700-1000)	Abundant
Phoenix sylvestris Roxb.	Wild date palm	Khajoor	Udaipur Chamba Rajpura	N 32° 32' and 32° 43' E 75° 59' and 76° 21'	(750-900)	Occasional
			Kakira, Lahru	N 32° 15' and 32° 38' E 75° 50' and 76° 10'		Abundant
Ficus palmata Forsk.	Wild Fig	Dhura, Fagura	Sherpur, Saru, Sarol, Chamba, Kiani, Udaipur	N 32° 32' and 32° 43' E 75° 59' and 76° 21'	(700-2000)	Frequent
			Tissa	N 32° 1' and 32° 35' E 75° 59' and 76° 26'		Occasional
Ficus roxburghii Wall.		Trimbal, Trimal	Sinhunta, Chowari,	N 32° 15' and 32° 38' E 75° 50' and 76° 10'	(700-900)	-do-
			Manjir, Sundla, Rajpura, Kiani, Rajnagar, Saru	N 32° 32' and 32° 43' E 75° 59' and 76° 21'		-do-
Berberis aristata DC	Indian Barberry	Kaimbal	Chamba, Dharwala, Dunali, Brehi, Masrund, Sandhi, Mani, Sarol,	N 32° 32' and 32° 43' E 75° 59' and 76° 21'		Frequent
			Dalhousie, Khajiar,	N 32° 15' and 32° 38' E 75° 50' and 76° 10'	(700-2000)	-do-
			Tissa,	N 32° 15' and 32° 38' E 75° 50' and 76° 10'		-do-

Species	Name English	Local Name	Name of Village	Latitude and Longitude	Altitude (m above sea level)	Frequency of occurrence
			Salooni	N 35° 15' and 75° 38' E 75° 50' and 76° 26'		-do-
Pyrus pashia Buch-Ham	Wild Pear	Kainth	Entire Chamba	N 32° 10' and 33° 13' E 75° 45' and 77° 33'	(645-2400)	Frequent
Prunus armeniaca L.	Wild Apricot	Chir	Chamba, Kiani, Udaipur,Sarol, Kundi	N 32° 32' and 32° 43' E 75° 45' and 76° 21'		Occasional
			Bharmour, Garola	N 32° 11' and 32° 41' E 76° 22' and 76° 33'	(800-2400)	Frequent
			Tissa	N 32° 1' and 32° 35' E 75° 59' and 76° 26'		-do-
			Salooni	N 35° 15' and 75° 38' E 75° 50' and 76° 26'		-do-
Fragaria indica Andr.	Wild Strawberry	Akhren	Lodoo, Sarol, Udaipur, Khajiar Rajnagar, Bathri	N 32° 32' and 32° 43' E 75° 59' and 76° 21'		Occasional
			Salooni	N 32° 15' and 75° 38' E 75° 50' and 76° 10'	(800-2000)	-do-
			Tissa Tikarigarh	N 32° 1' and 32° 35' E 75° 59' and 76° 26'		-do-
Syzygium cumini		Jaman Jamun	Chamba, Sarol	N 32° 32' and 32° 43' E 75° 59' and 76° 21'	(600-1500)	Occasional
			Chowari, Lahru, Sinhuta, Samot	N 32° 15' and 32° 38' E 75° 50' and 76° 10'		-do-
Olea cuspidata	Wild olive	Kahu	Saru, Chamba, Bakani, Phukhari, Koti, Sundla, Manjir, Lanji	N 32° 32' and 32° 43' E 75° 59' and 76° 21'		Abundant
			Mehla	N 32° 20' and 32° 38' E 75° 25' and 76° 02'	(900-2300)	-do-
			Garola	N 32° 11' and 32° 41' E 76° 22' and 76° 33'		-do-
Ziziphus nummularia (Burm. F.) Wight.	Wild Ber	Beri	Saru, Rajpura, Sarol, Rajnagar, Kiani, Udaipur	N 32° 32' and 32° 43' E 75° 59' and 76° 21'		Occasional
			Tissa	N 32° 1' and 32° 35' E 75° 59' and 76° 26'	(900-1900)	-do-
			Salooni	N 35° 15' and 75° 38' E 75° 50' and 76° 10'		-do-

Species	Name English	Local Name	Name of Village	Latitude and Longitude	Altitude (m above sea level)	Frequency of occurrence
Juglans regia L.	Wild seedling of walnut	Khor	Holi, Garola, Khani, Bharmour, Kundi	N 32° 11' and 32° 41' E 76° 22' and 76° 33'		Abundant
			Tissa	N 32° 1' and 32° 35' E 75° 59' and 76° 26'	(1800-2400)	-do-
			Salooni	N 35° 15' and 75° 38' E 75° 50' and 76° 26'		-do-
Pinus gerardiana Wall.	Wild seedlings of Neoza Pine	Chillgoja	Ulansa Khani	N 32° 11' and 32° 41' E 76° 22' and 76° 33'	(2300-5000)	Frequent
			Pangi	N 33° -06' E 76° - 24'		-do-
Corylus avellana (wild seedlings)	Filbet	Thangi	Pangi	N 33° - 06' E 76° -24'	(5000)	Abundant

Table 2. Indigenous knowledge/economic use of wild fruits

Name of fruit	Potential value
Wild Pomegranate	Extract from leaves and fruits are used to cure indigestion and to strengthen gums. Ripe fruits cure soar throat, brain diseases and chest ailments. Fruit is a rich source of vitamin 'C'. Fruit rind contains yellow pigment and it is used for dying clothes. Seeds are used for preparing 'chutney' (sauce).
Wild Cherry	Plant, flower in autumn and attract honeybees. The wood is used for making local plough, as well as other agricultural implements. This fruit is still unexplored for dessert and medicinal purpose.
Wild Raspberry	An unexplored fruit, of good desert quality and can be used for squash, ice-cream jam preparations.
Karaunda	The fruits are eaten raw. This is thorny bush and it is used as a fencing material for agricultural fields. The leaves are the best green fodder for goats and sheep. The root of the bush is used as snake repellent and also to cure rheumatism.
Aonla	Fruits are used in curing jaundice and digestive disorders; and leaves are used to make ointments to cure skin infections. Fruit is rich in vitamin C and is used in pickles and morraba making. This fruit is also used as a principal ingredient of famous ayurvedic preparation (triphala and chyavanprash).
Curry leaf Plant	Fruits are very sweet and rich in vitamin C. The leaves of plant are used as spice and twigs as "Datun" (for cleaning teeth). Roots, bark and leaves are used in curing poisonous animal bites. The oil extracted from leaves has antibiotic and anti-fungal properties.
Wild Date palm	Fruits are rich in iron and having good dessert quality. Plant has dissected leaves which are used to make brooms, fans and flower mats. Fruits are effective in heart and abdominal disorders.
Wild Fig	Fruits act as demulcent and laxative. Fruits are juicy and have good dessert quality. Raw fruits are used as vegetable.
Trimal	Fruits have good dessert quality and can be used for quality jelly making. In rural areas its broad leaves are used for 'patal' (plates) making.
Indian Barberry	Fruits are of good dessert quality. Roots are used in making an alcoholic drink. Fruits are used as laxative and used to cure ulcer and opthalmia. Plant serve as a good flora for honeybees.
Wild Pear	Fruits are of good dessert quality, wood is used to make agricultural implements, plants is used as root stock for pear.
Wild Apricot	Fruits have good dessert quality, seeds are also eaten. The edible oil extracted from seed is also used to cure ear ailments. The extracted oil is used as baby oil.
Wild Strawberry	Fruits are edible.
Jamun	Fruits are edible. Twigs, leaves and fruits are used in control of diabetes.
Wild Olive	Leaves are used as green fodder, wood is generally used to make agricultural implements.

Name of fruit	Potential value
Wild Beri	Fruit are edible and also used in chutany making. Plants are used as fencing material to protect agricultural field form wild animals.
Wild Walnut	Nuts are edible and plant having good timber quality.
Neoza Pine/ Filbert	Nuts are edible and good source of energy.

Source : Watt (1889); Kirtikar and Basu (1935); Chopra *et al.*, (1958); Dastur (1962); Jain (1968); Gautam and Purohit (1974); Parmar and Kaushal (1982); Latha (2002).

By relying upon only few commercial fruits for their livelihood, the growers also face high financial risks. So, the diversification in horticulture is a need of the hour. The trees of these wild fruit species grow only in forests or wastelands. Due to deforestation and land clearing, trees of these fruits are decreasing in numbers at a very fast rate and a result may face the situation of oblivion in a few decades. The valuable traits of these fruits such as their resistance to biotic and abiotic stress and vigour can be incorporated in their cultivated relatives through systematic crop improvement programme (Singh *et. al.*, 2000). Very few attempts have been made by the horticulturists to exploit the genetic potential of these fruits. In the light of above, there is an exigency to conserve the existing biodiversity of the Chamba as well as the western Himalays by identifying, collecting and domesticating these species which are still unexplored. This in turn will serve for the generations as a food bowl and also diversify and sustain the food producing agriculture.

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Medicinal Uses of Rice Field Weeds of Orissa

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This paper deals with medicinal value of 35 weed species under 33 genera belonging to 24 angiospermic families collected from different rice ecosystems of Orissa. In the enumeration, the correct botanical name of each species along with basionyms occurring in the Botany of Bihar and Orissa and family name, vernacular name, locality of collection, phenology, habit and medicinal uses are reported.

Key words: Medicinal Value, Orissa, Rice Ecosystem, Weed Species

Weeds have been treated as obnoxious or unwanted plants growing in the places where they are not required. On one hand, they are harmful by heavily affecting the crop yield causing hindrance for achievement of crop targets. On the other hand, many of the weed species have ethno-botanical importance in general and traditional medicinal value in particular. Orissa is phytogeographically diverse terrain of tribal and various ethnic groups, which are the rich source of ethno-botanical information (Saxena & Dutta, 1975). Whereas, studies on ethnobotany of rice field weeds were not attempted so far and no comprehensive account, especially on the traditional medicinal value of the weed species occurring in rice ecosystem is available.

Some of the notable ethno-botanical studies have been conducted in Orissa by Choudhury (1963); Yoganarasimhan *et al.* (1970); Saxena and Dutta (1975); Dash, (1979); Sharma *et al.* (1985); Subudhi & Choudhury (1985); Murthy *et al.* (1986); Das & Kant (1988); Brahman & Saxena (1990); Mishra (1990) Mukherjee & Namhata (1990); Pradhan *et al.* (1990); Aminuddin & Girach (1991); Satapathy & Panda (1992); Girach (1992); Choudhury *et al.* (1993); Girach *et al.* (1993), and Dash *et al.* (1994).

The survey of literature shows that considerable work has been done on floristic studies in Orissa. But ethno-botanical studies in general and medicinal uses of rice field weeds in particular is meagre and fragmentary. Realising this, a survey was undertaken under the auspices of National Bureau of Plant Genetic Resources (NBPGR) Base Centre, Cuttack. Consequently 35 rice field weeds having ethno-botanical value were collected from different rice ecosystems of Orissa. These species were properly identified and housed in the herbarium of NBPGR Base Centre, Cuttack, Orissa.

The present attempt is therefore, a comprehensive account of information on the treatments prevailing in tribals, rural and urban poor dominated places with rice field weeds of Orissa to enrich the traditional systems and to document the information. In the present investigation, relevant information was collected from earlier contributions in this direction by Pattanaik (1956), and Subudhi and Dikshit (1998). The plants were collected from rice ecosystem of various regions of Orissa covering all the seasons. The herbarium specimens were prepared according to standard methods (Jain and Rao, 1976) and specimens were identified with the help of local flora by Saxena and Brahmam (1994).

The information were gathered from local vaidyas, tribals, rural and urban poor and experienced old people in different localities. The authors approached the informants with live plants within their area and in few cases, the same was done with herbarium sheets also. The details about the mode of preparation, methods of administration, doses and composition of drugs were recorded and the medicinal value of the species has been confirmed by as many cross checkings as possible.

The present study includes medicinal use of 35 weed species spread over 33 genera and 24 angiospermic families collected from rice ecosystem of Orissa. The botanical names of the plants have been arranged in alphabetical order followed by angiospermic family, vernacular name (Oriya), phenology, habit and medicinal practices by local populace and herbalists in Orissa. The herbarium specimens were deposited in the Herbarium of National Bureau of Plant Genetic Resources, Base Centre, Cuttack.

Enumeration of the Plant Species

Achyranthes aspera *L. (Amaranthaceae); Apamaranga; September-December; Erect, annual herb*

Juice of the plant (1-2 tsp.) in a cup of luke warm

water (twice daily) at bed time is used as an anthelmintic. Dry ash of the plant mixed with water thoroughly and filtered and then boiled till the deposition of some solid or semi-solid mass in the bottom. One-two spoons of the mass is taken for a month to cure tumour in stomach. Gargling in morning and evening with decoction of root is useful in relieving toothache, stomach pain and given to women after menstrual period for antifertility (1 tsp. for seven days on empty stomach). The paste of fruits and seeds applied in venomous insect bite. Root paste is administered twice a day for 3 days to stop excess bleeding during menstrual period. Leaves grinded with saffron and juice is extracted and applied as eye drop for opacity of cornea. The spike of the said plant and leaf of *Plumbago zeylanica* is ground to paste and administered as a contraceptive.

Aerva scadens *Wall (Amaranthaceae); Jatajatia; October to December; Erect, scandents herb*

Leaf juice (2 tsp.) with a glass of water everyday in morning used in jaundice. Root paste is used in toothache and pyorrhoea. Cooked young leaves is given to females for reducing pain after delivery.

Alternanthera sessilis *(L.) R. Br. ex DC. (Amaranthaceae); Madaranga; July to October; Prostrate ascending herb*

The juice of the root (2 tsp. thrice a day) is given to women after delivery to reduce pain. Leaf juice is applied externally to children suffering from measles. Juice extracted from the entire plant is used in purifying blood.

Ammania baccifera *L. (Lythraceae); Bilalabanga; August to December, Erect, Glabrous herb*

Juice of entire plant used as hypotensive and is a good source of Vitamin-C. 1-2 tsp. in empty stomach relieves common cold and throat problem. Warm decoction of the plant is applied in spinal cord infection to get rid of pain.

Blumea lacera *(Bum. F.) DC. (Asteraceae); Pokasunga; February to May; Erect, perennial, aromatic herb*

Leaf juice (2-3 drops) after little warming is dropped into the ear to get relief from otarrhoea and earache. Grinding the roots with black pepper used in sores of mouth. Juice of the plant (2 tsp. 2-3 times) is taken to cure bronchitis and burning sensation.

Boerhaavia diffusa *L. (Nyctaginaceae); Puruni; February to March; Prostrate herb*

The decoction of the entire plant is applied in inflammation of any part of the body. Juice of root and leaf is applied in eyelid as 'kajal' to get relief from eye infection. Young leaves and fruits ground with ginger are used in asthma. Roots and leaves of the plant crushed with roots of *Hybanthus enneaspermus* are administered in snake bite (paste is applied in the wounds).

Centella asiatica *L. (Apiaceae); Thalkudi, July to October, Prostrate herb*

Leaf juice rubbed in forehead to alleviate severe headache. Whole plant is eaten (raw/cooked) as antidote in snake or venomous bite. Decoction of entire plant is used as brain tonic, diuretic and in dysentery. Devouring young leaves in daily morning accelerates nervous activity, cures bowel complaints, increases memory power. Leaf is ground with coconut oil and applied in skin diseases.

Cleome viscosa *L. (Capparaceae); Anasorisa; August to October; Erect, annual herb*

Leaves and seeds are ground with water and taken (1-2 tsp. twice a day) to get relief from bodyache and joint pain. Dry powder of seed is used as anthelmintic and carminative. Leaf paste is applied externally on warts and sores.

Commelina benghalensis *L. (Commelinaceae); Kanasiri, August to December; Decumbent-ascending, annual herb*

Leaf decoction is applied in wounds of leprosy. The rhizomes are made into paste and taken for energy. The herb is laxative and emulcent.

Cynodon dactylon *L. (Poaceae); Dubaghasa; August to September; Stoloniferous herb*

Juice of the plant is used in cuts and wounds. Infusion of leaves is used in bleeding piles. Leaves ground with raw rice and tender sal leaves is used as tonic. 2 tsp. of leaf juice is given to children to check vomiting. Juice extracted from leaves administered daily in the morning for diabetes. The fresh juice or paste of leaves is applied locally in rheumatism.

Cyperus iria *L. (Cyperaceae); Swanti; August to September; Annual, tufted grass*

Decoction of the plant is used as tonic. 2-3 tsp. of juice with little water in morning is used as stomachic and aperient. The juice (2 tsp. 2-3 times a day) is administered in diarrhoea.

Cyperus rotundus *L. (Cyperaceae); Mutha; August to October, Rhizomatous, perennial herb*

Dry powder of the rhizome mixed with honey is

administered (1 tsp. thrice a day) for cough, to quench thirst and also to cure dyspepsia, diarrhoea, dysentery. The paste prepared from rhizomes, black pepper and alum is applied in the wounds and 2-3 tsp. paste mixed with half litre of milk is administered in venomous bite.

Eclipta alba *L. (Asteraceae); Kesadura; July to November; Decumbent ascending herb*

A preparation obtained from young heads and bulb with coconut or sesame oil is used as hair tonic. Tender shoots with sesame oil is applied in elephantiasis. Roots are emetic and applied in ulcers and wounds. Leaf juice with honey is used in catarrh of children. Juice of entire plant is used in preparations for liver, skin and hair tonic. Plant is used in hepatic and spleen enlargement. Leaf juice with curd is taken orally 2-3 tsp. in the morning till cure of jaundice.

Euphorbia hirta *L. (Euphorbiaceae); Chitakutei; August to October; Erect, ascending annual herb*

Juice extracted from leaves and inflorescence (25ml.) mixed with a glass of milk and is administered to increase the secretion of breast milk in lactating mothers. Juice from fruit with a cup of lukewarm water in morning for seven days is used as abortifacient. The latex is applied on warts, pimples, corns and curse skin diseases. The decoction of various parts is used as ingredient in preparing medicines for cough, cold, colic and dysentery.

Euphorbia rosea *Retz. Obs. Bot. (Euphorbiaceae); Raktachita; August to November; Prostrate herb*

Seeds are made into paste and given at bed time as an anthelmintic. Leaf juice is also used as an anthelmintic.

Evolvulus aisinoides *L. (Convolvulaceae); Bichhamalia; October to December; Decumbent, ascending perennial herb*

Dry leaves and plants are made into cigarettes and smoked in chronic asthma and bronchitis. Leaf juice (2 tsp.) mixed with cow's ghee (5 ml. butter oil) for 21 days and is used in increasing memory and reducing fever. Leaves and coconut (endosperm) grinded, filtered and boiled to prepare oil. It is used to hasten hair growth. Decoction of leaves and roots is administered as brain stimulant.

Glinus oppositifolia *L. (Aizoacae); Pitasaga; February to August; Prostrate, glabrous herb*

Leaves as pot herb used in curing bowel ailments. It is stomachic, aperient. Juice with raw turmeric and castor oil applied externally in itches and other skin diseases.

Grangea maderas patana L. (Asteraceae); Painjari; January to April; Procumbent herb

The paste of the entire plant with little pepper mint is applied in the forehead to get relief from acute headache. Leaves are ground and slightly warmed and applied in bone fracture.

Heliotrapium indicum *L. (Boraginaceae); Hati sundha; July to October; Erect, annual herb*

Plant juice is used in severe cold and fever. Decoction of leaf is used in boils, wounds, ulcers and as an antidote to venomous insect sting. Dried seed powder with black pepper is administered for getting immediate relief from acute stomach ache.

Hybanthus enneaspermus *L. (Violaceae); Madanmast; Most part of the year; Erect; annual herb*

Dried plant parts crushed and made into powder. One tsp. of the powder with a glass of water in every day morning cures bowel complaints, whooping cough, involuntary ejaculation of semen and improves sex potentiality. Fruit paste is used in venomous insect sting. One tsp. juice extracted from entire plant with three tsp. of goat milk is administered for 30 days for impotency.

Hydrolea zeylanica *L. (Hydrophyllaceae); Languliya; Most part of the year; Erect, diffuse, sub-succulent herb*

Decoction of leaves is antiseptic and applied as poultice in cuts and wounds and neglected callous ulcers.

Ipomoea aquatica *Forssk. Fl. (Convolvulaceae); Kalama; July to October; Prostrate, trailing herb*

Juice is used as emetic in opium and arsenic poisoning. The plant is used as pot herb and considered useful for women suffering from nervous and general debility.

Leucas aspera *(Wild) Linl. Enum. Hort. (Lamiaceae); Gayasa; October to April; Erect herb*

Juice of leaves applied externally in psoriasis and skin diseases. Decoction of roots applied in painful swellings of rheumatism. Inflorescence boiled with cow's milk is used as anthelmintic. Juice with black pepper (7 seeds) is used in venomous bites. Juice extracted from seven nos. of flowers and mixed with honey (1-2 tsp.) and given 2 times for 3 days to clear cough and cold. Gargling with decoction of root and bark of the plant in little lukewarm water cures pyorrhea. The paste of the plant

applied externally to relieve headache.

Lippia geminata *H.B.K. Nov. Gen. (Verbenaceae); Naguari; March to December; Erect, aromatic herb*

Leaf juice (1-2 tsp. for seven days) is used as anthelmintic and stomachic. Juice of roots is applied and administered in snake bite.

Ludwigia perennis *L. (Onagraceae); Bila labanga; October to January; Erect herb*

Juice extracted from leaves is given for reducing high body temperature due to fever. Decoction of entire plant is applied in painful swelling due to sprain.

Mimosa pudica *L. (Mimosaceae); Lajakuli; September to December; Prostrate to scandent, annual/perennial herb*

The root is ground with garlic and mixed with ghee is administered for chronic asthma. Dried powder of leaf mixed with ghee is used for healing wounds. Roots are considered strong snake repellant. Leaves decoction is taken for treatment of dysentery and root juice (5ml.) with water administered for 3-4 days as diuretic. Tender leaves is given to woman after delivery for relieving abdominal pain.

Passiflora foetida *L. (Passifloraceae); Bisripi; April to May; Slender, climber*

Decoction of leaves is administered in biliousness and asthma. Leaf crushed or ground and applied on the affected portion of the forehead to get relief from severe headache. Leaf powder mixed with milk and given at bed time for increasing memory power.

Phyllanthus niruri *Muel.-Arg. Linnaea (Euphorbiaceae); Badi aonla; April to June; Erect, annual herb*

The plant is ground and taken orally in the morning for 15 days to cure jaundice. The fruits/seeds crushed with aniseed is administered as aperient.

Physalis minima *L. (Solanaceae); Tiparikoli/Phutka; August to January; Erect herb*

Juice extracted from stem and leaf mixed with salt is administered in stomach pain and bowel complaint. Juice (25 ml.) taken orally in the morning (regularly) reduces the blood pressure.

Polygonum plebeium *R. Br. (Polygonaceae); Muthisaga; February to June, Prostrate, annual herb*

Leaves fried and taken for reducing body temperature. Leaves of the plant with other two species viz., *Morniga oleifera* and *Ipomoea aquatica* is fried and taken regularly for increasing vision power.

Portulaca oleracea *L. (Portulacaceae); Bada bal-balua; July to September; Erect, aromatic herb*

Regularly consumed as leafy vegetable, cures liver diseases. Leaf juice is applied to get relief from prickly heat.

Rungia pectinata *(L.) Nees in DC. (Acanthaceae); October to January; Decumbent, ascending, perennial herb*

Juice extracted from leaf is externally applied to children suffering from small pox to get relief from pain and burning sensation.

Scoparia dulcis *L. (Scorphulariaceae); Chira rita; September to November; Erect, Perennial herb*

The crushed leaves and roots are anti-emetic. The plant juice (2 tsp.) with a glass of water in the morning (empty stomach) is administered to cure jaundice, high fever. The juice is applied on forehead to get quick relief from severe headache.

Sida cordata *(Burm.) Borssum in Blumea. (Malvaceae); Bajramula; May to August; Decumbent, ascending, annual herb*

The plant crushed, filtered and mixed with 1 tsp. of sugar and regularly taken for one month in impotency. The decoction of leaf and root is applied as poultice for early healing of cuts and bruises. The juice of leaf is applied in venomous bite.

Solanum nigurm *L. (Solanaceae); Kanta bheji; February to July; Erect, aromatic herb*

Dried fruit powder is smoked in a cigarette to cure pharyngitis and acute toothache. Decoction of plant is used as enema in infants. Infusion of seeds and roots is administered orally in cough and cold. 2-3 tsp. of tender leaf juice twice a day for three to five days is given for getting relief from colic pain and the same is administered for 10-15 days to treat leucorrhoea in women.

Trianthema portulacastrum *L. (Aizoaceae); Puruni; July to December; Succulent, prostate herb*

Leaves ground with musk, saffron and pepper, given orally in scours; decoction of plant taken orally for rheumatism.

Tridax procumbens *L. (Asteraceae); Bisalay karani; Most part of the year; Prostrate, annual herb*

Leaf juice and powder are antiseptic and used in healing wounds. Fresh juice extracted from leaf is applied on cuts and wounds to stop bleeding. Juice of crushed leaves with decoction of flowers of *Hibiscus rosa-sinensis* applied for hair growth.

Vernonia cinerea *L. (Asteraceae); Badi pokasunga; Most part of the year; decumbent, ascending, annual/perennial herb*

Fresh juice and paste of seeds in lukewarm water is taken before bed time (for 2-3 days) after taking 1-2 tsp. sugar is found effective against round worm and thread worm. Plant juice with turmeric powder/paste is applied in affected parts for curing piles.

Conclusion

Rice field weeds were grossly ignored on ethanobotanical notes. The present study accounts for 35 rice field weeds used as herbal remedies by the local people for about 40 ailments. Out of them, 6 species are used for healing wounds, 5 species are found useful in common cold and cough, 6 species for venomous insect and snake bite, 8 species used as analgesic in joint pain and bodyache, 5 species are used in skin diseases and 2 species are related to various problems of women. The usage of a particular plant for the treatment of a number of diseases and a number of plants for the treatment of a particular disease has been observed in the present investigation.

Apart from this, the ailments like piles, diabetes, jaundice, blood pressure, pyorrhoea, rheumatism etc. are being treated effectively with the weed species. Based on their potential properties, further investigation can be attempted for conservation, phytochemistry and biological analysis. The present study on this aspect yielded interesting and important information which provide a lot of scope for further micro level studies to understand the scientific base involved in the use of crude drugs. The first hand information received from the local vaidyas, naturopaths, elderly knowledgeable people on the healing properties of the rice field weeds has been highlighted in this paper. All these plants are available locally and are being used by the local people as herbal remedies. Thirty five commonly used plants were collected, identified and verified with a number of uses.

The documentation of traditional knowledge based on the ethno-medicinal value of the plants and their use is an important step in safe-guarding and conserving the weed diversity. Moreover, attempts should be made to authenticate and evaluate the efficacy and medicinal value of those plants and products used by the ethnic groups.

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SHORT COMMUNICATION

Performance of Strawberry (*Fragaria* x *ananassa* Duch) Cultivars under Mid Hills Condition of Himachal Pradesh

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In an evaluation study of 15 cultivars of strawberry for various fruit characters, Etna gave highest yield/plot (626.8 g) while maximum fruit weight of 9.97 g was recorded in cultivar Fern. Maximum fruit length (3.68 cm) fruit breadth (2.83 cm) and TSS (11.82°B) were recorded from fruits of Belruby, Etna and Blakemore, respectively. Like other characters highest sugar percentage at the tune of 6.47 was estimated in cultivar Tioga while minimum acidity (0.85%) was found in cultivar Addie and Pajaro. Highest postive significant correlation coefficient was found to be 0.84 between yield and fruit weight which was followed by 0.55 between fruit length and fruit breadth. All cultivars flowered in February-March, and fruits were harvested from April to May.

Keywords: Evaluation, Fruit Characters, Himachal Pradesh, Strawberry

Strawberry (*Fragaria* x *ananassa* Duch) is an important fruit of family Rosaceae and occupies an important place among the small fruits. The cultivated varieties of strawberry are octoploid (2n=56) and perhaps is the only fruit in which all the culitvars have been evolved by man through hybridization. Besides quick returns, strawberry fruits are attractive with distinct and pleasant aroma/flavour, rich in Vitamin C and minerals. Strawberry fruits have a special demand by fruit processing industries for preparing jam, jellies, candies, drinks and other products. The crop is grown throughout the world and is rated high on the list of preferred foods. The cultivation of strawberry is presently associated with many problems, as fruit yield and quality are influenced by plant vigour, soil conditions, irrigation, duration of rest period, photo period, soil conditions, irrigation, temperature and disease resistance coupled with transportation, marketing, storage and processing facilities. These factors individually and collectively have greatly influenced the successful cultivation of strawberry under specific environmental conditions. Amongst all characters, fruit traits have always remained of prime importance and are much influenced by environmental factors. Hence proper evaluation of cultivars under different environmental conditions is essential prior to their release for commercial cultivation. Keeping these consideration in view the present study was carried out.

The present investigations were carried out in the strawberry block of the Department of Fruit Breeding and Genetic Resources, situated at 30-50° N and 77.8°

Table 1. Five year (1995-1999) mean for different characters of some strawberry cultivars

Cultivars	Yield/plot (g)	Fruit weight (g)	Length (cm)	Fruit/size Breadth (cm)	TSS -B	Acidity (%)	Sugars (%)
1. Addie	319.2	7.7	3.6	2.5	10.28	0.85	5.4
2. Belruby	423.4	7.8	3.7	2.6	11.66	0.87	5.9
3. Blakemore	382.6	6.2	3.5	2.6	11.82	1.21	4.10
4. Brigton	389.0	7.2	3.2	2.4	10.28	0.90	5.2
5. Catskill	458.2	6.8	3.1	2.4	10.42	1.08	5.2
6. Chandler	447.0	7.8	3.3	2.7	11.39	1.04	6.1
7. Dana	549.2	9.7	3.3	2.6	10.35	1.06	5.10
8. Etna	626.8	9.8	3.1	2.9	9.46	1.07	4.10
9. Fern	486.0	9.10	3.4	2.8	10.25	0.94	4.10
10. Howard	394.0	6.9	2.9	2.3	11.77	0.98	5.8
11. Pajaro	527.0	8.8	3.2	2.6	11.74	0.85	5.2
12. Selva	507.6	8.9	3.2	2.8	10.49	0.94	5.2
13. Shasta	284.8	6.2	3.4	2.6	11.08	0.91	4.8
14. Tioga	550.2	6.9	2.10	2.4	11.09	1.03	6.5
15. Torrey	421.0	8.2	3.1	2.8	10.36	0.88	5.10
CD (0.05)	241.86	1.81	0.39	0.35	0.76	0.098	0.397
SE (Means)	120.73	0.91	0.19	0.18	0.38	0.048	0.948

E latitude at an elevation of 1275 metres above mean sea level. Data on various fruit characters were recorded from 1995 to 1999 (for five years) on 15 strawberry cultivars. The germplasm consisted of collections both from within India and abroad. The statistical analysis was performed as per Panse and Sukhatme (1985). A plot size of 1.44 m^2 was used for carrying out the experiment, which was replicated three times randomly.

Data regarding five years mean for various traits in different cultivars are presented in Table 1.

The yield varied from 284.8g to 699.0g per plot. The highest and lowest yield per plot were recorded in cultivars Fern and Shasta. These two cultivars differed significantly from each other. The cultivars Catskill, Dana, Etna, Pajaro, Selva and Tioga were at par with Fern.

Fruit weight varied between 6.2g in Blakemore to 9.10 g in cultivar Fern. The differences were significant between the two cultivars. The cultivar Dana, Etna, Pajaro, Selva, Addie and Torrey were statistically at par with each other.

Highest fruit length was measured as 3.6cm in cultivar Belrubi, while it was lowest in cultivar Howard (2.9cm). The recorded fruit length both minimum and maximum were statistically different from one another. Cultivars Blakemore, Shasta and Fern did not differ statistically.

Cultivar Etna produced fruit of maximum width (2.9cm), which differed statistically from the fruit breadth (2.3cm) observed in cultivar Howard and it was lowest amongst all the cultivars studied. Cultivars Belrubi, Chandler, Shasta, Fern and Torrey revealed no significant variation in the trait.

The Total Soluble Solids (TSS) ranged from 9.46^{0}B to 11.82^{0}B. The minimum and maximum values of TSS were recorded in cultivars Etna and Blakemore, respectively. All other cultivars differed significantly from Etna.

Minimum acidity of 0.85 per cent was observed in fruits of cultivar Pajaro, which differed significantly from cultivar Blakemore which registered maximum acidity of 1.21 per cent. Cultivars Catskill, Chandler, Dana, Etna and Tioga were statistically at par with each other.

Maximum sugar percentage was obtained in fruit of cultivar Tioga (6.47%) while it was minimum (4.8%) in cultivar Shasta. The accessions differed significantly from each other. About half of cultivars evaluated i.e. Addie, Belrubi, Chandler, Dana, Howard, Tioga and Torrey were similar in their sugar contents.

Flowering and harvesting period in all cultivars varied between February to March and April to May; respectively. Although Fern and Selva being day neutral, perpetual flowering was suppressed on account of high temperatures which prevailed from April to July.

Among various characters studied, highest positive significant correlation coefficient was observed between fruit weight and yield (0.8408). Fruit length and fruit breadth also gave positive and significant correlation (0.5471). The non-significant associations between different pairs of characters observed in the present study is an indication of independent nature of these characters.

In the present study wide range of values were recorded for various fruit characters. These ranges have also been observed by various workers. (Dhaliwal and Singh, 1983, Joolka and Badiyala, 1983, Awasthi and Badiyala, 1983, Dhaliwal and Grewal, 1984, Avidov, 1986, Kader, 1991, Veazi, 1995, Kidmore *et al.m* 1996 and Gupta, 1998).

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SHORT COMMUNICATION

Evaluation of some Strawberry (*Fragaria x ananassa Duch)* Cultivars in Jammu Plains

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Key words : Cultivars, *Fragaria* x *ananassa* Duch, Strawberry

The cultivated strawberry (*Fragaria x ananassa* Duch) belongs to family Rosaceae and is derived from the hybridization of two native American species, *F. chiloensis* Duch and *F. virginiana* Duch, which was first developed in France in the 17th century (Sharma and Yamdagni, 2000). Delicacy of flavour and richness in vitamins and minerals, makes strawberry a favoured food in the diet of millions of people around the globe. It can be processed into a variety of products through various processes such as canning in syrup, jamming, drying, freeze drying, candying, freezing etc.

At present, the strawberry is grown in all kinds of climate including temperate, mediterranean, sub-tropical and tiaga zones. It offers a quicker return on capital investment than any other fruit since under special methods of cultivation, a crop can be picked as early as the first summer after planting (Hughes *et al.*, 1969). Strawberry yield and quality are greatly influenced by a number of factors (soil, environmental, pests, diseases etc.) and as a result, plants of a particular cultivar may grow well in one region but may perform poorly in another where environmental conditions are different (Hancock *et al.*, 1996). The fruiting potential of individual cultivar can be exploited only after growing it in the optimum/suitable soil and climatic conditions which needs testing.

In spite of being a highly remunerative crop for Jammu plains, very meagre attention has been given by the researchers to assess the suitability of strawberry cultivation. The present study was made to identify the suitable and locally adaptable cultivar(s) for commercial cultivation in the sub-tropical conditions of Jammu region.

The present study was made under the Division of Pomology & PHT, Udheywalla at KVK Farm, RS Pura, during 2000-2001 on eight strawberry cultivars viz. Addie, Belrubi, Brighton, Chandler, Confitura, Fern, Gorella and Selva, planted in mid November. The plants were planted on raised beds (3.00 x 1.35m) in triple rows. The experiment was laid out in Randomised Block Design and was replicated thrice. For recording data, 15 plants (out of 30 plants) of each cultivar in a replication were selected randomly. Total number of flowers of selected plants were recorded throughout the fruiting season and expressed as per plant basis. Fruit set per cent was culculated as per the formula given by Westwood (1978). Total number of malformed/deformed fruits from selected plants were counted and expressed in per cent. Duration of picking was calculated by counting the days between first picking to last picking. For calculating the yield/plant, the weight of total fruits of selected plants was measured and expressed on per plant basis.

The fruits were harvested at commercial maturity and subjected to various quality attributes. Fruit size and total soluble solids were measured with the help of vernier calliper and hand refractometer, respectively. Titratable acidity and sugars were estimated by titration method (Horwitz, 1980). To assess the consumer preference, organoleptic evaluation was conducted by a panel of 10 judges as per the method of Hedonic scale (Gould, 1978). Scoring was done out of 10 and their rating was done as per the following scale:

10 – Excellent; 9- Very good; 8- Good; 7- Moderately good; 6- Fair; 5- Moderately fair; 4- Poor; 3- Very poor; 2- Not accepted.

Data relating to various yield and quality contributing characters (Table 1) revealed that all the tested cultivars started to bloom in the beginning of 3rd week of January except Selva, where in blooming was 5-6 days late. The total number of flowers per plant were significantly higher in Belrubi (16.40) followed by Gorella (13.53) and Confitura (12.87), while their lowest number was

recorded in Brighton (7.67) without showing any statistical difference with Selva (9.41). Per cent fruit set was relatively higher in Brighton (86.21%) but it was found statistically at par with Belrubi (84.51%), Chandler (80.71%), Fern (80.17%) and Gorella (81.17%). The lowest proportion of malformed fruits was recorded in Belrubi (25.56%) showing similarity statistically with Confitura (34.30%), Fern (26.81%) and Gorella (26.88%), whereas Selva (42.12%) and Addie (40.00%) exhibited maximum deformity of the fruits.

The longest picking duration was observed in Gorella (52.33 days) followed by Confitura (50.67 days), Addie and Belrubi (each 50.33 days), Chandler (49.67 days), Brighton (49.33 days) and Confitura (49.00 days) without showing significant difference, while it was shortest in Selva (33.00 days). Of the various cultivars tested, Gorella gave the highest yield (81.90g/plant) which was found statistically at par with Belrubi (69.53g/plant) and Chandler (67.64g/plant). Of the 4 cultivars tested by Ivanov (1976), a satisfactory yield was obtained from Belrubi (12194 kg/ha) and Gorella (11656 kg/ha) strawberries. Bringhurst and Voth (1989) suggested Chandler to be the best cultivar for lower elevations.

The physio-chemical fruit characteristics of different cultivars is given in Table 1. The fruit size was larger in Belrubi (2.44 x 1.45 cm), Chandler (2.40 x 1.78 cm) and Gorella (2.40 x 1.67 cm) than other cultivars tested and smallest in Fern (1.40 x 1.07 cm). These three varieties were reported notable for large fruit size by Hancock *et al.*, (1996). Rosati *et al.*, (1982) also observed Gorella to be a large fruited variety.

The content of total soluble solids (TSS)was statistically higher in Fern (9.07°B) and Gorella (9.10°B) cultivars and lowest in Selva (6.75°B) (Table1). The highest and lowest values of fruit acid content were recorded in Belrubi (0.86%) and Fern (0.51%), respectively. The total sugar content was higher and statistically similar in Gorella (7.08%), Addie (6.97%) and Fern (6.62%) and was registered lowest in Selva (4.86%). Almost similar trend was noticed in case of reducing sugars. The content of non reducing sugar was highest in the fruits of Fern (2.72%). Similar variability in sugars and TSS contents in strawberries was also reported by several researchers (Grewal *et al.*, 1988; Wrolsted *et al.*, 1990, Shamaila *et al.*, 1992).

The fruits of Gorella strawberry were found most acceptable as they scored the highest numerical rating (9.63) followed by Chandler (8.00) and Belrubi (7.93) evaluated through organoleptic test (Table 1). The organoleptic quality of fruits is greatly influenced by sugar content (Alavoine and Crochen, 1989) as also observed in the present studies in case of Gorella.

Table 1. Mean values for some yield and quality traits in eight strawberry cultivars

Cultivar	Date of first flower emergence	Flower number /plant	Fruit set(%)	Malformed fruits (%)	Duration of picking (days)	Yield /plant (g)	Fruit size (L xW) in (cm)	Total Soluble Solids (°B)	Titratable acidity (%)	Sugars (%) Total	Reducing	Non-reducing	Organoleptic rating
Addie	19.01.2001	12.45	74.10	40.00	50.33	54.54	1.95 x 1.34	8.70	0.72	6.97	5.22	1.66	7.27
Belrubi	18.01.2001	16.40	84.51	25.56	50.33	69.53	2.44 x1.45	7.67	0.86	5.09	4.11	0.93	7.93
Brighton	18.01.2001	7.67	86.21	38.89	49.33	42.47	2.12 x 1.34	7.53	0.73	5.67	4.09	1.50	7.47
Chandler	19.01.2001	12.20	80.71	37.30	49.67	67.64	2.40 x 1.78	7.67	0.71	5.36	4.67	1.26	8.00
Confitura	18.01.2001	12.87	77.40	34.30	49.00	52.52	1.74 x 1.31	6.97	0.63	5.26	4.15	1.19	7.80
Fern	18.01.2001	11.73	80.17	26.81	50.67	36.60	1.40 x 1.07	9.07	0.51	6.62	4.43	2.72	7.73
Gorella	18.01.2001	13.53	81.17	26.88	52.33	81.90	2.40 x 1.67	9.10	0.63	7.08	5.34	1.65	9.63
Selva	24.01.2001	9.41	78.10	42.12	33.00	46.02	2.33 x 1.63	6.57	0.68	4.86	3.92	0.89	6.43
CD (0.05)	—	2.80	6.77	9.05	4.20	17.29	0.49 x 0.38	0.30	0.10	0.56	0.30	0.50	0.98

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SHORT COMMUNICATION

Studies in Brinjal Genotypes: Part I–Qualitative Characterization for Northern Karnataka

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An experiment was conducted to characterise the plant type traits of 90 brinjal genotypes in Dharwad, Karnataka. The characterization was done with reference to fourteen vegetative, flower and fruit traits. All genotypes were grouped into round, long, oblong and teardrop depending upon the shape; and depending upon stripeness on the fruit surface genotypes divided into striped and non-striped cultivars. Amongst the non-striped accessions, purple black fruited genotypes were dominant in number followed by purple, light green and pale purple

Key words: Brinjal, Characterization, Northern Karnataka, Qualitative

In brinjal, rigid preferences for colour of the fruit, shape of the fruit, size of the fruit, spinyness, suitability for the preparation of specific culinary preparations (stuffed, sliced, bartha etc.) are prevalent in Northern Karnataka. Hence, in brinjal improvement programme, these local preferences should be taken care of. Thus, an experiment was carried out to help breeders to select an appropriate genotype for crop improvement based on the knowledge of genetics of various characters.

Ninety brinjal genotypes from germplasm maintained at Department of Horticulture, UAS, Dharwad were evaluated during 2000-2001 in a randomized block design with two replications in vegetable sections of Golden Jubilee Block, Kumbapur Farm, Dharwad. The visual observations for 14 characters were recorded on three plants selected randomly and shown in Table 1.

Of all the 90 brinjal genotypes, round fruited genotypes were dominant in number (36.7%), followed by long (33.4%), oblong (26.7%) and teardrop (2.2%). Based on colour of the fruit surface, non-striped genotypes were grouped into purple black (36.7%), purple (16.7%), light green (6.7%) and pale purple (4.4%). Among striped genotypes, 71.4% fruits had green background and 8.9% had white background. Purple striped fruits with white/ green blackground and round/oblong/teardrop shaped fruits are highly suitable for stuffed brinjal and bhaji

Table 1. Qualitative characterization if ninety brinial genotypes for fourteen traits

S. No	Genotypes	Cotyledon Colour	Hypocotyle colour	Plant growth	Leaf blade Lobing	Leaf blade angle	Midrib colour	Lamina colour	Petiole colour	Spinyness				Flower colour	Fruit colour at markable stage	Fruit colour distribution at marketable stage	Fruit colour at physiological maturity	Fruit shape
										Stem	Leaf	Flower	Fruitz					
1	DBC-1-TR	DG	LG	I	W	A	V	LG	V	NS	NS	S	S	LV	LG	U	CY	OB
2	DBC-2-KA	G	LG	U	I	I	GV	G	GV	NS	NS	S	S	LV	G	S	SBY	R
3	DBC-7-MP	DG	DG	U	S	A	V	G	G	NS	NS	NS	NS	BV	PB	U	BY	R
4	DBC-8-KA	DG	LG	U	I	A	V	G	G	S	S	S	S	PV	P	S	YS	R
5	DBC-9-KA	DG	LG	U	VW	I	G	G	GV	NS	NS	NS	NS	PV	G	U	BY	R
6	DBC-10-BI	DG	LG	U	VW	A	V	DG	G	NS	NS	NS	NS	LV	P	M	BY	R
7	DBC-11-BI	DG	LG	P	I	A	G	G	G	NS	NS	NS	NS	BV	LG	U	CY	L
8	DBC-12-BI	G	LG	U	I	A	GV	DG	G	NS	NS	NS	NS	BV	PB	U	Y	OB
9	DBC-13-BI	G	LG	P	I	A	GV	LG	GV	NS	NS	NS	NS	BV	LG	U	CY	L
10	DBC-14-KA	GV	LG	U	S	A	G	G	GV	S	S	S	S	LV	PB	U	BY	OB
11	DBC-15-AP	DG	LG	I	I	A	V	G	G	NS	NS	NS	NS	LV	PB	U	BY	OB
12	DBC-16-AP	YG	YG	I	I	A	G	DG	GV	NS	NS	NS	NS	BV	PB	U	BY	OB
13	DBC-17-AP	YG	YG	I	VW	A	V	G	G	NS	NS	NS	NS	PV	G	S	CY	R
14	DBC-18-AP	DG	LG	U	VW	A	G	DG	GV	NS	NS	NS	NS	V	P	U	CY	L
15	DBC-19-KA	DG	LG	U	S	I	G	G	G	NS	NS	NS	NS	LV	G	S	CY	R
16	DBC-20-KA	DG	LG	U	S	I	G	G	G	S	S	S	S	LV	G	S	CY	R
17	DBC-21-PU	DG	DG	P	S	A	V	LG	GV	NS	NS	NS	NS	W	P	U	Y	OB

S. No	Genotypes	Cotyledon Colour	Hypocotyle colour	Plant growth	Leaf blade Lobing	Leaf blade angle	Midrib colour	Lamina colour	Petiole colour	Spinyness				Flower colour	Fruit colour at markable stage	Fruit colour distribution at marketable stage	Fruit colour at physiological maturity	Fruit shape
										Stem	Leaf	Flower	Fruitz					
18	DBC-22-PU	DG	LG	U	W	A	GV	G	GV	NS	NS	NS	NS	V	P	U	BY	L
19	DBC-23-KA	YG	YG	I	S	I	G	G	G	S	S	S	S	V	G	S	SBY	R
20	DBC-25-KA	DG	LG	U	I	I	G	DG	G	S	S	S	S	V	G	S	CY	R
21	DBC-26-KA	DG	DG	U	I	A	GV	G	G	NS	NS	NS	NS	LV	P	U	BY	R
22	DBC-27-KA	DG	LG	U	S	A	G	G	G	NS	NS	NS	NS	PV	P	M	BY	OB
23	DBC-29-TA	DG	LG	U	S	O	V	DG	GV	NS	NS	NS	NS	V	PP	U	CY	OB
24	DBC-30-TA	DG	JG	U	I	I	V	DG	GV	NS	NS	NS	NS	V	PP	U	CY	OR
25	DBC-31-HA	YG	YG	I	I	A	V	DG	GV	NS	NS	NS	NS	LV	PB	U	BY	TD
26	DBC-33-HA	DG	LG	I	VW	A	V	DG	GV	NS	NS	NS	NS	BV	P	U	BY	OB
27	DBC-34-HA	DG	DG	U	W	A	V	G	G	NS	NS	NS	NS	BV	P	U	BY	L
28	DBC-35-HA	YG	YG	I	VW	A	V	GV	V	NS	NS	NS	NS	BV	PB	U	BY	TD
29	DBC-36-HA	DG	DG	I	Q	I	V	DG	GV	NS	NS	NS	NS	BV	DB	U	BY	L
30	DBC-37.HA	DG	DG	U	S	A	V	DG	V	NS	NS	NS	NS	LV	LG	U	CY	L3
31	DBC-38-HA	DG	DG	U	I	A	V	DG	V	NS	NS	NS	NS	BV	PB	U	BY	R
32	DBC-39-HA	YG	VG	P	VW	I	V	G	GV	S	S	S	S	BV	PB	U	Y	L
33	DBC-40-HA	YG	VG	I	W	A	V	DG	V	NS	NS	NS	NS	BV	PB	U	BY	L
34	DBC-42-HA	DG	VG	P	VW	A	V	DG	GV	NS	NS	NS	NS	BV	PB	U	BY	OB
35	DBC-43-HA	DG	DG	P	VW	A	V	DG	GV	NS	NS	NS	NS	BV	P	U	BY	L
36	DBC-44-HA	DG	LG	P	I	A	V	G	V	NS	NS	NS	NS	PV	P	U	U	L
37	DBC-46-HA	DG	LG	I	S	A	V	GG	GV	NS	NS	NS	NS	PV	P	U	BY	L
38	DBC-47-HA	YG	LG	U	I	A	G	DG	V	NS	NS	NS	NS	PV	P	V	BY	OB
39	DBC-49-HA	DG	DG	P	I	A	V	LG	V	NS	NS	NS	NS	BV	PB	U	BY	L
40	DBC-50-HA	DG	DG	I	W	A	V	DG	GV	S	NS	S	S	LV	PB	U	U	L
41	DBC-53-HA	DG	G	U	I	A	G	G	G	NS	NS	NS	NS	W	LG	U	CY	L
42	DBC-54-HA	DG	G	U	I	A	V	LG	V	NS	NS	NS	NS	V	P	U	BY	L
43	DBC-56-HA	DG	G	U	S	A	V	DG	V	NS	NS	NS	NS	V	P	U	U	L
44	DBC-58-HA	DG	G	U	I	A	V	LG	G	NS	NS	NS	NS	V	PB	U	BY	L
45	DBC-65-HA	DG	G	P	I	A	V	DG	V	NS	NS	NS	NS	BV	U	BY	L	
46	DBC-66-HA	DG	G	U	VW	A	V	DG	V	NS	NS	NS	NS	BV	PB	U	BY	L
47	DBC-68-KA	G	G	U	S	A	V	G	G	NS	NS	NS	NS	PV	G	S	CY	R
48	DBC-75-KA	DG	G	U	I	I	G	G	G	S	S	S	S	PV	G	N	CY	R
49	DBC-76-KA	G	G	U	S	I	G	DG	G	NS	S	NS	NS	PV	G	S	Y	R
50	DBC-77-KA	G	G	U	S	O	V	DG	V	NS	NS	NS	NS	LV	G	N	CY	L
51	DBC-79-KA	DG	G	U	I	I	G	GD	G	S	S	S	S	BV	PB	U	BY	R
52	DBC-80-KA	YG	LG	U	I	A	V	G	V	NS	NS	NS	S	PV	G	S	CY	R
53	DBC-81-BI	DG	LG	U	I	A	V	G	GV	NS	NS	NS	NS	LV	P	U	BY	R
54	DBC-82-TA	DG	DG	P	W	A	V	G	V	NS	NS	NS	NS	LV	PB	U	BY	R
55	DBC-83-AP	LG	LG	U	I	A	V	DG	V	NS	NS	NS	NS	LV	G	S	CY	OB
56	DBC-84-KA	YG	LG	U	S	A	G	G	G	S	S	S	S	PV	G	S	CY	R
57	DBC-85-KA	YG	YG	I	I	A	V	G	G	NS	NS	NS	NS	LV	G	S	CY	R
58	DBC-88-KE	DG	LG	U	S	A	V	DG	G	NS	NS	NS	S	LV	PB	U	BY	OB
59	DBC-89-ND	DG	G	I	W	A	V	DG	G	NS	NS	NS	NS	BV	PB	U	BY	L
60	DBC-91-ND	LG	LG	U	W	A	V	DG	G	NS	NS	NS	NS	LV	PB	U	BY	L
61	DBC-94-KE	G	G	U	I	A	V	DG	G	NS	NS	NS	NS	LV	LG	U	CY	L
62	DBC-95.KA	DG	G	U	S	A	V	V	G	NS	NS	NS	NS	BV	U	BY	L	
63	DBC-96-KA	DG	LG	U	W	I	V	V	G	NS	NS	NS	NS	PV	G	S	CY	R
64	DBC-97.TA	YG	LG	U	I	A	V	G	G	NS	NS	NS	NS	LV	G	S	CY	OB
65	DBC-98-TA	LG	LG	U	W	A	V	G	G	NS	NS	NS	NS	LV	P	S	Y	OB
66	DBC-99-KA	YG	LG	U	W	A	V	G	G	NS	NS	NS	NS	LV	P	S	CY	OB
67	DBC-100-KA	G	G	U	W	A	V	G	G	S	S	S	S	LV	P	S	CY	OB
68	DBC-101-KA	YG	LG	U	W	A	V	G	G	NS	NS	NS	NS	LV	P	S	YS	OB
69	DBC-102-KA	LG	LG	U	W	A	V	G	G	S	S	S	LV	G	S	CY	R	
70	DBC-103-KA	YG	LG	U	S	A	V	G	G	NS	NS	NS	NS	PV	G	S	CY	R
71	DBC-104-MH	G	G	U	S	A	V	G	G	NS	NS	NS	NS	V	PB	U	BY.	R
72	DBC-105-MH	YG	YG	I	W	A	V	G	G	S	S	S	S	V	G	S	Y	R
73	DBC-106-MH	G	LG	U	I	A	G	G	G	S	S	S	S	LV	P	S	BY	OB
74	DBC-107-KA	YG	LG	I	I	A	V	G	G	NS	NS	NS	NS	V	GS	Y	R	
75	DBC-108-KA	G	G	U	I	A	V	V	GV	NS	NS	NS	NS	LV	PV	U	BY	OB
76	DBC-109-TR	LG	LG	U	I	A	V	V	GV	NS	NS	NS	NS	LV	PP	U	BY	OB
77	DBC-11-KA	LG	LG	U	S	A	V	G	G	NS	NS	NS	NS	LV	PB	U	BY	OB
78	DBC-112-GO	YG	LG	U	S	A	V	G	G	NS	NS	NS	NS	PV	PB	U	BY	R
79	DBC-113-GO	YG	LG	U	S	A	V	G	G	NS	NS	NS	NS	PV	P	U	Y	R
80	DBC-114-GO	YG	LG	U	S	A	V	G	G	NS	NS	NS	NS	PV	P	U	BY	R
81	DBC-115-KA	DG	LG	U	I	A	G	G	G	NS	NS	NS	NS	PV	P	S	YS	R
82	DBC-116-UP	YG	LG	U	I	I	V	LG	V	NS	NS	NS	NS	LV	PB	U	BY	L
83	DBC-117-UP	YG	LG	U	I	A	V	LG	GV	NS	NS	NS	NS	LV	PB	U	BY	L
84	DBC-118-KA	DG	DG	U	I	A	G	DG	G	NS	NS	NS	NS	BV	P	S	Y	R
85	DBC-119-KA	G	G	U	S	A	G	G	G	NS	NS	NS	NS	LV	G	S	CY	R
86	DBC-120-KA	LG	LG	U	S	A	GV	DG	G	NS	NS	NS	NS	LV	P	U	BY	R
87	DBC-121-KA	DG	LG	U	S	A	V	DG	V	NS	NS	NS	NS	LV	PB	U	BY	L
88	DBC-122-KA	DG	LG	U	S	A	V	DG	V	NS	NS	NS	NS	BV	PB	U	BY	
89	DBC-123-KA	DG	G	U	S	A	V	DG	V	NS	NS	NS	NS	LV	PB	U	BY	L
90	DBC-124-KA	DG	G	U	S	A	G	DG	G	NS	NS	NS	NS	BV	PB	U	BY	L

1. Cotyledon colour : G: Green, LG : Light Green, DG : Dark Green: YG :Yellowish Green, GV: Greenish Violet
2. Hypocoty Colour : G : Green, LG : Light Green, DG : Dark Green, YG : Yellowish Green, GV: Greenish Violet
3. Plant growth : U : Upright, I : Intermediate, P : Prostrate
4. Leaf blade lobing : S Simple, W : Weak, VW : Very Weak, I : Intermediate
5. Leaf blade angle : A: Acute, I : Intermediate, O : Obtuce
6. Mid rib colour : G : Green, GV : Greenish Violet, V : Violet
7. Lamina colour : G. Green, LG : Light Green, DG : Dark Green
8. Petiole colour : G : Green, GV : Greenish Violet, V : Violet
9. Spinyness : S: Spiny, NS : Non spiny
10. Flower colour : LV : Light Violet, PV : Pale Piolet, BV : Bluish Violet
11. Fruit colour at marketable stage : LG : Light Green, G : Green, P : Purple, PB : Purple Black, PP : Pale Purple
12. Fruit colour distribution at marketable stage : U : Uniform S : Striped, N : Netted, M : Mottled
13. Fruit colour at physiological maturity : BY : Brownish Yellow, Y : Yellow, CY : Complete Yellow, YS : Yellow Striped, SBY : Striped Brownish Yellow
14. Fruit shape, R : Round, OB : Oblong, L : Long, TD : Tear Drop

preparation in Northern Karnataka region. The green fruits with creamy patches at stylar end are preferred along the West Coast (Udipi, Karwar etc.) and also interior Northern Karnataka (Kudchi, Bijapur etc.) For this DBC-75-KA is a promising genotype with high yielding potential.

Seventy genotypes were non-spiny and rest (20) were spiny. Violet midrib colour was observed in 63 genotypes followed by green (21) and greenish violet (6). Green coloured lamina was observed in 43 genotypes followed by dark green (35), light green (8) and violet (4). Colour of the petiole was green in 38 genotypes, greenish violet in 22 and violet in 20 genotypes. NBPGR (1995) have also characterized the 1181 brinjal genotypes. PDVR (1995-96) characterized 165 genotypes of brinjal and Singh *et al.*, (1999) characterized 325 accessions.

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SHORT COMMUNICATION

Studies in Brinjal Genotypes: Part II–Genetic Divergence

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Mahalanobis's D^2 statistics was used to study genetic divergence for 20 characters in a collection of 90 brinjal genotypes. These 90 genotypes were grouped into 7 clusters on the basis of relative magnitude of D^2 values. The maximum contribution towards the total genetic divergence was from yield per plant. It has been observed that no close correspondence is evident between geographical distribution to genetic divergence as estimated by D^2 statistics. The maximum inter cluster distance was observed between cluster IV and VII, while minimum was recorded between III and IV.

Key Words : Brinjal, Cluster Analysis, Divergence

A successful breeding programme is associated with diversity of parents. More diverse the parents, better are the chances of improving economic characters. This genetic divergence existing in the population helps in selecting the suitable parents for hybridization programme resulting superior hybrids and desirable recombinants. Mahalanobis's (1936) genaralized distance estimated by D^2 statistics was employed to assess the amount of genetic diversity for 90 brinjal genotypes.

Ninety brinjal genotypes from the germplasm maintained at Department of Horticulture, UAS Dharwad were evaluated during 2000-2001 in a Randomized Block Design with two replications in Vegetable Section of Golden Jubilee Block, Kumbapur Farm, Dharwad. Ten plants of each genotype were transplanted in each replication in a single row. The recommended cultural practices were adopted as per the UAS, Dharwad. The observations for 20 characters were recorded on three plants selected randomly. The mean values were used for Mahalanobis D^2 statistics to know the genetic divergence as described by Tocher's method (Rao, 1952).

Analysis of variance indicated highly significant differences among the genotypes for all the characters except fruit pedicel thickness. On the basis of D^2 analysis, the 90 genotypes were grouped into 7 clusters. The maximum number of genotypes were found in cluster I (38) followed by cluster V (20), cluster II(18), Cluster III(10) and Cluster IV (2). Cluster VI and VII were solitary consisting only one genotype in each. The clustering pattern of these genotypes under the study suggested that geographic diversity may not be necessarily related with genetic diversity. Similar findings were also reported by Yadav *et al.* (1996) and Rajeshkumar *et al.* (1998).

Contribution of different plant characters for total genetic divergence is important for the purpose of further selection and choice of parents for hybridization. The maximum contribution was found from yield per plant (97.95%) followed by fruit weight (1.34%) leaf area (0.56%), plant height at 50 per cent flowering (0.07%), days to 50 per cent flowering (0.05%) and leaf length (0.02%). However, Rajeskumar *et al.*, (1998) have reported fruit width followed by fruit length and yield per plot as responsible for grouping of germplasm. The differences in the contributing factors for genetic divergence is attributed to different genotypes under study, grouping patterns of the genotypes based upon colour and shape of fruits, method of analysis etc.

Intracluster distance was minimum (D^2 = 61.275) in the cluster IV, while maximum (D^2 = 255.48) in cluster V (Table 1). The highest genetic diversity in cluster V may due to both natural and artificial selection forces among the genotypes. Intracluster distance was

Table 1. Intra- and inter-cluster distance in 7 clusters

Clusters	I	II	III	IV	V	VI	VII
I	237.72	564.73	1390.00	935.76	684.30	999.359	2050.15
II		191.38	1905.68	419.49	1184.03	1514.65	2570.33
III			230.17	2296.932	768.02	417.28	690.43
IV				61.275	1570.36	1905.98	2963.86
V					255.48	389.06	1414.90
VI						0.00	1058.24
VII							0.00

Table 2. Cluster means for 20 quantitative characters in brinjal

Sl. No.	Character	Clusters						
		I	II	III	IV	V	VI	VII
1	Petiole length (cm)	1.97	2.18	1.99	2.57	2.22	1.90	1.49
2	Leaf length (cm)	11.87	12.19	11.21	10.815	11.37	10.00	11.15
3	Leaf breadth (cm)	8.28	8.49	7.5	7.45	7.42	5.79	7.08
4	Leaf area (cm)	47.66	39.92	47.94	39.51	43.52	34.23	50.90
5	Stem girth (cm)	1.72	1.81	1.75	2.44	1.86	1.65	2.35
6	Plant height at 50% flowering	23.73	22.22	25.84	26.72	24.11	17.92	22.60
7	Number of branches per plant	6.76	6.4	8.19	6.66	6.47	9.83	8.00
8	Days to 50% flowering	50	49.22	43.65	48.0	47.75	47	44
9	Number of flowers per cluster	3.20	2.64	3.14	2.33	2.08	3.33	3.50
10	Number of fruits per cluster	1.43	2.07	1.06	1.0	1.52	2.66	1.0
11	Flower length (cm)	3.48	3.72	4.14	3.50	3.46	3.70	3.55
12	Flower width (cm)	2.96	2.96	3.76	3.10	3.23	3.60	4.95
13	Fruit pedicel length (cm)	3.82	3.22	4.50	4.15	4	4.58	5.48
14	Fruit pedicel thickness (cm)	0.99	1.43	1.13	0.79	1.0	0.88	1.18
15	Fruit calyx length (cm)	3.28	3.3	3.72	2.55	3.48	3.23	5.14
16	Fruit length (cm)	8.86	7.35	7.70	5.12	7.26	7.85	6.30
17	Fruit Diameter (cm)	4.35	4.27	5.49	3.43	5.92	3.10	6.93
18	Fruit weight (g)	57.35	45.78	110.91	30.25	90.81	77.50	112.50
19	Number of fruits per plant	26.64	25.58	24.85	18.75	25,13	32.0	31.5
20	Yield per plant (g)	1411.81	1214.22	2785.00	693.75	2230.89	2607.45	3665.0

minimum between the cluster III and IV while maximum intracluster distance between clusters IV (DBC-46-HA & DBC-104-MH) and VII (DBC-18-AP) followed by between cluster II (DBC-75-KA and DBC-125-KA) and V (DBC-76-KA and DBC-77-KA) indicating the genotypes of these clusters could be used as parents in hybridization programme to get the higher heterotic hybrids or isolate a good variant as genotypes from the seggregant population. Similar views were also expressed by Pramanik *et al.* (1992) and Rajeshkumar *et al.* (1998).

Cluster means for different characters (Table 2) revealed that the cluster values excelled in respect of different characters. Cluster VII was diverse with a good source of yield per plant, fruit weight, fruit width, fruit calyx length, fruit pedicel length, flower width, number of flowers per cluster and leaf area. Cluster III represented with lowest number of fruits per plant, higher fruit calyx length and early maturing genotypes in terms of days to 50 per cent flowering. Thus by involving in the hybridization the genotypes of higher mean performance for required characters under consideration as potential parents, future improvement in brinjal can be achieved (Rajeshkumar *et al.*, 1998).

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SHORT COMMUNICATION

Curcumin Content in Relation to Date of Harvesting in Turmeric (*Curcuma longa* L.)

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Key words : *Curcuma longa*, Curcumin, Genetic Advance, Heritability, Moisture, Sodic Soil

Curcuma longa L. (Zingiberaceae), commonly known as turmeric, is an important crop used in Indian traditional system of medicine and also as a spices. It grows well under partially shaded condition. India is the largest producer and exporter of turmeric in world market (Kumar and Shankar, 1998). Andhra Pradesh, Tamilnadu, Orissa, Maharashtra and Assam are major states for turmeric production. Its rhizomes are used as condiments, spices, natural dye and in pharmaceutical, confectionery and food industries, As medicine, it is commonly being used for several aliments (Raghunath and Mitra, 1982, Chauhan *et al,* 1999). Yellow colour in turmeric is due to the presence of crystalline matter called curcumin, a bis-diferuloyl methane, which makes it suitable for food, confectionery and cosmetics. The curcumin content is dependent on developmental stages and selection of suitable turmeric of genotypes. Very little work has been done to breed high yielding, high curcumin varieties. The present study is an attempt to determine the curcumin content in relation to different developmental stages (harvesting) in a crop grown on sodic soil.

The experiment was conducted on sodic soil of Banthra Research Station of the Institute (longitude 80°45'–80°54'E and latitude 26°45'-26°45'N at 129 m above sea level) in 2^2 factorial randomized block design with 4 replications in 1998-99 and 1999-2000. The experimental site is representative of alkali soil and represented by high pH (8.5) with electric conductivity (EC) upto 2.0 dsm^{-1} and poor aeration due to high exchangeable sodium percentage (ESP 20%). Fertilizers at the rate of 90 kg nitrogen, 60 kg phosphorus and 60 kg potash per hectare were applied. Spacing was kept 0.5 x 0.2 cm^2 as inter crop in popular planted during 1988-1989. Normal cultural practices were done through out the crop season. Harvesting of rhizomes was started on October and further diggings were done at the interval of 15 days to estimate curcumin and mositure contents.

Moisture content was estimated following official and standardized methods of analysis (Anonymous, 1994) while the curcumin content was estimated following the method of Chauhan *et al.* (1999).

To study the effect of different harvesting on curcumin content, the mean data was analysed following 2^2 factorial experiment (Panse and Sukhatme, 1961).

Table 1. Analysis of variance of moisture and curcumin content in *C. Longa* L.

Source	df	Moisture content	Curcumin content (%)
Replications	3	0.16	0.05
Treatment	15	2.03	1.45**
(i) Varieties (V)	1	1.65 NS	0.08 NS
(ii) Date of digging (D)	7	1.78 NS	1.69**
(iii) V x D	7	1.99 NS	0.02 NS
Error	45	0.76	0.106

** = significant at 1% probability level, NS = non-significant

Analysis of variance in 2^2 factorial design and mean of two genotypes (BRS-1 and BRS-2) at different harvesting stages are presented in Table 1 and 2 respectively. Variance in curcumin due to different dates of digging(D) was significant indicating much variation in curcumin content in different development stages. However, for moisture content no significant difference was noticed. Interaction effects VxD was also not significant for both the characters.

Curcumin content ranged from 3.65 to 6.01 per cent in BRS-1 and 3.70 to 6.08 percent in BRS-2 with arithmetic mean of 4.92±0.34 and 5.07±0.33 per cent respectively. In general curcumin content was found increasing in each subsequent harvesting. Comparing with general mean, it was significantly higher in rhizomes harvested during January and February. This indicates that synthesis of curcumin was maximum at maturity and thus January and February may be recommended

Table 2. Moisture and curcumin content in *C. Longa* L.

Date of Harvesting	Moisture content (%)			Curcumin content		
	BRS-1	BRS-2	X±SE	BRS-1	BRS-2	X±SE
28.10.98	78.95	80.02	79.49±0.54	3.65	3.70	3.67±0.02
13.11.98	76.57	79.89	78.23±1.66	4.13	4.15	4.14±0.01
28.11.98	79.68	79.91	79.80±0.10	4.25	4.58	4.42±0.15
12.12.98	77.15	77.70	77.43±0.28	4.64	4.72	4.68±0.04
27.12.98	77.64	77.70	77.67±0.02	4.91	5.37	5.14±0.23
11.01.99	79.69	78.54	79.12±0.58	5.82	5.90	5.86±0.04
11.02.99	75.68	79.10	77.39±171	5.98	6.05	6.01±0.03
26.02.99	79.90	77.53	78.72±1.18	6.01	6.08	6.05±0.03
±SE	78.16±0.57	78.80±0.38	78.48±0.33	4.92±0.34	5.07±0.33	4.99±0.32

		Selection Parameters	
1.	Heritability (%)	63.46	81.25
2.	Genetic advance	1.25	1.33
3.	Genetic advance in per cent of mean (%)	1.60	26.82

as an ideal period of harvesting in the Indo-gangetic plains of India. Among the two selections curcumin was higher in BRS-2 and BRS-1. However, the difference was not very significant. Earlier, Lynrah *et al,* (1998) noticed a wide range in curcumin content (0.08-8.64 per cent) among 25 genotypes with average of 3.96 per cent while Chauhan *et al,* (1999) reported total curcuminoid upto 2.38 per cent and 2.37 per cent estimated through spectrophotometric and HPLC methods respectively.

For mositure content no regular trend was found in different dates of harvesting in both the genotypes. It ranged from 75.68 to 79.90 per cent in BRS-1 and 77.53 to 80.02 per cent in BRS-2 with average mean of 78.16±0.57 and 78.80±0.38 per cent respectively. The moisture content was less variable and almost similar in all the diggings which also confirms the non-significant 2^2 analysis (Table 1) for moisture content.

Heritability for curcumin content was 81.25 per cent while for moisture content it was 63.46 per cent. Though the heritability was high for both the characters under study but high heritability coupled with high genetic advance (26.82 per cent) was noticed for curcumin content. This suggests that curcumin content may be increased through clonal selections. High heritability and genetic advance were also reported (Lynrah *et al,* 1998, Pathania *et al,* 1988).

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SHORT COMMUNICATION

Biodiversity and Improvement in *Kalanamak* – A Local Scented Rice Cultivar in Uttar Pradesh

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Among small- and medium-grained aromatic rice varieties, *Kalanamak* is most important in India. It derives its name from its black husk. It is grown widely in Tarai Area adjoining Nepal particularly in districts of Gorakhpur, Maharajganj, Gonda, Mirzapur and Varanasi in Uttar Pradesh and West Champaran in Bihar. It is also cultivated in small pockets in district Kapilvastu of Nepal. History of cultivation of *Kalanamak* dates back to Buddha period. Till a decade ago about 10 per cent area was Kalanamak cultivated in the Sidharthanagar and Basti districts. However, due to severe panicle blast problem during the years 1998 and 1999, area under *Kalanamak* declined to less than 1 per cent. However, *Kalanamak* production is better than previous years in 2001 and high price (paddy Rs. 25 per kg and milled rice Rs. 45 per kg) definitely increase farmers' interest.

Kalanamak is a tall and late maturing variety. It belongs to Group V (Singh *et al.*, 2000). It has small- to medium-sized grain (4.3 to 6.4 mm), medium to strong aroma and about 150 per cent elongation after cooking. Elongation of *Kalanamak* after cooking is better than Taraori Basmati (80-100%). Cooked rice is fluffy, soft, non-sticky, sweet, and easily digestible with relatively longer shelf-life. In local market it earns higher price than Basmati. It surpasses Basmati in all other quality traits except grain length. This variety is highly suitable for organic farming as its nitrogen requirement is quite low.

In spite of the high quality, *Kalanamak* is poor yielder. There is no seed production or improvement programme. Farmers are using their own seed from hundreds of the years. This has resulted in decline in quality of seed. In a survey of the *Kalanamak* belt of district Sidharthanagar, it was found that this variety is now a mixture of several types of seeds, which share one major characteristic, *i.e.* black husk. Because of admixture, both quality and yield are adversely affected. However, it has certain advantages also. This variety behaves as multi-line. In its native areas of cultivation *Kalanamak* suffers less from different diseases and pests as compared to other cultivars or land races of aromatic races, collected from other areas.

Because of this mixture at farmers' field, flowering and maturity periods are also not uniform. Quite often they are spread-over to more than one week. Small-size slender grain lines are of superior quality. Proportion of this type of *Kalanamak* line is higher in Alidapur area of district Sidharthnagar, which is famous for producing finest quality *Kalanamak*.

In an attempt to quantify diversity in *Kalanamak*, 34 germplasm of *Kalanamak* were collected from districts of Sidharthanagar, Basti and Gorakhpur of Uttar Pradesh and West Champaran of Bihar. These germplasm were purified by single line selection and evaluated for various traits.

Table 1. Maturity duration and plant height of *Kalanamak* germplasm

Maturity duration		Plant height	
Days	Germplasm	cm	Germplasm
140	321	100-110	3130, 3131, 3222
143	3256	111-120	3113, 3128, 3168, 3212, 3213, 3219, 3312, 3319, 3320, 3321
158	3081, 3113, 3121, 3319, 3124, 3125, 3126, 3212, 3213, 3214, 3219, 3259, 3266, 3327	121-130	3081, 3114, 3117, 3124, 3125, 3126, 3214, 3216, 3257, 3266, 3327
160	3089, 3114, 3117, 3119, 3120, 3128, 3130, 3131, 3215, 3257	131-140	3089, 3120, 3121, 3215, 3220, 3256
162	3129, 3168, 3312	141-150	3119, 3122, 3259
165	3216, 3220, 3222		

As shown in tables 1 to 3, there is wide variation in different germplasm with respect to maturity duration, plant height, number of grains per hill, grain length (4.4 to 6.4 mm), breadth (1.5 to 2.9 mm) and length/ breadth ratio (2.3 to 3.6). Susceptibility of germplasm to various diseases and pests also varied widely (Table 3 and 4). One of the most interesting observation was high degree of resistance (index <5%) in some of the germplasm against panicle blast (Table 3). Some of the germplasm showing high or moderate degree of resistance against panicle blast were also superior in yield and other quality traits (Table 3 and 5). In a 20 m^2 plot many of these germplasm yielded more than 20 q/ha against 10 q/ha average yield at farmers' fields in their native areas of cultivation. In a survey it was observed that in its native area of cultivation farmers value dark coloured, small and slender grains more (Singh US and Singh RK, unpublished). These characteristics

Table 2. Grain characteristics (grain / panicle, grain length/breadth ratio) of *Kalanamak* germplasm

Grains per panicle		Length/Breadth ratio	
Number	Germplasm	Ratio	Germplasm
90-100	3113, 3266	≤ 2.5	3128, 3219
101-125	3081, 3130, 3215, 3216, 3222, 3256, 3320, 3321	2.6-3.0	3117, 3122, 3124, 3129, 3130, 3131, 3212, 3213, 3215, 3257, 3259, 3266, 3327, 3319, 3121, 3216
126-150	3089, 3117, 3119, 3125, 3257, 3259, 3312	3.1-3.5	3089, 3114, 3120, 3214, 3222, 3229, 3256, 3278, 3319
151-175	3121, 3122, 3131, 3168, 3319	≥3.6	3126, 3321
176-200	3114, 3120, 3214, 3219		
201-225	3126, 3128		
226-250	3213		
251-275	3124		
276-300	3327		

Table 3. Susceptibility of *Kalanamak* germplasam against different diseases

Disease Reaction	Neck blast	Sheath blight	Sheath rot	Stem rot
Resistant (R)	3114, 3121, 3128, 3130, 3131, 3213, 3216, 3220, 3259 3320		3117, 3119, 3120, 3131, 3212, 3213, 3259, 3319, 3320	3220, 3320
Moderately resistant (MR)	3081, 3089, 3119, 3120, 3126, 3130, 3168, 3214, 3215, 3256, 3266	3220	3089, 3113, 3114, 3121, 3122, 3124, 3126, 3128, 3130, 3168, 3215, 3216, 3219, 3220, 3222, 3257, 3321, 3327	3122, 3124, 3129, 3168, 3213, 3222 3327
Moderately Susceptible (MS)	3113, 3117, 3125 3129, 3202, 3327, 3329	3113, 3126, 3128, 3130, 3168, 3214, 3256, 3319, 3321, 3327	3081, 3266	3089, 3120, 3126, 3128, 3131, 3214, 3215, 3219, 3259, 3321
Susceptible (S)	3121, 3122, 3124, 3168, 3212, 3219, 3222, 3257, 3319	3081, 3089, 3114, 3117, 3119, 3120, 3121, 3122, 3124, 3125, 3129, 3131, 3212, 3213, 3215, 3216, 3219, 3222, 3257, 3259, 3266, 3320	3129	3081, 3113, 3114, 3117, 3119, 3121, 3130, 3212, 3216, 3257, 3266, 3319

Table 4. Incidence of white head in *Kalanamak* germplasm

Per cent incidence	*Kalanamak* fermplasm
≤ 10%	3113, 3117, 3126, 3128, 3219, 3222, 3257, 3319
11-15%	3081, 3114, 3119, 3120, 3124, 3129, 3130, 3131, 3168, 3212, 3213, 3214, 3216, 3220, 3256, 3259, 3266, 3320, 3321, 3327
>15%	3089

Table 5. Characteristics of some selected germplasm of *Kalanamak*

Germplasm	Plant Height (cm)	Duration (days)	Tillers/ hill	Panicles/ hill	Panicle length (cm)	Grains per panicle	Grain characteristics			Paddy yield (q/ha)*
							Length (mm)	Breadth (mm)	L/B	
3114	116	160	8.8	8.6	24	218	5.1	1.6	3.2	25
3119	136	160	8.4	8.4	24	205	4.6	1.6	2.9	25
3120	141	160	9.8	9.2	24	247	4.8	1.6	3.0	16
3130	107	160	9.4	8.8	30	203	5.9	1.9	2.6	23.5
3131	108	160	11.8	11.6	27	227	4.7	1.8	2.7	20
3216	125	165	8.2	8.0	22	202	4.7	1.6	2.9	13

* Based on 20 m^2 plot.

are shared by some of the blast resistant germplasm like 3114, 3119, 3131, 3216 etc. Therefore, they offer great promise for being exploited for the cultivation as improved lines. These germplasm are being evaluated in 100 m^2 plots in district Sidharthanagar and Gorakhpur at farmers' field during the year 2001.

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PLANT GERMPLASM REGISTRATION NOTICE

Rice Germplasm from Andamans

Asit B Mandal and R Elanchezhian
Central Agricultural Research Institute, Port Blair (Andamans)

Black Burma Rice (INGR No. 01019, IC 296798)

Black Burma rice, *Oryza sativa* is a very tall (174.4 cm), traditional, indica cultivar grown in middle and south Andamans. It has been identified to be tolerant to aluminium toxicity and moderately tolerant to salinity. The cultivar flowers after 150 days and matures within 190 days. Each plant possesses lesser tillers (6.8) with an average of 5 panicles indicating moderate tillering capacity. The flag leaf area is 38.25 cm^2. Panicles are small (25.9 cm) with low spikelet sterility (25.35%). Average grain yield is 2.1 tons/ha. The grain length is around 9.7 mm, while the width is 3.85 mm with a length/width ratio of 2.52. The dehusked rice is creamy white in colour with a length/width ratio of 2.2. The grains possess opaque endosperm. On cooking the grain showed 6.67% elongation, and 2.22 times volume expansion. Alkali digestion value was found to be high with low amylose content and low gelatinisation temperature. Gel consistency value was scored as 3 with very soft texture on a scale of 0-9.

The genotype is found to be tolerant to sheath blight (caused by *Rhizoctonia solani*), bacterial leaf spots (caused by *Cercospora oryzae*), sheath rot (caused by *Xanthomonas campestris* pv. *oryzae*), and neck and leaf blight (caused by *Pyricularia oryzae*), and tolerant to leaf folder (*Cnaphalocrocis medinalis*), gundhi bug (*Leptocorisa oratoria*), while moderately tolerant to stem borer (*Scirphophaga incertulas* Walker) under field conditions.

It has violet coloured ligules with pink margin. It is specially suited for preparation of breakfast items. In Andamans it is used for *lasa* preparation (a local food item). It can be a source for improving nutritional quality, and tolerance to excess salt and aluminium toxicities.

Nona Rice (INGR No. 01020, IC 296799)

Nona is a traditional dwarf (66 cm) variety of rice, *Oryza sativa* grown in north, middle and south Andamans. It belongs to indica group. In was identified to be moderately tolerant to salinity and iron toxicities. The cultigen's flowers after 80 days and matures within 110 days. Each plant possesses moderate number of tillers (8) with an average number of 7 panicles indicating abundance of productive tillers. Panicles are small (20.0 cm) with test weight of 36.0 g. The average yield of the Nona rice is 1.5 tons/ha. The grains are bold with light brownish coloured husk. The endosperm of the grain was opaque with chalkiness at the centre. The grain elongates up to 33.4% and expands 1.87 times on cooking. The alkali digestion and gelatinisation temperature values were found to be intermediate with soft gel consistency.

The cultigen is moderately tolerant to bacterial leaf blight (*Xanthomonas campestris* pv. *oryzae*), bacterial leaf spot (*Cercospora oryzae*), *Helminthosporium* leaf spot and blast (*Pyricularia oryzae*), and tolerant to stem borer caused by *Scirphophaga incertulas* Walker.

Basmati Quality Cytoplasmic Male Sterile Rice

FU Zaman, AK Singh, A Hariprasad, MJ Abraham, Anju Mehendru, F Mohammad, RA Singh, Jagbir Singh, G Ravindran, AK Mittal, A Haque, Mahadev Mahto, R Paramsivam
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PUSA 4A (INGR No. 01021, IC 296800)

PUSA 4A is a basmati type cytoplasmic male sterile line of paddy, *Oryza sativa* derived from IR 58025A/IET 10649 through back crossing and selection. The plant height is 95 cm with purple base. The grains possess ideal basmati characteristics and pollen grains are completely sterile. It is a semi-dwarf, high tillering type with dark green leaves and purple stigma with better exsertion. Number of spikelets are 175 per panicle. Days to 50 per cent flowering is between 95 to 100 and to maturity 135.

PLANT GERMPLASM REGISTRATION NOTICE

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The genotype is found to be tolerant to sheath blight (caused by *Rhizoctonia solani*), bacterial leaf spots (caused by *Cercospora oryzae*), sheath rot (caused by *Xanthomonas campestris* pv. *oryzae*), and neck and leaf blight (caused by *Pyricularia oryzae*), and tolerant to leaf folder (*Cnaphalocrocis medinalis*), gundhi bug (*Leptocorisa oratoria*), while moderately tolerant to stem borer (*Scirphophaga incertulas* Walker) under field conditions.

It has violet coloured ligules with pink margin. It is specially suited for preparation of breakfast items. In Andamans it is used for *lasa* preparation (a local food item). It can be a source for improving nutritional quality, and tolerance to excess salt and aluminium toxicities.

Nona Rice (INGR No. 01020, IC 296799)

Nona is a traditional dwarf (66 cm) variety of rice, *Oryza sativa* grown in north, middle and south Andamans. It belongs to indica group. In was identified to be moderately tolerant to salinity and iron toxicities. The cultigen's flowers after 80 days and matures within 110 days. Each plant possesses moderate number of tillers (8) with an average number of 7 panicles indicating abundance of productive tillers. Panicles are small (20.0 cm) with test weight of 36.0 g. The average yield of the Nona rice is 1.5 tons/ha. The grains are bold with light brownish coloured husk. The endosperm of the grain was opaque with chalkiness at the centre. The grain elongates up to 33.4% and expands 1.87 times on cooking. The alkali digestion and gelatinisation temperature values were found to be intermediate with soft gel consistency.

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Division of Genetics, Indian Agricultural Research Institute (IARI), New Delhi-110012

PUSA 4A (INGR No. 01021, IC 296800)

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Thermo-Sensitive Genic Male Sterile Rice

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Two-line hybrid breeding system, utilizing thermo-sensitive genic male sterility (TGMS) is simpler and highly efficient for hybrid seed production and obtaining heterotic combinations than three-line hybrid breeding in rice, *Oryza sativa*. TGMS line should combine important features of low critical temperature for fertility transformation and high critical temperature for sterility induction. To achieve this the G B Pant University of Agriculture and Technology, Pantnagar developed two TGMS lines viz., UPRI 95-140 TGMS and UPRI 95-167 TGMS.

UPRI 95-140 TGMS (INGR No. 01022, IC 296801)

UPRI 95-140 TGMS is a spontaneous thermo-sensitive genic male sterile line identified from UPRI 95-140. It was a single plant selection. The plants are semi-dwarf (72 cm), early maturing (107 days from seed to seed) with purple base and narrow erect flag leaves. The plants are vigorous and have high tillering capacity. The panicles are fully exserted and awnless. The grains are long and slender. UPRI 95-140 TGMS expresses thermo-sensitive reaction with male fertility. The average thermo-sensitive temperature for complete sterility is 27.1^0C in dry season (DS) to 28.7^0C wet season (WS) and 21.8^0C in DS to 26.2^0C in WS under northwestern Indian conditions. Optimum spikelet fertility is more than 40% and the period of complete male sterility is 104 days (May-Sept). These features are desirable for two-line hybrid rice breeding programme.

UPRI 95-167 TGMS (INGR No. 01023, IC 296802)

UPRI 95-167 TGMS has been developed from *in vitro* non-pollinated F_1 ovary culture of the cross between UPRI 95-140 TGMS and UPRI 95-117. The plant type is semi-dwarf (73 cm), early maturing type (107 days from seed to seed) with good panicle and stigma exsertion and long slender grains. It transforms from complete sterility to fertility between an average temperature of 24.2 and 28.7^0C respectively during late wet season, while transformation of fertility to complete sterility occurs at mean minimum or average temperatures of 18.2^0C and 26.5^0C respectively during dry season. UPRI 95-167 TGMS has stable and long male sterility stage between May 1 to September 5, suitable for hybrid development in early wet season and partial line multiplication during dry season and late wet season. It is an ideal TGMS line of commercial potential for two lines hybrid development.

Moth Bean Germplasm

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CZM-32 (INGR No. 01024, IC 296803)

CZM-32 is a mutant of moth bean *Vigna aconitifolia* (Jacq.) Marechal variety Jadia, developed by treating seeds with 30 kR Co^{60} gamma ray. The mutant was isolated in M_3 generation during 1992 at CAZRI, Jodhpur. The mutant exhibited higher drought tolerance potential in terms of maintaining high y plant (-1.50) than RMO-40 and Maru Moth-1 (-1.35 and 1.30 y plant, respectively) at 9th day of water stress (Garg *et al.*, 2001). CZM-32 has erect and upright growth behaviour, early partitioning (28-30 days) and maturity (58-60 days). It has higher productivity per day (10.3 g day^{-1}) than the parental line (4.5 g day^{-1}). In All India Co-ordinated trials during *Kharif* seasons of 1995 and 1996, it yielded 450 kg ha^{-1} retaining green foliage till maturity, making it, suitable both for grain and fodder. Due to early maturity it can escape yellow mosaic virus.

Two-year evaluation of 3 moth bean genotypes, including CZM-32, Maru Moth-1 and RMO-40 under rainfed conditions at CAZRI confirmed higher grain and fodder yield (Anonymous, 1997). This was attributed to better utilization of available soil moisture and nutrient, leading to higher photosynthetic efficiency and better leaf metabolism. Also, the mutant requires lesser macro-

Thermo-Sensitive Genic Male Sterile Rice

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Two-line hybrid breeding system, utilizing thermo-sensitive genic male sterility (TGMS) is simpler and highly efficient for hybrid seed production and obtaining heterotic combinations than three-line hybrid breeding in rice, *Oryza sativa*. TGMS line should combine important features of low critical temperature for fertility transformation and high critical temperature for sterility induction. To achieve this the G B Pant University of Agriculture and Technology, Pantnagar developed two TGMS lines viz., UPRI 95-140 TGMS and UPRI 95-167 TGMS.

UPRI 95-140 TGMS (INGR No. 01022, IC 296801)

UPRI 95-140 TGMS is a spontaneous thermo-sensitive genic male sterile line identified from UPRI 95-140. It was a single plant selection. The plants are semi-dwarf (72 cm), early maturing (107 days from seed to seed) with purple base and narrow erect flag leaves. The plants are vigorous and have high tillering capacity. The panicles are fully exserted and awnless. The grains are long and slender. UPRI 95-140 TGMS expresses thermo-sensitive reaction with male fertility. The average thermo-sensitive temperature for complete sterility is 27.1^0C in dry season (DS) to 28.7^0C wet season (WS) and 21.8^0C in DS to 26.2^0C in WS under northwestern Indian conditions. Optimum spikelet fertility is more than 40% and the period of complete male sterility is 104 days (May-Sept). These features are desirable for two-line hybrid rice breeding programme.

UPRI 95-167 TGMS (INGR No. 01023, IC 296802)

UPRI 95-167 TGMS has been developed from *in vitro* non-pollinated F_1 ovary culture of the cross between UPRI 95-140 TGMS and UPRI 95-117. The plant type is semi-dwarf (73 cm), early maturing type (107 days from seed to seed) with good panicle and stigma exsertion and long slender grains. It transforms from complete sterility to fertility between an average temperature of 24.2 and 28.7^0C respectively during late wet season, while transformation of fertility to complete sterility occurs at mean minimum or average temperatures of 18.2^0C and 26.5^0C respectively during dry season. UPRI 95-167 TGMS has stable and long male sterility stage between May 1 to September 5, suitable for hybrid development in early wet season and partial line multiplication during dry season and late wet season. It is an ideal TGMS line of commercial potential for two lines hybrid development.

Moth Bean Germplasm

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CZM-32 (INGR No. 01024, IC 296803)

CZM-32 is a mutant of moth bean *Vigna aconitifolia* (Jacq.) Marechal variety Jadia, developed by treating seeds with 30 kR Co^{60} gamma ray. The mutant was isolated in M_3 generation during 1992 at CAZRI, Jodhpur. The mutant exhibited higher drought tolerance potential in terms of maintaining high y plant (-1.50) than RMO-40 and Maru Moth-1 (-1.35 and 1.30 y plant, respectively) at 9th day of water stress (Garg *et al.*, 2001). CZM-32 has erect and upright growth behaviour, early partitioning (28-30 days) and maturity (58-60 days). It has higher productivity per day (10.3 g day^{-1}) than the parental line (4.5 g day^{-1}). In All India Co-ordinated trials during *Kharif* seasons of 1995 and 1996, it yielded 450 kg ha^{-1} retaining green foliage till maturity, making it, suitable both for grain and fodder. Due to early maturity it can escape yellow mosaic virus.

Two-year evaluation of 3 moth bean genotypes, including CZM-32, Maru Moth-1 and RMO-40 under rainfed conditions at CAZRI confirmed higher grain and fodder yield (Anonymous, 1997). This was attributed to better utilization of available soil moisture and nutrient, leading to higher photosynthetic efficiency and better leaf metabolism. Also, the mutant requires lesser macro-

nutrients compared to spreading and late type checks (GMO-9102 and GMO-9103) and more or less the same or higher in comparison to erect but late type mutants in unfertilised rainfed arid lands (Table 1); depicting better nutritional partition towards sinks (Kumar, 1996). CZM-32, therefore, is a good example of fine source-sink relation in terms of nutritional partitioning and higher productivity.

Table 1. Nutrient requirement for one kg seed of moth bean (Kharif 1996 CAZRI, Jodhpur)

Group	Strains	N	P	K	Ca (mg g^{-1})	Mg	Cu	Fe	Mn (m g^{-1})	Zn
Spreading	GMO-9102	2.69	0.09	0.91	1.07	0.56	1.01	42.48	4.63	3.58
and late	GMO-9103	1.34	0.08	0.23	0.27	0.09	2.48	22.79	1.93	0.96
	Mean	**2.01**	**0.09**	**0.57**	**0.67**	**0.33**	**1.75**	**32.64**	**3.28**	**2.27**
Erect and	CZM-32 E	0.38	0.03	0.28	0.16	0.22	0.40	3.69	1.37	1.51
early	CZM-18 E	0.24	0.03	0.30	0.36	0.05	0.48	18.33	1.44	2.43
	Mean	**0.31**	**0.03**	**0.29**	**0.26**	**0.14**	**0.44**	**11.01**	**1.41**	**1.97**
Erect, late,	CZM-225	1.12	0.09	0.65	0.84	0.18	1.1	39.92	9.01	4.75
unbranched	CZM-170	0.86	0.02	0.62	0.53	0.14	1.4	3.86	2.64	2.82
	Mean	**0.99**	**0.06**	**0.64**	**0.69**	**0.16**	**1.3**	**21.89**	**5.83**	**3.79**

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Cytoplasmic Genic Male Sterile Line and their Restorers in Pigeonpea

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Main Pulses Research Station, Gujarat Agricultural University, Sardar Krushinagar-385 506 (Gujarat)

Cytoplasmic Genic Male Sterile Line of Pigeonpea, GT 290A (INGR No. 01025, IC-296804)

GT 290A is the second stable cytoplasmic genic male sterile line of pigeonpea, *Cajanus cajan* developed at S.K. Nagar. It has been developed from a cross between *C. scarabaeoides* x *C. cajan,* wherein F_2 was back-crossed with GT 100, followed by repeated back-crossing with GT 290 until BC_8 generation. The screening for restorer has resulted in identification of a restorer line designated as GT 290B.

Morphologically, it has determinate growth habit with plant height ranging from 115-130 cm. It matures between 140 to 150 days and produces pods in bunch with an average of 150-180 pods per plant. The pods are 4 to 5 cm long, green in colour with black strip, while the seeds are red. Average number of seeds per pod is 4, and 100 seed weight is 10 g.

Fertility Restorer, GTR-3 (INGR No. 01026, IC 296805) for GT 288A

GTR-3 is a fertility restorer line identified for a stable cytoplasmic genic male sterile line GT 288A. It is a selection from SKNP-9902 and can be used for developing commercial hybrids.

Morphologically, it has non-determinate growth habit with plant height ranging from 140-150 cm. It matures between 130 to 140 days and produces pods in scattered fashion with an average of 162-180 pods per plant. The pods are 5 to 6 cm long and green in colour, while the seeds are white in colour. Average number of seeds per pod is 4, and 100 seed weight is 10 g.

Fertility Restorer, GTR-4 (INGR No. 01027, IC 296806) for GT 288A

GTR-4 is a fertility restorer line of stable cytoplasmic genic male sterile line GT 288A. It is a selection from SKNP-9813.

nutrients compared to spreading and late type checks (GMO-9102 and GMO-9103) and more or less the same or higher in comparison to erect but late type mutants in unfertilised rainfed arid lands (Table 1); depicting better nutritional partition towards sinks (Kumar, 1996). CZM-32, therefore, is a good example of fine source-sink relation in terms of nutritional partitioning and higher productivity.

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	Mean	**0.31**	**0.03**	**0.29**	**0.26**	**0.14**	**0.44**	**11.01**	**1.41**	**1.97**
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	Mean	**0.99**	**0.06**	**0.64**	**0.69**	**0.16**	**1.3**	**21.89**	**5.83**	**3.79**

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Morphologically, it has determinate growth habit with plant height ranging from 115-130 cm. It matures between 140 to 150 days and produces pods in bunch with an average of 150-180 pods per plant. The pods are 4 to 5 cm long, green in colour with black strip, while the seeds are red. Average number of seeds per pod is 4, and 100 seed weight is 10 g.

Fertility Restorer, GTR-3 (INGR No. 01026, IC 296805) for GT 288A

GTR-3 is a fertility restorer line identified for a stable cytoplasmic genic male sterile line GT 288A. It is a selection from SKNP-9902 and can be used for developing commercial hybrids.

Morphologically, it has non-determinate growth habit with plant height ranging from 140-150 cm. It matures between 130 to 140 days and produces pods in scattered fashion with an average of 162-180 pods per plant. The pods are 5 to 6 cm long and green in colour, while the seeds are white in colour. Average number of seeds per pod is 4, and 100 seed weight is 10 g.

Fertility Restorer, GTR-4 (INGR No. 01027, IC 296806) for GT 288A

GTR-4 is a fertility restorer line of stable cytoplasmic genic male sterile line GT 288A. It is a selection from SKNP-9813.

Morphologically, it has non-determinate growth habit with plant height ranging from 130-150 cm. It matures between 120 to 140 days and produces pods in scattered fashion with an average of 150-160 pods per plant. The pods are 6 to 7 cm long and green in colour, while the seeds are red in colour. Average number of seeds per pod is 5, and the 100 seed weight is 10.5 g.

Fertility Restorer, GTR-5 (INGR No. 01028, IC 296807) for GT 288A

GTR-5 is a fertility restorer line of stable cyptoplasmic genic male sterile line GT 288A. It has been developed from cross *C. scarabaeoides* x *C. cajan* followed by back-crossing of F_2 progenies with ICPL- 87119 until BC_6 generation.

Morphologically, it has non-determinate growth habit with plant height ranging from 140-150 cm. It matures between 160 to 180 days and produces pods in scattered fashion with an average of 170-180 pods per plant. The pods are 5 to 6 cm long and green in colour with black strips, while the seeds are red in colour. Average number of seeds per pod is 4, and 100 seed weight is 10 g.

Fertility Restorer, GTR-6 (INGR No. 01029, IC 296808) for GT 288A

GTR-6 is a fertility restorer line of stable cytoplasmic genic male sterile line GT 288A. It has been developed from cross *C. scarabaeoides* x *C. cajan* followed by back crossing of F_2 progenies with GT-100 and further back-crossing with GUT 88-9 until BC_8 generation.

Morphologically, it has non-determinate growth habit with plant height ranging from 170-180 cm. It matures between 150 to 160 days and produces pods in scattered fashion with an average of 180-200 pods per plant. The pods are 5 to 6 cm long and green in colour with dark strips, while the seeds are white in colour. Average number of seeds per pod is 4, and 100 seed weight is 8.5 g.

Fertility Restorer, GTR-2 (INGR No. 01030, IC 296809) for GT 288A

GTR-2 is a fertility restorer line of stable cytoplasmic genic male sterile line GT 288A. It has been developed from cross *C. scarabaeoides x C. cajan* followed by back crossing of F_2 progenies with QMS-2 until BC_8 generation.

Morphologically, it has non-determinate growth habit with plant height ranging from 125-140 cm. It matures between 160 to 180 days and produces pods in scattered fashion with an average of 170-180 pods per plant. The pods are 5 to 6 cm long and green in colour with black strips, while the seeds are brown in colour. Average number of seeds per pod is 4, and 100 seed weight is 9.5 g.

Foliar Disease Resistant Spanish Bunch, Derived from Interspecific Derivative of Groundnut

MVC Gowda, BN Motagi, GK Naidu, R Sheshagiri and SB Diddimani
Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwar (Karnataka)

GPBD 4 (INGR No. 01031, IC 296810)

GPBD 4 (D39d), (*Arachis hypogaea* L. Subsp. *hypogaea* var. *fastigiata*), is an improved Spanish bunch line resistant to late leaf spot [*Phaeoisariopsis personata* (Berk. & M. A. Curtis) Deighton] and rust (*Puccinia arachidis* Speg.). It was developed at the Department of Genetics and Plant Breeding, University of Agricultural Sciences, Dharwad. It scores 3.0 and 4.0 for rust and late leaf spot respectively on a 0-9 scale, compared to 8.0 and 9.0 for JL 24, a susceptible check at Dharwad. GPBD 4 is derived from a cross between KRG 1 (selection from cultivar Argentine), an early maturing, Spanish bunch and an interspecific derivative, CS16 (ICGV 86855) involving wild *Arachis* species, *A. cardenasii*, a virginia bunch foliar disease resistant interspecific derivative developed at International Crops Research Institute for Semi-Arid Tropics (ICRISAT). GPBD 4 was developed by pedigree selection method in F_2 generation.

GPBD 4 has erect growth habit and sequential branching with medium sized wide-elliptical dark green leaves (IBPGR and ICRISAT, 1992). On an average

Morphologically, it has non-determinate growth habit with plant height ranging from 130-150 cm. It matures between 120 to 140 days and produces pods in scattered fashion with an average of 150-160 pods per plant. The pods are 6 to 7 cm long and green in colour, while the seeds are red in colour. Average number of seeds per pod is 5, and the 100 seed weight is 10.5 g.

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GPBD 4 has erect growth habit and sequential branching with medium sized wide-elliptical dark green leaves (IBPGR and ICRISAT, 1992). On an average

it has four primary and two secondary branches and matures between 100-110 days. It has medium sized pods (22.3 and 8.9 mm average pod length and width) with slight reticulation and beak, and moderate constriction. The majority of pods are two-seeded with few one-seeded with an average shelling out-turn of 76%. The seeds are tan in colour with 100 seed weight of 42 g. The seeds contain 48% oil with a 1.76 oleic/ linoleic acid ratio (Motagi et al. 2000c). In trials conducted at three locations in northern transitional tract of Karnataka during the 1998, 1999 and 2000, crop seasons, GPBD 4 out-yielded the national check variety JL 24 for pod (16.0%), kernel (18.0%), oil (18.75%) and fodder (19.2%) yield (Motagi et al. 2001 and 2000a).

Further, it was also found free from early leaf spot (*Cercospora arachidicola* S. Hori) and moderately efficient in iron absorption efficiency (Motagi *et al.* 2000b).

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Motagi BN, MVC Gowda and SN Naidu 2000c) Oil recovery and quality as influenced by foliar diseases in groundnut. *International Arachis Newsletter*, **20**: 87-88.

Iron-chlorosis Tolerant Groundnut Line

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National Research Centre for Groundnut, Ivnagar Road, P. O. Box. 5, Junagadh-362 001 (Gujarat)

PBS-24004 (INGR No. 01032, IC 296811)

PBS 24004, is a high yielding elite groundnut, *Arachis hypogaea* L. subsp. *hypogaea* var. *hypogaea* germplasm line with tolerance to lime induced iron-deficiency. Screening for iron-chlorosis tolerance along with resistant and susceptible checks in calcareous soil having soil pH of 7.9, 29.6 per cent calcium carbonate, 6 ppm available P and 1.35 ppm available Fe at National Research Centre for Groundnut, Junagadh during summer 1999 resulted in identification of PBS 24004. The comparative data on visual chlorotic rating (VCR) on a 1 to 5 scale (1=tolerant and 5=susceptible) is given in the Table.

It was developed from a cross between Latur 33 and Tifrun, using combination of pedigree and bulk method. Tifrun (ICG 9937) is a released variety from USA belonging to *A. hypogaea* L. subsp. *hypogaea* var. *hypogaea*. Early generation were handled through pedigree selection and later generations through bulk method. From F_5 bulk, green plants were tagged, grouped and bulked based on similar plant type, pod, maturity and reaction to iron chlorosis. In subsequent generations similar process was followed until F_8 resulting in development of a stable, uniform advanced breeding culture, PBS 24004.

PBS 24004 has a decumbent–3 growth habit (IBPGR and ICRISAT 1992), alternate branching, with medium-sized, oblong, dark green leaves with acute leaf tip and moderate pubescence. It has six primary and 6-8 secondary branches. It matures in 115-120 days in the rainy season and 110-115 days in summer season. The pods are slightly reticulated, constricted and beaked. The average length and width of pod was 25 and 11 mm, respectively. The pods are mostly two-seeded with

Table 1. Visual chlorotic rating (VCR), chlorophyll a (Chl a) and total chlorophyll content (mg/g on dry weight basis) and pod yield of PBS 24004 compared checks

Culture name	VCR	Chl a (mg/g dwt)	Total chl (mg/g dwt)	Pod yield (g/plant)
PBS 24004	1.25	6.42	8.55	11.26
I_1 (tolerant check)	1.00	7.67	9.86	9.31
VRI 3 (susceptible check)	3.16	4.06	5.24	6.79

it has four primary and two secondary branches and matures between 100-110 days. It has medium sized pods (22.3 and 8.9 mm average pod length and width) with slight reticulation and beak, and moderate constriction. The majority of pods are two-seeded with few one-seeded with an average shelling out-turn of 76%. The seeds are tan in colour with 100 seed weight of 42 g. The seeds contain 48% oil with a 1.76 oleic/ linoleic acid ratio (Motagi et al. 2000c). In trials conducted at three locations in northern transitional tract of Karnataka during the 1998, 1999 and 2000, crop seasons, GPBD 4 out-yielded the national check variety JL 24 for pod (16.0%), kernel (18.0%), oil (18.75%) and fodder (19.2%) yield (Motagi et al. 2001 and 2000a).

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average shelling of 67%. The average length and width of seed was 13.3 and 7.6 mm, respectively. The seeds are tan coloured with average 100-seed weight of 67g. The seeds contain 49.6% oil and 18.2% protein.

Also, PBS 24004 is moderately resistant to early leaf spot (*Cercospora arachidicola* Hori) and rust (*Puccinia arachidis* Spegazzini) and scores 5.0 and 5.1 respectively on 1-9 scale under field conditions.

References

IBPGR and ICRISAT (1992) Descriptors for groundnut, IBPGR, Rome, Italy and ICRISAT, Patancheru, India 22p.

Narrow Leaf Mutant of Groundnut

RK Mathur, P Manivel, MY Samdur and A Bandyopadhyay
National Research Centre for Groundnut, Ivnagar Road, P.O. Box 5, Junagadh-362 001 (Gujarat)

Girnar 1 nlm (INGR No. 01033, IC 296812)

Girnar 1 nlm (PBS 30008) is a small narrow leaved groundnut, *Arachis hypogaea* L. ssp. *hypogaea* var. *hypogaea* mutant. This mutant was identified in M_2 generation of ethyl methane sulphonate (EMS) and diethyl sulphonate (DES) treated Spanish bunch groundnut cultivar, Girnar 1, *Arachis hypogaea* sub-species *fastigiata* var. *vulgaris* at National Research Centre for Groundnut, Junagadh. The mutant bred true in subsquent M_3 and M_4 generations and was designated as Girnar 1 nlm. The first four leaves are normal and the narrow leaflet character is manifested at fifth or sixth leaf stage of initial growth.

The genetics of narrow leaf trait was studied in F_1 and F_2 of the cross between Girnar 1 nlm and Girnar 1. In F_1 generation, all plants were similar to Girnar 1. In F_2 generation 189 plants had normal leaf and 66 had narrow leaf, fitting in the segregation ratio of 3 normal: 1 narrow leaf (c^2 value = 0.11 with P value ranging between 0.7 and 0.8). This indicated that a single recessive gene governs the narrow leaf character. The gene symbols for this character could be $\mathbf{I^N I^N}$ for normal leaf and $\mathbf{I^n I^n}$ for narrow leaf.

Girnar 1 nlm has erect growth habit (IBPGR and ICRISAT, 1992), alternate branching, and small sized linear lanceolate leaves with moderate pubescence. It has 5-6 primary and 6-8 secondary branches. It matures in 90-95 days in the rainy season in Junagadh, Gujarat, India. The pods are mostly three-seeded with shelling out turn of 64%. The pods have slight constriction, moderate reticulation and medium beak. The seeds are tan coloured with 100 seed weight 20 g, containing 49.6% oil. Compared to the parent, the narrow leaf mutant is dwarf with shorter internodes and more branching and peculiar small, narrow and pointed leaflets. Girnar 1 has Spanish, *Arachis hypogaea* ssp *fastigiata* var. *vulgaris* growth habit, while the mutant has a shift towards Virginia bunch growth habit, *Arachis hypogaea* ssp. *hypogaea* var. *hypogaea* (Table). The mutant is early in maturing, has low specific leaf area (SLA) and is moderately resistant to rust (*Puccinia arachidis*).

References

IBPGR and ICRISAT 1992. Descriptors for Groundnut, IBPGR, Rome Italy, and ICRISAT, Patancheru, India.

Table 1. Salient features of the Girnar 1 nlm mutant and its parent Girnar 1

Salient Characteristics	Girnar 1 nlm	Girnar 1
Growth habit	Virginia bunch	Spanish
Flowering habit	Alternate	Sequential
Height of main axis (cm)	9.30	15.30
Maximum branch height (cm)	10.90	20.30
Number of primary branches	4.00	4.07
Number of secondary branches	7.00	1.30
Number of nodes on main axis	9.90	9.90
Number of leaves per plant	80.00	43.00
Inter-nodal length (cm)	0.94	1.55
Leaflet length (cm)	2.00	3.50
Leaflet width (cm)	0.73	1.70
Petiole length (cm)	2.20	4.40
Specific leaf area (cm^2)	53.18	96.38
Days to maturity	90 days	100 days
Number of pods/plant	7.00	15.33
Number of seeds/plant	10.13	28.47
Pod length (cm)	1.20	3.20
Pod weight/plant (g)	2.86	10.39
Seed weight/plant (g)	1.77	6.05
100 seed weight (g)	20.00	29.00
Shelling out turn (%)	64.00	68.00

average shelling of 67%. The average length and width of seed was 13.3 and 7.6 mm, respectively. The seeds are tan coloured with average 100-seed weight of 67g. The seeds contain 49.6% oil and 18.2% protein.

Also, PBS 24004 is moderately resistant to early leaf spot (*Cercospora arachidicola* Hori) and rust (*Puccinia arachidis* Spegazzini) and scores 5.0 and 5.1 respectively on 1-9 scale under field conditions.

References

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Narrow Leaf Mutant of Groundnut

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The genetics of narrow leaf trait was studied in F_1 and F_2 of the cross between Girnar 1 nlm and Girnar 1. In F_1 generation, all plants were similar to Girnar 1. In F_2 generation 189 plants had normal leaf and 66 had narrow leaf, fitting in the segregation ratio of 3 normal: 1 narrow leaf (c^2 value = 0.11 with P value ranging between 0.7 and 0.8). This indicated that a single recessive gene governs the narrow leaf character. The gene symbols for this character could be $\mathbf{I^N I^N}$ for normal leaf and $\mathbf{I^n I^n}$ for narrow leaf.

Girnar 1 nlm has erect growth habit (IBPGR and ICRISAT, 1992), alternate branching, and small sized linear lanceolate leaves with moderate pubescence. It has 5-6 primary and 6-8 secondary branches. It matures in 90-95 days in the rainy season in Junagadh, Gujarat, India. The pods are mostly three-seeded with shelling out turn of 64%. The pods have slight constriction, moderate reticulation and medium beak. The seeds are tan coloured with 100 seed weight 20 g, containing 49.6% oil. Compared to the parent, the narrow leaf mutant is dwarf with shorter internodes and more branching and peculiar small, narrow and pointed leaflets. Girnar 1 has Spanish, *Arachis hypogaea* ssp *fastigiata* var. *vulgaris* growth habit, while the mutant has a shift towards Virginia bunch growth habit, *Arachis hypogaea* ssp. *hypogaea* var. *hypogaea* (Table). The mutant is early in maturing, has low specific leaf area (SLA) and is moderately resistant to rust (*Puccinia arachidis*).

References

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Number of nodes on main axis	9.90	9.90
Number of leaves per plant	80.00	43.00
Inter-nodal length (cm)	0.94	1.55
Leaflet length (cm)	2.00	3.50
Leaflet width (cm)	0.73	1.70
Petiole length (cm)	2.20	4.40
Specific leaf area (cm^2)	53.18	96.38
Days to maturity	90 days	100 days
Number of pods/plant	7.00	15.33
Number of seeds/plant	10.13	28.47
Pod length (cm)	1.20	3.20
Pod weight/plant (g)	2.86	10.39
Seed weight/plant (g)	1.77	6.05
100 seed weight (g)	20.00	29.00
Shelling out turn (%)	64.00	68.00

Lemon Yellow Colour Leaf Mutant of Groundnut

RK Mathur, P Manivel, MY Samdur and A Bandyopadhyay
National Research Centre for Groundnut, P.O. Box 5, Junagadh-362 001 (Gujarat)

Girnar 1 Lym (INGR No. 01034, IC 296813)

Girnar 1 lym (PBS 30017), *Arachis hypogaea* L. spp. *hypogaea* var. *vulgaris* is a lemon yellow colour leaf groundnut mutant. This mutant was identified in M_2 generation progeny of a Spanish bunch groundnut cultivar, Girnar 1, whose seeds were treated with 0.10% ethyl methane sulphonate (EMS) at National Research Centre for Groundnut, Junagadh. The mutant bred true in subsequent M_3 and M_4 generations and was designated as Girnar 1 lym. The lemon yellow colour leaf started expressing from fourth to fifth leaf stage onwards and continued till maturity, resulting in lemon yellow appearance of the plant.

Based on F_2 generation segregation of the cross between Girnar 1 lym and Girnar 1, this trait appears to be governed by a monogenic recessive gene (Table 1). The gene symbols proposed are **Ly** for green and **ly** for lemon yellow.

Girnar 1 lym has erect growth habit (NBPGR and ICRISAT, 1992), sequential branching, and medium sized wide elliptic lemon yellow colour leaves. It has 6 primary and occasionally 1-2 secondary branches. It matures in 95 days in the rainy season at Junagadh, Gujarat, India. The pods are mostly three-seeded, with shelling out turn of 75%. The pods have slight constriction, moderate reticulation and medium beak. The seeds are tan colour with 100 seed weight of 37g and contain 47% oil and 13% protein. Based on field screening during two rainy seasons, Girnar 1 lym is moderately resistant/tolerant to early leaf-spot, late leaf-spot, and rust scoring 5 on 1-9 scale.

Table 1. F_2 segregation of lemon yellow leaf trait in cross, Girnar 1 lym x Girnar 1

Families	Number of F_2 phenotypes*			χ^2 (3:1 ratio)	Probability
	Normal green	Lemon yellow	Total		
1.	58	15	73	0.7717	0.5-0.3
2.	47	13	60	0.3556	0.7-0.5
3.	76	20	96	0.8889	0.5-0.3
4.	60	19	79	0.3890	0.9-0.8
5.	30	11	41	0.0732	0.8-0.7
6.	52	17	69	0.0048	0.95-0.9
Pooled	323	95	418	1.1515	0.3-0.2
Hetero-geneity	–	–		0.9806	0.95-0.90

*F_1 had normal green leaves like male parent, Girnar 1

Vegetable Type Soybean

VD Verma
National Bureau of Plant Genetic Resources (NBPGR), Regional Station, Phagli, Shimla-171 004 (Himachal Pradesh)

P-1366 (INGR No. 01035, IC 296814)

P-1366 is a vegetable type bold seeded soybean, *Glycine max* L. Merr. collected during 1988 by Mr. KC Pant, NBPGR, Regional Station, Bhowali from Pithoragarh district of Uttar Pradesh (Now Uttaranchal). P-1366 has determinate growth habit with thick dark green leaves. The plant height is 30-35 cm at Bhowali and 35-40 cm at Akola. It has tawny pubescence with normal density and white flowers. It flowers between 32-34 days at Bhowali and 30-32 at Akola and matures between 105-108 days. It has thick brown pods containing 2-3 seeds/pod. The seeds are creamish yellow with black hilum and contain 20.13% oil and 40.20% protein on dry weight basis. It was evaluated at NBPGR, Regional Station, Akola, Maharashtra (1991-1997) and at Bhowali (1988-2000) for agronomic features. Grain yields of 18-22 q/ha with bold seeds were recorded. The seeds are sweet in taste and have no beany flavour during pod filling stage. Hundred seed weight is 44-46 g at Akola and 36-38 g at Bhowali.

Lemon Yellow Colour Leaf Mutant of Groundnut

RK Mathur, P Manivel, MY Samdur and A Bandyopadhyay
National Research Centre for Groundnut, P.O. Box 5, Junagadh-362 001 (Gujarat)

Girnar 1 Lym (INGR No. 01034, IC 296813)

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Based on F_2 generation segregation of the cross between Girnar 1 lym and Girnar 1, this trait appears to be governed by a monogenic recessive gene (Table 1). The gene symbols proposed are **Ly** for green and **ly** for lemon yellow.

Girnar 1 lym has erect growth habit (NBPGR and ICRISAT, 1992), sequential branching, and medium sized wide elliptic lemon yellow colour leaves. It has 6 primary and occasionally 1-2 secondary branches. It matures in 95 days in the rainy season at Junagadh, Gujarat, India. The pods are mostly three-seeded, with shelling out turn of 75%. The pods have slight constriction, moderate reticulation and medium beak. The seeds are tan colour with 100 seed weight of 37g and contain 47% oil and 13% protein. Based on field screening during two rainy seasons, Girnar 1 lym is moderately resistant/tolerant to early leaf-spot, late leaf-spot, and rust scoring 5 on 1-9 scale.

Table 1. F_2 segregation of lemon yellow leaf trait in cross, Girnar 1 lym x Girnar 1

Families	Number of F_2 phenotypes*			χ^2 (3:1 ratio)	Probability
	Normal green	Lemon yellow	Total		
1.	58	15	73	0.7717	0.5-0.3
2.	47	13	60	0.3556	0.7-0.5
3.	76	20	96	0.8889	0.5-0.3
4.	60	19	79	0.3890	0.9-0.8
5.	30	11	41	0.0732	0.8-0.7
6.	52	17	69	0.0048	0.95-0.9
Pooled	323	95	418	1.1515	0.3-0.2
Hetero-geneity	–	–		0.9806	0.95-0.90

*F_1 had normal green leaves like male parent, Girnar 1

Vegetable Type Soybean

VD Verma
National Bureau of Plant Genetic Resources (NBPGR), Regional Station, Phagli, Shimla-171 004 (Himachal Pradesh)

P-1366 (INGR No. 01035, IC 296814)

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P-1366 is resistant to yellow mosaic virus and moderately resistant to bacterial pustules (*Xanthomonas campestris*), but susceptible to pod blight (*Colletotrichum dematium*). Being bold seeded it has poor seed storability.

Table 1. Nutritional profile of P1336 compared with nationally released varieties

Cultivars	100-seed weight (g)	Oil (%)	Protein (%)	Major fatty acids				
				Palmitic	Stearic	Oleic	Linoleic	Linolenic
PK-416	10.20	20.88	41.60	10.88	4.13	23.85	52.80	6.98
Pusa 16	12.50	19.45	41.68	11.20	3.60	19.58	54.57	7.82
P 1336	36.38	20.13	40.20	10.29	3.33	24.89	50.75	8.12

Crotolaria Germplasm

N R Das, N Ghosh, S Mitramajumdar and D Panda
Agronomy/Seed Science & Technology Department, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur-741 252 (West Bengal)

Bidhan Shan (INGR No. 01036, IC 296815)

Bidhan Shan is an improved self-compatible sunnhemp, *Crotolaria juncea* L. germplasm developed at Bidhan Chandra Krishi Viswavidyalaya, West Bengal. It was selected from the bulk seed obtained from local market (Chinsurah, West Bengal) and was further improved and fixed by the repeated bulk selection method (1998-99 and 1999-2000).

In April/May planting, the stem height of Bidhan Shan is 3.3 m with less branches and flowers, while in rabi planting, the stem height is about 1 m with higher number of branches and more number of flowers per branch. It requires 60 days for green manure and 120 days for fibre production in summer planting, while 125-130 days in *rabi* planting for seed production. It possesses kidney shaped glossy blackish coloured seeds, with 1000-seed weight of about 25-30 g. It can smother the weeds in field. In yield trials conducted at BCKV Farm, Kalyani (1997-98) Bidhan Shan out yielded ST 55, by nearly 200% with an average seed yield of 6.2 quintal and stover yield of 33.3 q/ha.

This germplasm is highly resistant to diseases and pests and could be cultivated as a *paira/utera* crop in rice-fallows. Also, it can be utilized as annual bast fibre, fodder and green manure crop in the drier areas.

Watermelon Germplasm

JP Luthra and VS Yadav
Melon Scheme, Department of Horticulture, Agriculture Research Station, Durgapura, Jaipur-18 (Rajasthan)

Yellow Flesh Watermelon, RW 187-2 (INGR No. 01037, IC 296816)

Watermelon 'RW 187-2' has been selected from the local germplasm material available at Agriculture Research Station, Durgapura, Jaipur. Individual plant progenies were advanced to establish the pure line. The vines are 2.5-3 meters long. It takes 105-110 days for first picking. The fruits are oval, light green with dark linings on rind, with yellow/saffron colour flesh and white colour medium sized seeds. Sweetness is 9-11 per cent and average fruit weight is 3-5 kg. Fruit yield is 350-500 q/ha, 56.10 per cent higher than the best checks, Sugarbaby (local check) and Arkamanik (national check) in trials conducted under All India Co-ordinated Vegetable Improvement Project (Table). RW 187-2 is suited to well drain sandy loam soil. RW 187-2 is moderately resistant to powdery mildew and blight under field conditions.

P-1366 is resistant to yellow mosaic virus and moderately resistant to bacterial pustules (*Xanthomonas campestris*), but susceptible to pod blight (*Colletotrichum dematium*). Being bold seeded it has poor seed storability.

Table 1. Nutritional profile of P1336 compared with nationally released varieties

Cultivars	100-seed weight (g)	Oil (%)	Protein (%)	Major fatty acids				
				Palmitic	Stearic	Oleic	Linoleic	Linolenic
PK-416	10.20	20.88	41.60	10.88	4.13	23.85	52.80	6.98
Pusa 16	12.50	19.45	41.68	11.20	3.60	19.58	54.57	7.82
P 1336	36.38	20.13	40.20	10.29	3.33	24.89	50.75	8.12

Crotolaria Germplasm

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Agronomy/Seed Science & Technology Department, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur-741 252 (West Bengal)

Bidhan Shan (INGR No. 01036, IC 296815)

Bidhan Shan is an improved self-compatible sunnhemp, *Crotolaria juncea* L. germplasm developed at Bidhan Chandra Krishi Viswavidyalaya, West Bengal. It was selected from the bulk seed obtained from local market (Chinsurah, West Bengal) and was further improved and fixed by the repeated bulk selection method (1998-99 and 1999-2000).

In April/May planting, the stem height of Bidhan Shan is 3.3 m with less branches and flowers, while in rabi planting, the stem height is about 1 m with higher number of branches and more number of flowers per branch. It requires 60 days for green manure and 120 days for fibre production in summer planting, while 125-130 days in *rabi* planting for seed production. It possesses kidney shaped glossy blackish coloured seeds, with 1000-seed weight of about 25-30 g. It can smother the weeds in field. In yield trials conducted at BCKV Farm, Kalyani (1997-98) Bidhan Shan out yielded ST 55, by nearly 200% with an average seed yield of 6.2 quintal and stover yield of 33.3 q/ha.

This germplasm is highly resistant to diseases and pests and could be cultivated as a *paira/utera* crop in rice-fallows. Also, it can be utilized as annual bast fibre, fodder and green manure crop in the drier areas.

Watermelon Germplasm

JP Luthra and VS Yadav
Melon Scheme, Department of Horticulture, Agriculture Research Station, Durgapura, Jaipur-18 (Rajasthan)

Yellow Flesh Watermelon, RW 187-2 (INGR No. 01037, IC 296816)

Watermelon 'RW 187-2' has been selected from the local germplasm material available at Agriculture Research Station, Durgapura, Jaipur. Individual plant progenies were advanced to establish the pure line. The vines are 2.5-3 meters long. It takes 105-110 days for first picking. The fruits are oval, light green with dark linings on rind, with yellow/saffron colour flesh and white colour medium sized seeds. Sweetness is 9-11 per cent and average fruit weight is 3-5 kg. Fruit yield is 350-500 q/ha, 56.10 per cent higher than the best checks, Sugarbaby (local check) and Arkamanik (national check) in trials conducted under All India Co-ordinated Vegetable Improvement Project (Table). RW 187-2 is suited to well drain sandy loam soil. RW 187-2 is moderately resistant to powdery mildew and blight under field conditions.

P-1366 is resistant to yellow mosaic virus and moderately resistant to bacterial pustules (*Xanthomonas campestris*), but susceptible to pod blight (*Colletotrichum dematium*). Being bold seeded it has poor seed storability.

Table 1. Nutritional profile of P1336 compared with nationally released varieties

Cultivars	100-seed weight (g)	Oil (%)	Protein (%)	Major fatty acids				
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Pusa 16	12.50	19.45	41.68	11.20	3.60	19.58	54.57	7.82
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Crotolaria Germplasm

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Bidhan Shan (INGR No. 01036, IC 296815)

Bidhan Shan is an improved self-compatible sunnhemp, *Crotolaria juncea* L. germplasm developed at Bidhan Chandra Krishi Viswavidyalaya, West Bengal. It was selected from the bulk seed obtained from local market (Chinsurah, West Bengal) and was further improved and fixed by the repeated bulk selection method (1998-99 and 1999-2000).

In April/May planting, the stem height of Bidhan Shan is 3.3 m with less branches and flowers, while in rabi planting, the stem height is about 1 m with higher number of branches and more number of flowers per branch. It requires 60 days for green manure and 120 days for fibre production in summer planting, while 125-130 days in *rabi* planting for seed production. It possesses kidney shaped glossy blackish coloured seeds, with 1000-seed weight of about 25-30 g. It can smother the weeds in field. In yield trials conducted at BCKV Farm, Kalyani (1997-98) Bidhan Shan out yielded ST 55, by nearly 200% with an average seed yield of 6.2 quintal and stover yield of 33.3 q/ha.

This germplasm is highly resistant to diseases and pests and could be cultivated as a *paira/utera* crop in rice-fallows. Also, it can be utilized as annual bast fibre, fodder and green manure crop in the drier areas.

Watermelon Germplasm

JP Luthra and VS Yadav
Melon Scheme, Department of Horticulture, Agriculture Research Station, Durgapura, Jaipur-18 (Rajasthan)

Yellow Flesh Watermelon, RW 187-2 (INGR No. 01037, IC 296816)

Watermelon 'RW 187-2' has been selected from the local germplasm material available at Agriculture Research Station, Durgapura, Jaipur. Individual plant progenies were advanced to establish the pure line. The vines are 2.5-3 meters long. It takes 105-110 days for first picking. The fruits are oval, light green with dark linings on rind, with yellow/saffron colour flesh and white colour medium sized seeds. Sweetness is 9-11 per cent and average fruit weight is 3-5 kg. Fruit yield is 350-500 q/ha, 56.10 per cent higher than the best checks, Sugarbaby (local check) and Arkamanik (national check) in trials conducted under All India Co-ordinated Vegetable Improvement Project (Table). RW 187-2 is suited to well drain sandy loam soil. RW 187-2 is moderately resistant to powdery mildew and blight under field conditions.

Table 1. Performance of RW 187-2 in station (1989-95) and in coordinated (1992-96) trials

S. No	Selected entries	Station trials (1989-91, 95)	Co-ordinated trials (1992-96)	Pooled	Per cent increase in trials				
					Station	Co-ordinated	Pooled mean		Average
1	RW-187-2	401.09 (4)	271.48 (15)	336.28	116.65	18.26	23.56	56.1	53.06
2	Sugarbaby	185.13 (4)	229.50 (15)	215.43	00.00	0.00	-	00.0	-
3	Arkamanik	-	219.71 (15)	219.71	-	-	00.00	-	00.0

Figures in parenthesis are number of locations

Simple Un-lobed Leaf Watermelon, RW 177-3 (INGR No. 01038, IC 296817)

Watermelon RW 177-3 (Durgapura Lal), was a selection from segregating population of a cross between Sugarbaby and K-3566, a Russian culture at A.R.S. Durgapura, Jaipur. The vines are 3.0–3.5 meters long. The leaves are simple and un-lobed unlike other varieties. The fruits are round, dark green with darker linings and thin and hard skin. The flesh is dark red in colour with 10–11% sugar. The fruit size is medium, weighing 4 to 5 Kg and easy to transport. It takes 110 days for first picking. The seeds are less in number, small and brown in colour with black spots. The 1000 seed weight is 44g. Fruit yield is 350-450 q/ha, 27 per cent higher over the best national check, Arkamanik and 41 per cent over the local check, Sugarbaby (Table). The portion of fruit that touches the ground turns pale yellow on maturity. It is suitable for irrigated areas.

Table 1. Performance of watermelon culture RW-177-3 in station trials

S. No.	Cultures	Yield (q/ha) 1995	Pooled Mean 1996	1997	1998	2001	Percent Increase over Sugarbaby	Arkamanik	
1	RW-177-3	381.94 (8.5)	355.55 (11.0)	327.77 (11.00)	462.47 (10.5)	369.75 (11.0)	379.50 (10.40)	40.94	26.72
2	Sugarbaby (Local check)	236.11 (9.0)	224.00 (9.0)	224.07 (9.5)	338.87 (9.5)	323.30 (10.50)	269.27 (9.50)	-	-
3	Arkamanik (National check)	222.03 (8.0)	327.78 (9.0)	214.81 (9.0)	433.30 (9.5)		299.40 (8.67)	-	-
	CD at 5%	47.57	62.25	37.65	20.22	27.54			
	CV (%)	12.01	11.86	8.36	3.22	6.28			

Figures in parenthesis are total soluble sugar in per cent.

Hybrid Coffee Germplasm

RL Narasimhaswamy and S Vishveshwara, M Ramchandran and VB Suresh Kumar
Central Coffee Research Institute, Coffee Research Station, Post 577 177, Chikmagalur District (Kerala)

Genus *Coffea* of the family Rubiaceae contains about 100 species of which two are commercially cultivated namely *Coffea arabica* L. (arabica coffee) and *C. canephora* Pierre ex Froehner (robusta coffee). Most of the species are native of Africa. *C. arabica* was introduced to India in 1600 A.D. and *C. canephora* in about 1900 A.D. Arabica is the only allotetraploid in this genus with 2n=44 and is predominantly self-pollinated, while *C. canephora* is diploid (2n=22) and an obligate cross-pollinator. After the establishment of Central Coffee Research Institute (CCRI) in 1925 near Chikmagalur in Karnataka, organised research on coffee breeding was undertaken and several new genotypes of arabica and robusta were developed and established through inter-specific hybridisation. The seeds of these genotypes were distributed for cultivation.

A Compact Hybrid of Coffee, Congensis x Robusta (INGR No. 01039, IC 296818)

It is an interspecific hybrid between *Coffea congensis*, Froehner and *C. canephora* cv. S-274 robusta, developed by back crossing to *C. canephora* followed by pedigree selection and sib-mating. It is compact, bush type with shorter internodes than robusta and drooping to semi-

Table 1. Performance of RW 187-2 in station (1989-95) and in coordinated (1992-96) trials

S. No	Selected entries	Station trials (1989-91, 95)	Co-ordinated trials (1992-96)	Pooled	Per cent increase in trials				
					Station	Co-ordinated	Pooled mean		Average
1	RW-187-2	401.09 (4)	271.48 (15)	336.28	116.65	18.26	23.56	56.1	53.06
2	Sugarbaby	185.13 (4)	229.50 (15)	215.43	00.00	0.00	-	00.0	-
3	Arkamanik	-	219.71 (15)	219.71	-	-	00.00	-	00.0

Figures in parenthesis are number of locations

Simple Un-lobed Leaf Watermelon, RW 177-3 (INGR No. 01038, IC 296817)

Watermelon RW 177-3 (Durgapura Lal), was a selection from segregating population of a cross between Sugarbaby and K-3566, a Russian culture at A.R.S. Durgapura, Jaipur. The vines are 3.0–3.5 meters long. The leaves are simple and un-lobed unlike other varieties. The fruits are round, dark green with darker linings and thin and hard skin. The flesh is dark red in colour with 10–11% sugar. The fruit size is medium, weighing 4 to 5 Kg and easy to transport. It takes 110 days for first picking. The seeds are less in number, small and brown in colour with black spots. The 1000 seed weight is 44g. Fruit yield is 350-450 q/ha, 27 per cent higher over the best national check, Arkamanik and 41 per cent over the local check, Sugarbaby (Table). The portion of fruit that touches the ground turns pale yellow on maturity. It is suitable for irrigated areas.

Table 1. Performance of watermelon culture RW-177-3 in station trials

S. No.	Cultures	Yield (q/ha) 1995	Pooled Mean 1996	1997	1998	2001	Percent Increase over Sugarbaby	Arkamanik	
1	RW-177-3	381.94 (8.5)	355.55 (11.0)	327.77 (11.00)	462.47 (10.5)	369.75 (11.0)	379.50 (10.40)	40.94	26.72
2	Sugarbaby (Local check)	236.11 (9.0)	224.00 (9.0)	224.07 (9.5)	338.87 (9.5)	323.30 (10.50)	269.27 (9.50)	-	-
3	Arkamanik (National check)	222.03 (8.0)	327.78 (9.0)	214.81 (9.0)	433.30 (9.5)		299.40 (8.67)	-	-
	CD at 5%	47.57	62.25	37.65	20.22	27.54			
	CV (%)	12.01	11.86	8.36	3.22	6.28			

Figures in parenthesis are total soluble sugar in per cent.

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drooping branches. Thirty to 50 fruits occur at each node in tight clusters, which are orange to crimson red in colour with prominent and projected nanel. The fruits are bold in size with protruding honey disc. Seeds are bold giving 60 per cent 'A' type grade (retained on 6.65 mm screen). Cup quality is superior to robusta with soft neutral and light acidity, which is normally absent in other robustas. It is cross-pollinated and seeds are produced by inducing blossom through irrigation in seed blocks. Most of the plants are resistant to leaf rust with tolerance to drought.

Leaf Rust Resistant Arabica Coffee Selections

RL Narasimhaswamy and S Vishveshwara
Central Coffee Research Institute, Coffee Research Station, Post 577 177, Chikmagalur District (Kerala)

S.795 (INGR 01040, IC 296819)

S. 795, is a selection from the F_2 progenies of a cross between S. 288 and Kent's arabica, both of which have originated in India. Majority of plants show resistance to common races I and II of leaf rust caused by *Hemileia vastatrix*. S 795 is characterised by vigorous growth, spreading habit and profuse cropping wood. The internodes are short being 1.5 – 3.5 inches long. Leaves are linear-oblong, thick and leathery, dark green and shining with prominent wavy margin, and longish acuminate apex. Fruits are borne in thick clusters. Seeds are oblong, bold with small to broad navel and 60-65 per cent 'A' grade. Yields vary from 1000 to 2000 kg/ha with an all India average of 975 Kg/ha. It is predominantly self-pollinated.

Leaf Rust Resistant Arabica Selections, 5B (INGR No. 01041, IC 296820)

5B (S. 2931 & S. 4422), is a selection identified from a cross between S 333 and Devamachy hybrid. Devamachy is a spontaneous Indian hybrid originated from a cross, robusta x arabica. For development of this genotype pedigree method was practised from F_2 to F_5 and progenies showing uniformity for bush, vigour and resistance to leaf rust caused by *Hemileia vastatrix* was selected. The bush has medium internodes, spreading primaries with dark green broad elliptic leaves, and bronze apex. Fruits are medium bold, squarish with flush and small honey disc. Seeds are medium bold. Yield potential is 1500 Kg/ha. Pollination is predominantly autogamous.

Self-Pollinating Hybrid, Selection 6 (INGR No. 01042, IC 296821)

Selection 6 is a hybrid selected from an interspecific cross between between *C.canephora* cv. S 274 (robusta) and *C. arabica* Kent. backcrossed twice with arabica. The third generation progeny from BC_2 showed better uniformity for bush size and vigour; with high resistance to leaf rust caused by *Hemileia vastatrix*, with yield, bean size and cup quality similar to arabica. Chromosome number is 2n=44. Yield potential is 1000 to 1500 Kg/ha and pollination is predominantly autogamous.

Drought Tolerant Selection 7.3 (INGR No. 01043, IC 296822)

The selection 7.3, is an interspecific hybrid evolved out of step by step crossing first between San Ramon (dwarf mutant of arabica isolated in Colombia and introduced into India from Guatemala in 1953) and S.795, followed by crosses with Agaro and Hibrido-de-Timor in subsequent steps to improve leaf rust resistance. It is tolerant to drought. It segregated into 70 per cent dwarfs and 30 per cent tall. Dwarfs can be used for closer planting (1.5 x 1.5 m). The plant height is 2 m, internodes are extremely short with lateral branches of reduced length, and leaves are wide elliptic and dark green. Also, it is resistant to drought and produces fruits with delayed ripening. Suited to low rainfall areas, its yield potential 1000-1500 Kg/ha.

Drought Tolerant Selection 9 (INGR No. 01044, IC 296823)

The selection has evolved out of cross between Hibrido-de-Timor (a natural hybrid of robusta x arabica from Timor, introduced to India from Portugal in 1967) and Tafarikela, an Ethiopian arabica. This was an F_3 progeny showing high uniformity. The plants are tall, vigorous with drooping to spreading branches. Internodal distance is more in spreading type. Fruits are bold with often persistent calyx. It is an early ripening variety and

drooping branches. Thirty to 50 fruits occur at each node in tight clusters, which are orange to crimson red in colour with prominent and projected nanel. The fruits are bold in size with protruding honey disc. Seeds are bold giving 60 per cent 'A' type grade (retained on 6.65 mm screen). Cup quality is superior to robusta with soft neutral and light acidity, which is normally absent in other robustas. It is cross-pollinated and seeds are produced by inducing blossom through irrigation in seed blocks. Most of the plants are resistant to leaf rust with tolerance to drought.

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produces 60 to 65 percent 'A' grade beans, which are bold in size and bettering cup quality. This selection has good drought tolerance with resistance to common races I and II of leaf rust caused by *Hemileia vastatrix* It is predominantly self-pollinated and yields 1200-1500 Kg/ha.

Novel Non-Narcotic Poppy

JR Sharma, RK Lal, AP Gupta, HO Misra and V Pant
Central Institute of Medicinal and Aromatic Plants, (Central Institute for Medicinal and Aromatic Plants (CIMAP), Lucknow-226 015 (Uttar Pradesh)

Sujata (INGR No. 01045, IC 296824)

An opium-less, alkaloid-free (non-narcotic) var. *Sujata* (LL34) of opium poppy (*Papaver somniferum*) was developed for the first time at CIMAP, Lucknow. It is a fine example of genetic conversion of a narcotic crop, like 'opium' poppy into non-narcotic 'seed' poppy. It does not exude latex (raw opium) on lancing (incision) of the capsule (Fig. 1). The straw (capsule hull) is also free from opium alkaloids, viz. morphine, codeine, thebaine and papaverine, etc.

It was developed by mutation breeding through a combined mutagenic treatment of 20 Kr gamma rays and 0.4 per cent Ethyl Methane Sulphonate on the high opium yielding parental strain, Mass-2B (var. *Sampada*). A latex-less mutant, LL34 was detected by 'ray-pluck' method (JR Sharma *et al.*, 1999) in M_2 generation, stabilized by M_7 generation and was finally re-christened as var. *Sujata*. The table summarises the morphological features of the mutant. It was evaluated for seed yield and non-latex production in initial evaluation (replicated, paired rows), bench scale (replicated, 5 x 3m plot size), and pilot scale trial (200 m^2 plot size) at Central Institute of Medicinal and Aromatic Plants for three years; giving 10-20 per cent higher seed yield (Table 1) than parent.

References

Sharma JR, RK Lal, AP Gupta, HO Misra, V Pant, NK Singh and V Pandey (1999) *Plant Breeding* (Berlin) **118**:449-452.

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Table 1. The comparative features of *Sujata* and its parent Mass-2B

S. No.	Quali-quantitative traits	Sujata	Mass-2B
1.	Days to mid-flowering	100-105	100-104
2.	Plant height (cm)	80-100	85-110
3.	Capsule surface	Glabrous	Waxy
4.	Number of stigmatic rays per capsule	10-12	12-14
5.	Latex-flow on incision	Absent	Profuse
6.	Alkaloids in straw (capsule hulls)	Absent	Present
7.	Seed count per g of weight	3040-3310	4410-4520
8.	Seed size	Bold	Medium
9.	Estimated average seed yield (q/ha)	8-10	7-8
10.	Protein content in seeds (%)*	24.0	24.5
11.	Oil content in seeds (%)*	58.9	59.4
12.	Oleic + Linoleic fatty acids in oil (%)*	82.1	81.1
13.	Ca in seeds (mg/100g)*	1702	1213
14.	Fe in seeds (mg/100g)*	9.5	7.9
15.	Mg in seeds (mg/100g)*	405	286

*Analysed by ESAQC Lab., Central Food Technology Research Institute, Mysore

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Early Rice

SN Chakrabarti
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Jaldi Dhan 8 (INGR No. 01046, IC 296825)

Jaldi Dhan 8 is an extra early (80 days), medium tall upland rice, developed from cross between mutants Dular and N-22, having marked tolerance to moisture stress and coastal salinity. It is an improved plant type of medium tall stature with extra-early maturity, long glume opening period and ability to maintain cytoplasmic male sterility with wide abortiveness, making it a potential parent for hybrid rice breeding involving tropical japonica restorers. Also, it has been identified as an improved source for wide compatibility gene (WCG) to overcome sterility barriers in crosses between indica and japonica.

Table 1. Grain yield (q/ha) of Jaldi Dhan 8 under co-ordinated trials (1988-1991)

Variety	Direct seeded rainfed	Transplanted	Direct seeded irrigated
Jaldi Dhan 8	17.35 (60)*	32.29	38.19
Checks			
Sattari	12.89 (54)	24.03	–
Heera	15.93 (54)	20.59	17.51
Aditya	8.76 (68)	29.45	22.88

* days to 50% flowering

It is widely adapted to rainfed upland situation that has low inherent fertility status and frequent droughts. It possesses tolerance for Brown spot disease and pests like Gall midge biotype I, and leaf folder.

Powdery Mildew Resistant Hybrid, Hexaploid Triticale x Bread Wheat

GS Sethi and P Plaha
Biotechnology Centre, Chaudhury Saran Kumar Himachal Pradesh Krishi Vishwavidhyalaya (CSKHPKV), Palampur-176 062 (Himachal Pradesh)

RL 22 (INGR No. 01047, IC 296896)

One hundred true-breeding derivatives of triticale (X *Triticosecale* Wittmack, 2n=6x-42) x bread wheat (*Triticum aestivum* L. m. Thell, 2n=6x-42) were screened for their reaction against powdery mildew (*Erysiphe graminis* DC. Ex Merat f. sp. *tritici*), at the Himachal Pradesh Krishi Vishva Vidyalaya, Palampur and its regional research station, Kukumseri (Lahaul valley). One derivative, RL 22, was found to be free from powdery mildew. It has been maintaining its resistance since 1983.

Twenty-one diverse single-colony cultures of *Egt*, collected from North India, were used to characterize the resistance in RL 22. Seventeen lines/cultivars with known resistance genes and RL 22 was subjected to infection-typing technique. The RL 22 was resistant to all the cultures, but due to the non-differential response, the resistance gene could not be ascertained. Based upon the reaction of different cultures, it is inferred that the resistance gene in RL 22 is other than Pm 2, Pm 3a, Pm 3b, Pm 3c, Pm 4a, Pm 5, Pm 6, Pm 7, Pm 8, Pm (Ma), Pm 17 and Pm 20. All the 25 genes reported for powdery mildew resistance in wheat (McIntosh *et al.* 1998) are dominant, except Pm 5. In RL 22, the inheritance pattern of powdery mildew resistance revealed the presence of a single recessive gene governing resistance. Allelic test revealed that the resistance gene in RL 22 is different from Pm 5. Meiotic analysis of the F_1 of RL 22 with normal 42-chromosome wheat and *in situ* hybridisation pattern of mitotic metaphase chromosomes of RL 22 using labeled total genomic DNA as probe showed the presence of a pair of rye (*Secale cereale* L., 2n=2x=14) chromosomes. The C-binding analysis revealed this rye chromosome to be 6R, substituting the corresponding homoeologue 6D. This substituting rye chromosome might be imparting resistance to powdery mildew.

RL 22 is semi-spreading type with dark green, coarse leaves, pubescent glumes, late maturing, and has red and laterally compressed grains. However, considering a wide range of resistance to *Egt* isolates of northern India, RL 22, having a new resistance gene, can potentially be involved in the hybridisation programme to broaden the genetic base of wheat cultivars and impart a wide

Early Rice

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spectrum of resistance to powdery mildew.

The derivative was also free from the disease at the seedling stage as ascertained by inoculating with single-colony cultures of *Egt*. The triticale parent 'TL 68' of this line was free from powdery mildew, whereas, the bread wheat parent 'Shailaja' was susceptible.

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Early Maturing Gobhi Sarson

SP Landge

Botany Department, Nagpur University, Nagpur and National Dairy Development Board (NDDB), Anand, Gujarat

The exotic double zero cultivars of Gobhi sarson (*Brassica napus*) introduced in India are very late. These cultivars are not suitable for cultivation in mustard growing areas of the country. Therefore, an induced mutation-breeding programme was initiated to develop early maturing double zero genotypes suitable to agro-climatic conditions of the country.

NUDB-38 (INGR No. 01048, IC 296827)

NUDB-38 is an early maturing mutant of exotic Canadian variety Westar (*B. napus* L.) developed at the Botany Department, Nagpur University, Nagpur. Seeds of variety Westar of '00' quality (12 m moles/g seed and less than 1% erucic acid) were treated with sodium azide (pre-soaked in water for 12 hrs followed by Sodium azide, 0.06 % for 6 hrs). In M_2 generation 12 early flowering and maturing plants were isolated. They were subsequently tested for breeding behaviour. In M_3 generation, selection NUDB-38 was isolated from one of the mutants with early maturity (Table 1).

NUDB-38 has ovate dark green leaves, glabrous white coating, and undulate margin and dentations. Petiole is grooved with leafy wings at the base. Seed coat colour is blackish dark brown. Scanning Electron Microscopy showed two types of reticulation i.e., primary and secondary and pits shallow and circular in shape. It has shown early maturity across the locations. The '00' quality characters are similar to that of the parent variety 'Westar' (0 erucic acid with glucosinolate about 9.4 m moles/g of seed). Under multi-location trial in 1988-99 it gave an average yield of 1815 kg/ha as against 1319 kg/ha of HPN-3 and 1838 kg/ha of Pusa Bold and 1940 kg/ha of Varuna (Table 2).

Table 1. Salient characteristics of NUDB-38 compared to its parent

Genotype	Height (cm)	50% flowering (days)	Maturity (days)	1000-seed weight (g)	Reaction to disease
NUDB-38	109.6± 2.2	49.0± 2.0	110.0± 3.0	4.0 ± 0.39	Resistant to white rust
Westar	129.0 ± 2.2	75.0 ± 3.0	169.0± 3.0	4.2 ± 0.22	Resistant to white rust

Table 2. Yield data of NUDB-38 under multi-location trial

Line	Salon	Mehsana	Nagpur	Bharatpur-I	Bharatpur-II	Chandigarh	Anand	Gwalior	Delhi	Average
NUDB-38	1765	1760	936	1212	1904	1892	2209	2863	1797	1815
Varuna	1067	2132	908	1616	1942	1164	3246	3305	2082	1940
Pusa Bold	1032	1662	1080	1122	2079	1235	3304	3051	1980	1838
HPN-3	680	555	515	755	1887	1649	1894	1960	1976	1319

NUDB-42 (INGR No. 01049, IC 01050)

NUDB-42 is an early maturing mutant developed from exotic Canadian variety Westar (*B. napus* L) at the Botany Department, Nagpur University, Nagpur. Seeds of variety Westar of '00' quality (12 m moles/g seed and less than 1% erucic acid) were treated with sodium azide (pre-soaked in water for 12 hrs followed by 0.06 % sodium azide for 6 hrs). In M_2 generation 12 early flowering and maturity mutants were isolated. In M_3 generation, selection NUDB-42 was identified for early

spectrum of resistance to powdery mildew.

The derivative was also free from the disease at the seedling stage as ascertained by inoculating with single-colony cultures of *Egt*. The triticale parent 'TL 68' of this line was free from powdery mildew, whereas, the bread wheat parent 'Shailaja' was susceptible.

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Early Maturing Gobhi Sarson

SP Landge

Botany Department, Nagpur University, Nagpur and National Dairy Development Board (NDDB), Anand, Gujarat

The exotic double zero cultivars of Gobhi sarson (*Brassica napus*) introduced in India are very late. These cultivars are not suitable for cultivation in mustard growing areas of the country. Therefore, an induced mutation-breeding programme was initiated to develop early maturing double zero genotypes suitable to agro-climatic conditions of the country.

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maturity from one of the mutants (Table 1).

NUDB-42 has ovate, dark green leaves with glabrous white coating, margin is undulate with dentation and petiole is grooved with leafy wings at the base. Seed coat colour is blackish dark brown and Scanning Electron Microscopy observations indicate primary and secondary reticulation and pits shallow and circular in shape. It has shown early maturity across the locations as compared to parent. The '00' quality characters of NUDB-42 are similar to that of the parent variety 'Westar' with zero erucic acid in oil and about 11.1 m moles of glucosinolate in per gram of seed. Under multi-location trials conducted by NUDB during 1988-99, the NUDB-42 yielded 1758 kg/ha as against 1319 kg/ha of HPN-3, 1838 kg/ha of Pusa Bold and 1940 kg/ha of Varuna (Table 2).

Table 1. Some characteristic features of NUDB-42

Genotype	Height (cm)	50% flowering (days)	Maturity (days)	1000 seed weight(g)	Reaction of disease
NUDB-42	102.1± 3.6	44.0± 2.0	100.0 ± 3.0	3.7 ± 0.37	Resistant to white rust
Westar	129.0 ± 2.2	75.0 ± 3.0	169.0 ± 3.0	4.2 ± 0.22	Resistant to white rust

Table 2. Yield evaluation of NUDB-42 under multi-location trial

Line	Salon	Mehsana	Nagpur	Bharatpur-I	Bharatpur-II	Chandigarh	Anand	Gwalior	Delhi	Average
NUDB-42	1605	1938	993	1291	1884	1241	2402	2953	1518	1758
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Yellow Seeded Indian Mustard

GG Nayar
Anantham, N. Paravur-683513, Ernakulam Dist., Kerala

TM-1 (INGR No. 01050, IC 296829)

Mustard (*Brassica juncea*) is being grown in our country from times immemorial for the seeds and oil that are used for various purposes, in medicine, food, industry etc. It is a seasonal crop and cultivated primarily during *Rabi* season. All the varieties of Indian mustard under cultivation possess black or blackish brown seeds. A mutant TM-1 having yellow seeds was developed for the first time in the country following irradiation of the seeds of a popular black seeded variety, Rai-5 of West Bengal. The mutant is identified for yellow seeds as a source for breeding yellow mustard that can restrict adulteration of mustard with similar looking seed of other crops. The features characterising the genotype are presented in Table 1.

Table 1. Characteristic features of Yellow Seeded Indian Mustard, TM-1

Pedigree	An artificially induced mutant from mustard variety Rai-5 of West Bengal
Plant type	Medium
Stem	Moderately branched, hairy
Leaves	Alternate, petiolate and hairy. Tender leaves are taken as a vegetable
Flowering	30-35 days after planting
Flowers	In raceme, bisexual, self-compatible. Sepals and petals-4, yellow in colour, hypogynous
Pods	Siliqua, beaked
Seeds	One seriate, yellow, seed coat reticulate, non-mucilaginous in water
Oil	25 to 30 per cent, golden yellow in colour
Maturity	100-110 days after planting
Pests and diseases	Moderately resistant to aphids, *Alternaria* blight and droughts
Chromosome number	2n=36

maturity from one of the mutants (Table 1).

NUDB-42 has ovate, dark green leaves with glabrous white coating, margin is undulate with dentation and petiole is grooved with leafy wings at the base. Seed coat colour is blackish dark brown and Scanning Electron Microscopy observations indicate primary and secondary reticulation and pits shallow and circular in shape. It has shown early maturity across the locations as compared to parent. The '00' quality characters of NUDB-42 are similar to that of the parent variety 'Westar' with zero erucic acid in oil and about 11.1 m moles of glucosinolate in per gram of seed. Under multi-location trials conducted by NUDB during 1988-99, the NUDB-42 yielded 1758 kg/ha as against 1319 kg/ha of HPN-3, 1838 kg/ha of Pusa Bold and 1940 kg/ha of Varuna (Table 2).

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