

FMEC

Annual Report 1998 – 99



NATIONAL RESEARCH CENTRE ON BANANA
(Indian Council of Agricultural Research)
Trichy – 620 017.



PMEC

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राष्ट्रीय केला अनुसंधान केन्द्र
(भारतीय कृषि अनुसंधान परिषद)
त्रिची - 620 017 तामिलनाडू

NATIONAL RESEARCH CENTRE ON BANANA
(Indian Council of Agricultural Research)
TRICHY - 620 017.
INDIA

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Front Cover Page	:	Male bud of <i>Rhodochlamys</i> accession (Collected from NEH Region)
Back Cover Page	:	Top - Hill Bananas in Lower Pulney Hills Bottom - A view of banana garden in Jalgaon (Maharash)
Photography	:	Dr. P. Sundarajau, Dr. S. Uma, Dr. Padmanabhan
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1. PREFACE

Bananas and Plantains are the fourth most important food commodity. Productivity potential and their ability to yield round the year on a wide range of ecological conditions offer more options for the national strategic plan in providing food for the people and strengthening more stable food security that would reduce the risk of shortage of national food stock. Thus, with an overall objectives of enhancing and sustaining the production of bananas and plantains grown under different geographical regions of India, National Research Centre on Banana, Tiruchirapalli is making ceaseless efforts to identify major production constraints, formulate appropriate research strategies to overcome such maladies and constraints and outline time-bound research targets on aspects of crop improvement, management, protection and post-harvest handling and utilization.

The Annual Report 1998-99 of the National Research Centre on Banana is a comprehensive treatise of various research, development and other activities of the Centre on four major issues of production, as an outcome of combined and concerted efforts of the scientists, ably supported by other staff at various levels.

A vast collection of germplasm obtained from explorations of many regions of the country and as introductions from abroad, needs special mention. Such a vast genetic base is a boon for the breeders for identifying useful gene sources for yield, good quality and resistance to insect pests, nematodes and diseases.

Insect pests, nematodes and diseases surveillance made across the length and breadth of the country round the year has brought out the occurrence of new and dreaded fungal leaf pathogens and viral diseases. Efforts have already been initiated to contain such maladies through basic and applied research.

I owe much to all my colleagues for their unstinted efforts to successfully bring out this Annual Report 1998-99 with appreciable quality.



(S. SATHIAMOORTHY)
Director

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2. EXECUTIVE SUMMARY

The National Research Centre on Banana (NRCB) was established on the recommendations of the Task Force Committee appointed by the Indian Council of Agricultural Research w.e.f. 21st August, 1993, started functioning effectively from 1st April, 1994. The mandate of the Centre is to enhance the production and productivity through basic and strategic research. The vision of the NRCB is to improve the production and productivity through utilization of genetic resources, development of improved cultivars, improved production technologies, protection against insect pests, nematodes and diseases, and to reduce post harvest losses. In the last five years, the centre has made appreciable progress with respect to infrastructural development as well as in the research.

Research Achievements

A total of 31 new accessions have been collected in the North-East region and wide variability was noticed in respect of *Musa balbisiana*. Four different *balbisiana* clones, two each of diploid and triploid were noted with unique characters like black, shiny pseudostem, unusually long male phase of more than 5 ft., uniseriate fruiting habit and large male bud were identified. Under evaluation, germplasm was screened for fungal and viral diseases, nematodes and insect pests in order to find out the resistant/tolerant cultivars. Evaluation for yield and quality parameters has led to the identification of 18 promising accessions which performed well over the last 4-5 years with yield stability. Twelve promising diploid *acuminata* accessions were identified for breeding work. Thirtyfive female fertile accessions have been identified for diploid-triploidy breeding. Hi-tech model plot of banana with six commercial cultivars viz., Nendran, Monthan, Pachanadan, Rasthali, Poovan and Ney Poovan initiated during June, 1998 is performing very well.

Seventy two accessions have been conserved *in-vitro* successfully. Of the recent exotic introductions from INIBAP, 12 *acuminata* diploids, seven *acuminata* triploids, five accessions of ABB and two accessions of BBB have been subcultured and taken for rooting.

Studies on rate of multiplication has revealed Saba and Pisang Madu with highest proliferation rate of 1:8, while in others it ranged from 1:1 to 1:4.

Studies with different BAP concentrations to induce proliferation in Shy-Silk cultivars revealed that proliferating bud size can be increased by half strength MS in combination with meso-inositol and BAP (3 mg/l).

Use of liquid media in culture initiation was a failure while 2nd and subsequent subcultures had shown faster multiplication and growth rate in liquid medium in triploid *acuminata* and Pisang Awak cultivars.

Trial on use of growth regulators in overcoming dormancy and seed germination revealed that IAA and BA at 50 ppm individually facilitated faster germination in both crossed seeds and open pollinated seeds.

Seed viability trials using tetrazolium in two cultivars revealed that seed viability could be maintained for a period of four months when seeds are stored in congenial moist conditions at ambient temperatures.

In embryo culture studies undertaken in four different female fertile accessions, embryo development could not be observed due to improper stage of fruit harvest and embryo development. *Acuminata* diploids collected during exploration were also tried for embryo culture under laboratory conditions without any success..

Tissue culture plants of commercial cultivars were studied for the sequence of histological and histochemical processes during hardening. Results revealed that the presence of higher protein content by virtue of the presence of protein bodies in tissues of plants were grown under 75% shade.

A new variant of Pachanadan having dark brown coloured stem was identified in the Hi-tech model fields. In a field research trial related to soil salinity aspects, the treatment, including Gypsum and FYM and different levels of K requirements had significant positive effects over plant growth parameters of cultivars Rasthali and Nendran.

Occurrence of Giant African Snail, *Achatina fulica* Boadich infesting banana recorded for the first time in Villuppuram and Cuddalore districts of Tamil Nadu. It appears to be a serious menace. Occurrence of banana rhizome borer, *Cosmopolites sordidus* was also recorded for the first time in Villuppuram district of Tamil Nadu. Several newer insecticides were screened against the banana leaf eating caterpillar *Spodoptera litura* and found that maximum mortality was noticed in Monocrotophos and minimum in Caldan. Wide-spread occurrence of root-lesion nematode, *Pratylenchus coffeae*, root-knot nematode, *Meloidogyne incognita* and *Helicotylenchus multicinctus* was noticed in almost all banana growing regions in Kerala, Tamil Nadu and Pondicherry, whereas the burrowing nematode, *Radopholus similis* was maximum only in Kerala. Among the 670 germplasm screened, 75 cultivars were found to be highly susceptible to *P.coffeae*, 6 cultivars to *R.similis*, 54 to *M.incognita* and 14 to *H.multicinctus*.

Survey carried out in the wilt affected area revealed that the maximum incidence of wilt was in Thottiyam (60%) followed by Podavur (15%). Survey conducted in parts of Tamil Nadu and Kerala revealed the omni presence of BSV in Poovan cultivar and BBMV in cultivars Poovan, Rasthali, Robusta, Monthan, Nendran and Karpuravalli. Effect of abiotic stress on symptom expression and yield loss by BSV in Poovan revealed that the incidence severity was more in October than in July.

Evaluation of banana germplasm for postharvest fruit quality parameters revealed wide variation among the accessions in Cumulative Physiological Loss in Weight (CPLW), TSS, acidity and brix/acid ratio. Of the 67 accessions belonging to AAA, AAB, AB, ABB and AA genomic groupings the

TSS content of accessions 066 and 077 were significantly higher at 29.3° and 29° brix respectively, while other accessions had a TSS content in the range of 22-26° brix. By increasing the weight ratio of ethylene absorbent to fruit it was found that the green life was extended at the storage temperature of 13°C.

Among the different physical parameters, only finger girth to length ratio was found to have a positive relationship with maturity. During storage of fruits at different maturities, 75% mature fruits were found to have maximum shelf life (14 days in Poovan and 12 days in Karpuravalli) as compared to 90% and 100% under ambient conditions without any treatments.

The CPLW was more in 75% mature fruits than 90% or 100%. Pulp to peel ratio was more in Poovan than Karpuravalli and it increased with increase in maturity and ripening. The T.S.S. and sugars (reducing & total) and maturity had no correlation and all of them attained almost same level before completion of shelf life. The acidity increased with ripening and was higher in fruits of higher maturity. Poovan had almost double the acidity of Karpuravalli.

Reducing sugars were more than non-reducing throughout the storage life. Ripening was normal and complete in all maturity grades and organoleptic quality was acceptable at end of shelf life.

3. INTRODUCTION

The National Research Centre on Banana (NRCB) was established on the recommendations of the Task Force Committee appointed by the Indian Council of Agricultural Research w.e.f. 21st August, 1993, started functioning effectively from 1st April, 1994. It is located about 14 km. west of Trichy (11.50° N latitude 74.50° E longitude and 90 m. above mean sea level). The centre receives the precipitation of 800-900 mm annually both from North-East and South-West monsoons. Climate is tropical with highest mean temperature in April-May. The farm has a total area of 38 ha., the office-cum-laboratory is located in a rented building hired at 44, Ramalinga Nagar South Extn., Vayalur Road, Trichy-620 017.

3.1 Salient Research Achievements in the past

3.1.1 Genetic Resource Management

Emphasis has been paid on collection, conservation and evaluation of genetic diversity and the centre has assembled 690 accessions of which 32 are exotic collections. These accessions are planted in the field gene bank and efforts are under way for *in vitro* conservation. Many of the accessions collected have started fruiting and morphological evaluation of the gene pool is in progress. Accessions of North Eastern regions were genomically classified. Technique for *in vitro* handling of germplasm has been standardised and is being used. Four promising high yielding clones-two in Monthan and one each in Pisang Awak and Silk sub groups were identified and are being multiplied for further evaluation. Major research achievements include,

- a. Many of the *Musa* species and sub species used in global hybridization programmes have been introduced.
- b. *Musa* accessions have been assessed of their genomic status and are further characterized using INIBAP's *Musa* descriptor.
- c. Tentative key has been prepared for the first time for the identification of Indian bananas.
- d. Data base has also been developed for the *Musa* germplasm.

Explorations were made in the Southern points of Kerala and Tamil Nadu. Twenty seven virus free accessions were collected and added to the *Musa* genebank which includes the variability in Ney Poovan (AB), Rasthali (AAB-Silk), Nendran (Plantain - AAB), *M.balbisiana* (BB/BBB), a seeded wild AA diploid and a wild, seeded *M.balbisiana* accession. Hybrid seeds obtained by crossing Pisang Awak exhibited high percentage of germination and better survival in the nursery. The centre has developed a database to document the data on germplasm using MGIS software. Hybridization attempts and the results obtained suggests that among various diploids tried Hatidat, Amrit Sagar among *acuminata* triploids and Thiruvananthapuram among AAB are proved to be better pollen parents. The phyllochron

ranged from 5.84 days to 11.88 days and in general the phyllochron found gradually increased with the increase in mean temperature and humidity.

Improvement of Banana

As a first step in improvement, systematic evaluation has been done to identify the donor sources of resistance to major diseases. Efforts have been made to identify the parents for combining the desired characters. Breeding has been started using triploid and diploid crosses. To cut short long period required for the development of varieties in banana, promising global hybrids, resistant to sigatoka and fusarium were introduced through the collaboration of INIBAP and are being evaluated in the field. FHIA-1 (Gold Finger), a Pome hybrid and a Saba cultivar are found promising for subsistence cultivation in India.

3.1.2 Production Technology

In order to improve the quality of banana which can have export value, attempts are being made for the refinement of production technologies. In this direction, trials have been laid out for fine tuning the production system, canopy management, recycling of nutrients, efficient water management, bio-control and integrated management of insect pests, nematodes and diseases. Survey conducted has indicated that Banana Streak virus (BSV) and Banana Bract Mosaic virus (BBMV) are present in the country at alarming levels. These viral diseases may become serious, if the spread is continued through infested plants. Kokkan disease, hitherto known as malady of unknown etiology was identified, using serological techniques, to be BBMV. Management strategies for these diseases are being developed.

Results revealed that application of more organic source of nutrition favoured better plant growth, shorter crop duration, higher bunch weight and increased T.S.S. in all the varieties. Irrespective of varieties, the crop duration was extended by the application of 100% N from inorganic source. Application of more percentage of organic sources of nutrition increased plant vigour, yield and fruit quality which may be attributed to the change in physio-chemical and nutritional properties of the soil as well as significant reduction in the nematode population.

The experiment on assessment of losses due to weeds revealed that maintenance of weed free condition upto six months after planting, enhanced more vegetative growth, produced better bunches and reduced the crop duration. There was 33.15 percent loss in bunch weight under unweeded plots besides increasing the crop duration by more than four months.

It was interesting to note that the leaf K/Na had positive and significant correlation ($r=0.2131^{**}$) with the yield. From the above experiments, it was inferred that the banana leaves should have the K/Na ratio of more than one for the optimum yield.

Based on root and leaf K/Na ratio studies, Saba has the capacity of excluding Na and absorbing more K at the root level and this cultivar has high root and leaf K/Na ratio in the saline and saline sodic soils.

3.1.3. Crop Protection

Survey conducted in few districts of Tamil Nadu revealed the following insect pests viz., Tobacco caterpillar, *Spodoptera litura* (F.), Leaf thrips, *Heliothrips kadaliphilus* R&M, Flower thrips, *Thrips hawaiiensis* (Morgan), Bag worm, *Kophene cuprea* M. and Banana Mealy bug, *Pseudococcus* sp. Incidence of leaf thrips and bagworm was very severe in Trichy taluk, whereas pseudostem borer and rhizome weevil borer were found to be very severe in Periyakulam and Coimbatore districts. Occurrence of *Spodoptera litura* (F.) indicated a maximum feeding damage in Monthan and less in Pachanadan.

Survey conducted in Tamil Nadu and Pondicherry States revealed the occurrence of 17 genera of plant parasitic nematodes associated with the crop. Population fluctuation study revealed that the distinct increase of *R.similis* population during the months of January-April.

Preliminary screening of *Musa* germplasm available at NRCB was done in the field in order to identify the resistant/tolerant reaction to major nematode pathogens viz. *R.similis*, *P.coffeae*, *M.incognita* and *H.multicinctus*. Among the 670 germplasm screened, only 75 cultivars were found to be highly susceptible to *P.coffeae*, 6 cultivars to *R.similis*, 54 to *M.incognita* and 14 to *H.multicinctus*. The rest of the cultivars are relatively free from nematodes.

Sigatoka incidence was observed in all the commercial cultivars grown in Tamil Nadu during the survey. The fusarium wilt (FOC) incidence was high in Rasthali and Monthan and less in Karpuravalli (Pisang Awak).

Germplasm evaluated for their reaction to *Foc* and Sigatoka indicated that the accessions belonging to *M. balbisiana*, Pisang Awak, Monthan and Bluggoe groups which have more 'B' genome in their genomic constitution to be less susceptible to Sigatoka leaf spot than other groups which have more 'A' genome.

Cultivars such as local Peyan (ABB), Enna Benian (AAB), Thiruvananthapuram (AAB), Kalibow (AAB), Petite Naine (AAA) Vadakkan Kadali (AA) and Pisang Rajah (AAB) were found to be free from Sigatoka leaf spot disease.

The hybrids PA-03-22 (EMB-404) and FHIA-03 and natural germplasms such as cultivar Rose, Yangambi-KM-5, Pisang Jari Buaya and Pisang Lilin were found to be resistant to Sigatoka disease whereas the hybrids, FHIA-1, FHIA-23, EMB-402, GCTCV-119, GCTCV-215 and cultivars such as Burro Camsa, Saba, Bluggoe and Williams were found susceptible.

Among the IMTP genotypes evaluated for Sigatoka disease SH-343669, Saba, Pisang Ceylon and local cultivar Robusta were found to be susceptible to Sigatoka and PV-03644, PA-03622, Pisang lilin, Pisang Berlin, Niyarma Yik were found to be resistant.

The disease development time (DDT) recorded throughout the crop period ranged from 34-193 days and the DDT was high in Saba.

Maximum of 60% BBMV infection in Nendran and 24.0% BSV in Poovan was observed during the survey conducted in Tamil Nadu and Kerala.

In germplasm, 36 accessions were found to have BBMV infection. In 15 accessions symptoms were observed on bract, leaf and pseudostem of main plant and also on suckers. Seven accessions had symptoms only on suckers but not in the main plants.

The malady of unknown etiology, (less than 0.1%) 'Neer Vazhai' was also observed in Nendran plantations.

3.1.4 Post Harvest Technology

Although India is the largest producer of banana having annual production of 13.0 million tonnes, yet its share in the world trade is meagre. Emphasis, therefore has been given to refine the technologies aimed to produce fruits having export quality. Germplasm was evaluated for post harvest characteristics, which indicated wide variability for shelf life and other quality parameters.

The data revealed that chilling injury was caused when the fruits were stored at 10° C at the end of 5 days.

Experiments were conducted to extend the green life of 'Karpuravalli' banana under various conditions. The findings showed that pre-cooling of bunches in water for one hour followed by storage at room temperature increased the green life to 8 days as against 4 days in control.

In general, the green life showed an inverse relationship with maturity. The maximum green life was found in accession 0097 at 3/4th maturity and similarly the longest yellow life was recorded in accession 0122.

3.2 Mandate

- * To undertake the basic and strategic research for developing the technologies to enhance the productivity and utilization of banana.
- * To develop improved cultivars through traditional and biotechnological methods and conserve the diversity
- * To serve as national repository of germplasm and informations related to banana and plantain and also to disseminate the knowledge to improve the production and productivity.
- * To provide leadership and coordinate the network research for generating location specific varieties, technologies and for solving specific constraints on banana and plantain production.
- * To collaborate with relevant national and international agencies for achieving the above objectives.

3.3 Growth

During the period under report the following building constructions have been completed. (1) Plant Quarantine Laboratory (2) ARIS Cell (3) Fruit ripening chamber (4) Zero energy cool chamber and (5) Diesel generator shed. Overhead tank work which is in completion stage.

3.4 Budget and Man power (as on March 31, 1999)

3.4.1. Budget for 1998-99

(Rs. in lakhs)

Sl. Head No.	B.E.	R.E.	Expenditure amount
1. Establishment charges	18.06	11.94	54.73
2. Travelling allowances	2.00	0.50	2.64
3. Other charges including equipments	65.00	—	37.42
4. Works	60.00	—	28.80
Total	145.06	12.44	123.59

Revenue from Farm Produce: Rs. 1.87 lakhs

3.4.2. Manpower

Grade	Sanctioned	In position	Vacant
Scientific	16	12	4
Technical	15	15	—
Administration	9	9	—
Supporting	7	7	—
Total	47	43	4

4. RESEARCH ACHIEVEMENTS

4.1 CROP IMPROVEMENT

(General Leader : S.Uma)

Attempts were made to improve the crop through germplasm management, conventional breeding and biotechnological approaches. NRCB genebank has 690 indigenous and exotic accessions. Accessions are characterised and evaluated for a number of traits. Conventional breeding efforts has led to the identification of useful diploids and compatible crosses. Eighteen accessions have been identified for commercial exploitation based on five seasons evaluation. Seed yield and germination studies have revealed the problem of dormancy and seed coat dormancy seems to be very predominant. Protocol has been standardised for *in vitro* conservation of selected germplasm. Embryo culture has been successfully demonstrated in ABB cultivars.

The apical dominance in ABB cultivars was overcome by imposing a vertical cut of the explant and addition of adenine sulphate. Hurdle of regeneration of meristematic clumps in Silk group was tackled by optimising BAP concentrations to permit proliferation of viable shoots.

Screening Nendran cultivar for salt tolerance has been optimised at 750 ppm for isolation of variants. Molecular characterisation using isozymes viz. MDH, MR, SKDH, PGDH and PGI has been done for field accessions with a view to study the phylogeny of accessions by dendrogram.

4.1.1. Germplasm Enhancement and Utilization (S. Uma)

4.1.1.1. Collection and Conservation

A preliminary survey was undertaken in the North-Eastern region to prepare a base for the main survey during September-October 1998. Northern Brahmaputra was explored resulting in the identification of number of *balbisiana* clones growing wild as well as in backyards which include clones like Bhimkol, Athiakol, Borkal Baista and Kechulepa (Plate 1). Commercial orchards of Malbhog, Cheni Champa, Kachkel, Saapkal etc. were observed for identification and variability. An accession similar to Kachkel but with ashy coated fingers was found to have commercial significance around Potin (Arunachal Pradesh). The details of the accessions collected is provided in Table 1 and 2.



Plate 1 : Genetic variability in *Musa* collected during exploration to NEH region.

Table 1 : Areas covered during exploration to NEH region

States covered	Areas covered
Assam	Khetri, Nagaon, Tezpur, Lakhimpur, Tinsukia, Jorhat, Diphu, Margherita, Kaziranga, Digboi, Guwahati.
Arunachal Pradesh	Kimin, Potin, Yazuli, Namsai
Meghalaya	West Khasi hills.

Apart from these, 20 cultivars grown in NEH region were collected with their complete passport details. Other details of collections made during the exploration are provided hereunder.

Table 2 : Banana germplasm collected from NEH region

Section <i>Eumusa</i>	
Wild collections	
<i>Musa acuminata</i>	- 3 sub species.
<i>Musa balbisiana</i>	- 4 clones (ssp.level requires confirmation)
	- Unique, large seeded type, may belong to <i>M.nagensium</i> , <i>M.sikkimensis</i> and <i>M.cheesmani</i> .
Cultivated accessions	- 20
<i>M. acuminata</i> - <i>M. balbisiana</i> hybrids	- AAB and ABB types
<i>M. balbisiana</i>	- diploid and triploid clones.
Section <i>Rhodochlamys</i>	
Wild collections	
Species not identified	- 3 clones

Exploration in Khasi hills of Meghalaya led to the identification of few wild *acuminata* diploids. They exhibited an unique characteristic of ovules in four rows arranged irregularly. The suckers were collected for NRCB genebank for further characterisation. In the same Khasi hill range of Kamrangia (400 m. above m.s.l) village, few unique wild accessions were collected by name Rigitchi and Rissue. In the Khasi hill range, explorations were extended towards Dhipu and Karbiangurg to add three more new accessions/variability by names Nuchan, Nuzzat, Numit, Lorrop, Luchin and Lonbing King Tongk. Survey also included visits to H.R.S., Assam Agricultural University(AAU), Kahikuchi, A.A.U. Jorhat, ICAR Research complex, Barapani and NBPGR Regional Station, Barapani. The preliminary explorations resulted in collection of 20 new accessions to NRCB field gene bank. The plant details are provided in Table - 3.

A wide variability was observed with respect to *M. balbisiana* and *Rhodochlamys*, found in the deep forests of Arunachal Pradesh. Four different *balbisiana* clones, two each of diploid and triploids were noted with unique characters like black and shiny pseudostem, unusually long male phase

Table 3 : List of accessions collected during preliminary exploration to N-E India during 1998-99

Sl. No	Name	Tentative Genomic Subgroup	Tentative Subgroup	Place of Collection (State)
1	Malbhog	AAB	Silk	Assam
2	Gros Michel	AA	Cavendish	Assam
3	Honda	AAA	T.C	Assam
4	Kechulepa	ABB	Unique	Assam
5	Agnisagar	AAA	Red	Assam
6	Dudhsagar	AAB	Red	Assam
7	Bhimkol	BB	Balbisiana	Assam
8	Saapkal	AAB	Silk	Assam
9	Barjahaji	AAA	Robusta	Assam
10	Jatikal	AAB	Mysore	Assam
11	Athiokal	BB	Balbi	Assam
12	Jahaji	AAA	Cavendish	Assam
13	Amritsagar	AAA	Hatidat	Assam
14	Digjowa	AAB	Silk	Assam
15	Chenichampa	AAB	Mysore	Assam
16	Kachkel	ABB	Monthan	Assam
17	Manjahaji	AAA	Cavendish	Assam
18	Borkal Baista	ABB	Unique	Assam
19	Manohar	ABB	Unique	Assam
20	Garomoina	AAA	—	Assam
21	Rissue	BB	—	Meghalaya
22	Rigitchi	AA	—	Meghalaya
23	Nuzzat	ABB	—	Meghalaya
24	Nuchan	ABB	—	Meghalaya
25	Numit	ABB	—	Meghalaya
26	Lorrop	AA	—	Meghalaya
27	Luchin	AA	—	Meghalaya
28	Manohar-I	ABB/BBB	—	Meghalaya
29	Manohar-II	BBB	—	Meghalaya
30	Lobong king Tong	BBB	—	Meghalaya
31	Monthan-I	ABB	—	Assam
32	Ashy Kachkel	ABB	—	Assam
33	Pordu	ABB	—	Assam
34	Ankur-II	AAA	—	Assam
35	Borjahaji-I	AAA	—	Assam
36	Balbisiana clone	BBB	—	Meghalaya

of more than 150cm, uniseriate fruiting habit and bold male bud (Plate 1). Two wild accessions were also collected from NBPGR, Shillong. One unique wild accession which is non-suckering and seeds forming the only means of propagation was collected from hills of Diphu (Assam). The seeds were large, 8-10 mm in length and 5-6 mm diameter in size with a smooth seed coat. Plant characters fit the description of any one of the species viz. *M.nagensium*, *M.sikkimensis* or *M.cheesmani* which requires further confirmation.

Three ornamental species of the section *Rhodochlamys* which require confirmation were identified with unique erect branching, orange and pink bract pigmentation and uniseriate fruits with potential as ornamental banana (Plate 2). Wild seeded *acuminata* accessions were also collected from Meghalaya and Assam forests. Devastation of one of the *acuminata* diploids by a leaf spot disease was noted in Arunachal forests (Plate 3).

The trip also gave insight into the indigenous technical knowledge of the Nitshi and Apathani tribesmen who use the ash obtained by burning mature leaves as a detergent and information of wild *acuminata* species inflorescence for medicinal purpose (Plate 4). The exploration helped in collecting and cataloguing of accessions hitherto unobserved for further use in the improvement programmes in India and abroad.



Plate 2 : *Rhodochlamys* accession (Pink) with uniseriate fruits



Plate 3 : Leaf spot disease on *M. acuminata*



Plate 4 : Inflorescence of wild *acuminata* sp. being sold in NEH region

Apart from the above exploration, local surveys were carried out routinely in farmers field in search of variability among commercial cultivars. This resulted in the identification of a Silk member with black pseudostem. This has resemblance to normal Silk except for the black leaf sheaths like Krishna Vazhai (Pome). This has been brought to NRCB gene bank for characterization.

Apart from the collection of indigenous germplasm, 29 exotic germplasm was also received from ITC, Leuven (Transit centre, INIBAP, France) through NBPGR, New Delhi in the form of proliferating tubes. These were conserved in *in-vitro*, multiplied and shifted to the field genebank. The list of accessions obtained is given below.

Table 4 : List of INIBAP accessions received from NBPGR, New Delhi

	ITC-code	Accession name	Genomic group	Origin
1.	ITC.0567	Amas(south Johnstone)	AA	Australia
2.	ITC.0974	Bata Bata	AA	Philippines
3.	ITC.1226	Bata Bata	AA	Philippines
4.	ITC.0394	Cardaba	BBB	Costa Rica
5.	ITC.0101	Fougamou 1	ABB	Goban
6.	ITC.0484	Gros Michel	AAA	Nigeria
7.	ITC.1122	Gros Michel	AAA	Guadeloupe
8.	ITC.0714	Kirun	AA	Brazil
9.	ITC.0533	Kluai Lep Mu Nang	AA	Thailand
10.	ITC.0526	Kluai namwa Khom	ABB	Thailand
11.	ITC.1304	Kluai namwa Khom	ABB	Australia
12.	ITC.0176	Lacatan	AAA	Burundi
13.	ITC.0768	Lacatan	AAA	Guadeloupe
14.	ITC.0395	Lidi	AA	Costa Rica
15.	ITC.1150	Morong Princesa	AA	Philippines
16.	ITC.0659	Namwa khom	ABB	Thailand
17.	ITC.0213	Pisang Awak	ABB	Srilanka
18.	ITC.0480	Pisang Buntal	AA	Honduras
19.	ITC.1121	Pisang Lilin	AA	Guadeloupe
20.	ITC.0258	Pisang Madu	AA	Brazil
21.	ITC.0276	Pisang Madu	AA	Costa Rica
22.	ITC.0507	Pisang Madu	AA	Honduras
23.	ITC.0653	Pisang Mas	AA	Guadeloupe
24.	ITC.0435	Pisang Mas Ayer	AA	Honduras
25.	ITC.0340	Pisang Masak Hijau	AAA	Australia
26.	ITC.0976	Pisang Raja Udang	AAA	Philippines
27.	ITC.1308	Pisang Sipulu	AA	Honduras
28.	ITC.0575	Red Dacca	AAA	Australia
29.	ITC.1138	Saba	BBB	Guadeloupe

4.1.1.2. Evaluation of the germplasm accessions

Germplasm was evaluated for various morphological, quantitative, and qualitative traits for the fifth generation. This is helpful in evaluating the accessions for stability of desirable characters over generations and its further multi-location evaluation. Further study was

carried out to know the extent of variability existing for various quantitative characters and effectiveness of exercising selection, based on these characters.

Different components of variance indicate magnitude of environmental influence in the expression of a character. To determine the amount of heritable variability, estimates of heritability are used. These heritability estimates in conjunction with genetic advance gives an idea of accuracy with which an accession can be identified by its phenotypic performance. Here, three different subgroups of AAB genomic group were involved, viz, Silk, Pome and Mysore. Different estimates were worked out for 11 quantitative traits.

4.1.1.3 Estimation of genetic parameters in Silk sub group

In Silk group, study was made using 12 accessions. Phenotypic Co-efficient of Variation(PCV) ranged from 9.53-65.49 and Genotypic Co-efficient Variation(GCV) ranged from 9.04-58.58. Highest GCV was noticed for bunch weight which corresponded to highest PCV. Highest heritability estimate of 91.4% was noticed for plant height followed by duration(90%), leaf breadth(85.4%), bunch weight(80%) and number of leaves at shooting(70.4%). High genetic advance was obtained for bunch weight. Moderate values were obtained for plant height and number of leaves at shooting (Table 5).

Table 5 : Genetic parameters of AAB genomic group (Silk-subgroup)

Sl. No.	Characters	Mean	Phenotypic Co-efficient of Variation (PCV)	Genotypic Co-efficient of Variation (GCV)	Heritability (h ²)	Genetic Advance (% over mean)
1.	Height	256.72	14.62	13.98	91.4	27.54
2.	Girth	64.54	12.90	9.79	65.5	16.32
3.	Length	176.91	12.75	9.17	51.7	13.57
4.	Breadth	64.20	10.48	9.68	85.4	18.42
5.	No.of leaves at shooting	12.41	17.36	14.57	70.4	25.22
6.	No.of leaves at harvest	6.79	29.47	14.95	25.6	15.61
7.	Duration	489.00	9.53	9.04	90.0	17.60
8.	Weight	9.06	65.49	58.58	80.0	108.05
9.	No.of hands	7.04	26.19	13.08	24.9	13.14
10.	No.of fingers per hand	13.39	13.24	9.20	48.3	13.14
11.	Total no. of fingers	82.48	31.83	14.84	21.7	14.25

4.1.2.2 Estimation of genetic parameters in Pome subgroup

Total of 36 accessions were used for the analysis. Highest GCV estimate was obtained for bunch weight followed by number of leaves at harvest, total number of fingers and number of hands per bunch. High PCV values indicate larger influence of environment on the expression of the characters. Moderate genetic advance values of bunch weight, height, number of leaves at harvest and total number of fingers indicate importance of these traits in selection (Table 6).

Table 6 : Genetic parameters of AAB genomic group (Pome-subgroup)

Sl. No.	Characters	Mean	Phenotypic Co-efficient of Variation (PCV)	Genotypic Co-efficient of Variation (GCV)	Heritability (h ²)	Genetic Advance (% over mean)
1.	Height	252.34	8.25	3.74	20.5	35.11
2.	Girth	61.35	11.61	7.22	38.7	9.24
3.	Length	188.58	8.69	4.11	22.3	4.00
4.	Breadth	65.95	27.14	8.54	9.9	5.64
5.	No.of leaves at shooting	11.98	13.86	4.18	9.1	2.58
6.	No.of leaves at harvest	4.64	31.01	20.88	45.4	29.09
7.	Duration	417.14	7.15	4.63	41.9	6.12
8.	Weight	7.06	45.20	32.73	52.4	48.44
9.	No. of hands	6.95	21.54	13.35	38.4	16.98
10.	No. of fingers per hand	12.91	13.04	6.76	26.9	7.20
11.	Total no. of fingers	84.23	23.69	15.89	45.0	21.70

4.1.1.4 Estimation of genetic parameters in Mysore subgroup

Eleven accessions were used for the study. Smaller variation between GCV and PCV for duration, bunch weight indicated lesser influence of environment on these characters. Estimation of heritability ranged from 4.4% to 85.2%, the highest being for duration followed by bunch weight (Table 7).

All other characters except plant height showed moderate heritability. High genetic gain was noticed for bunch weight. Number of leaves at harvest, total number of fingers, number of hands and duration showed moderate genetic gain.

Table 7 : Genetic parameters of AAB genomic group (Mysore-subgroup)

Sl. No.	Characters	Mean	Phenotypic Co-efficient of Variation (PCV)	Genotypic Co-efficient of Variation (GCV)	Heritability (h ²)	Genetic Advance (% over mean)
1.	Height	261.86	8.48	1.77	4.4	0.76
2.	Girth	57.68	7.30	4.20	33.1	4.97
3.	Length	185.81	17.73	9.73	30.1	11.0
4.	Breadth	66.52	12.79	8.82	47.5	12.52
5.	No.of leaves at shooting	11.77	16.70	10.18	37.2	12.83
6.	No.of leaves at harvest	6.25	31.74	21.29	45.0	29.44
7.	Duration	436.86	9.48	8.75	85.2	16.62
8.	Weight	9.93	37.83	32.33	73.0	56.89
9.	No.of hands	9.86	23.39	15.09	41.6	20.08
10.	No.of fingers per hand	15.72	14.95	8.36	31.3	9.67
11.	Total no.of fingers	192.34	23.36	15.15	42.1	20.25

The graphs (Fig. 1 & 2) indicate the relative distribution of members for a particular trait emphasising the need for improvement. Study for improvement of plant height towards dwarfism revealed the necessity of imparting the trait to all ABB groups. Present study also emphasised that crop duration among AAB subgroups is contributed by Nendra Padathi (dwarf) sub group, while 68% of the members exhibited 326–350 days of crop duration. In ABB group most of the members exhibited long duration.

With the exception of Cavendish subgroup, high yield potential was with the inclusion of 'B' genome in genetic constitution. AB and AAB groups exhibited the necessity for improvement of that particular trait. The distribution for quality parameters is depicted in the graphs.

Evaluation of indigenous and global hybrids for subsistence cultivation

FHIA-01 (global hybrid), Pachanadan (commercial cultivar) and H-1 (Indian hybrid from KAU) were planted in CRBD and growth observations were recorded at bimonthly intervals and bunch observations at harvest. Immediately fruits were shifted to the lab where quality parameters were assessed.

Plant height at cessation of the vertical plant growth coinciding with the shooting revealed the short stature of FHIA-01 (2.16m) with maximum pseudostem circumference of 82 cm. This nature has virtually helped the plants to withstand strong winds during June-July months, while the tall local Pachanadan (AAB), collapsed. FHIA-01 exhibited a range of 6 to 9 leaves with an average of 7.2 leaves contributing to the bunch formation. H-1 followed FHIA-01 with 6.54 leaves and Pachanadan had the least of only 5.08 leaves. Both the hybrids FHIA-01 and H-1 were early to come to shooting with H-1 flowering in just 176 days and FHIA-01 in 212 days. Local cultivar is an exception to Pome group with 272 days for shooting but maturation time was on par with H-1.

Fig. 1. Variability Among the Genomic Groups for Selected Desirable Growth Traits

Fig. 1a - Dwarfism

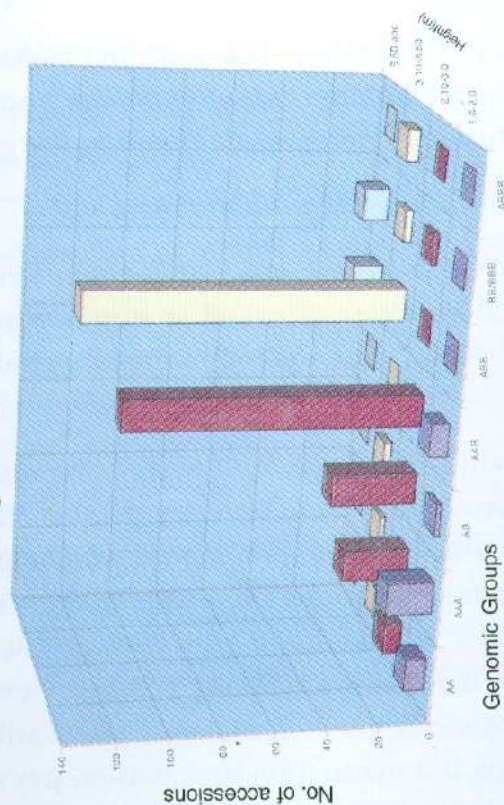


Fig. 1b - Sturdiness

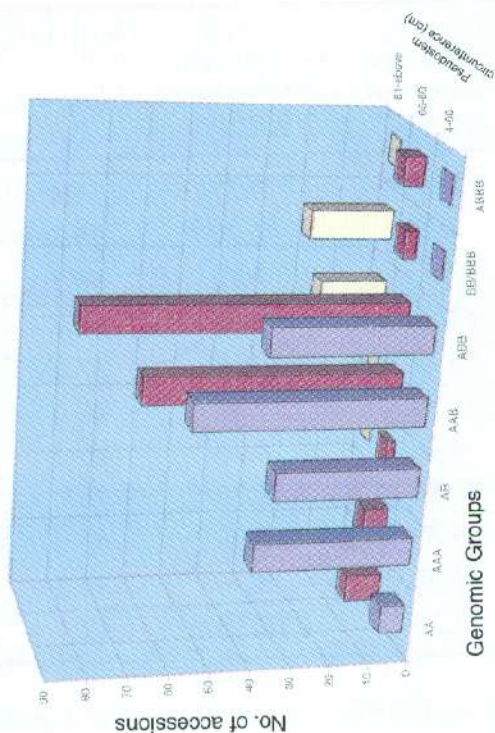


Fig. 1c - Earliness

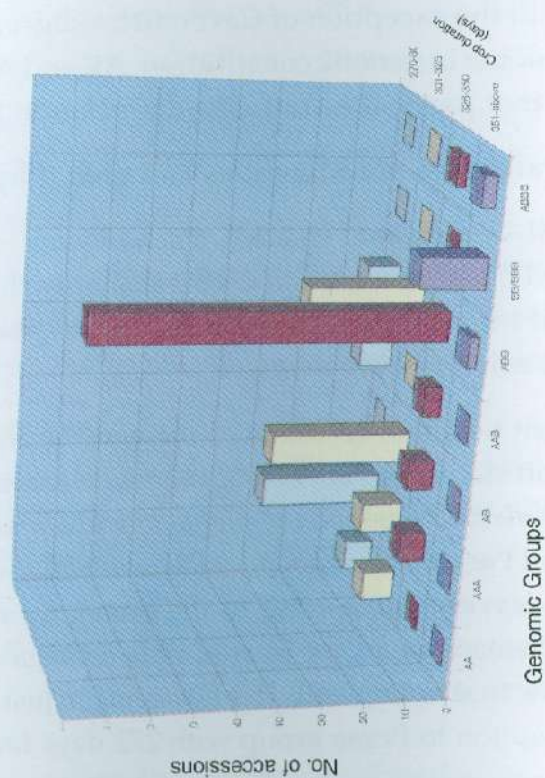


Fig. 1d - High yield potential

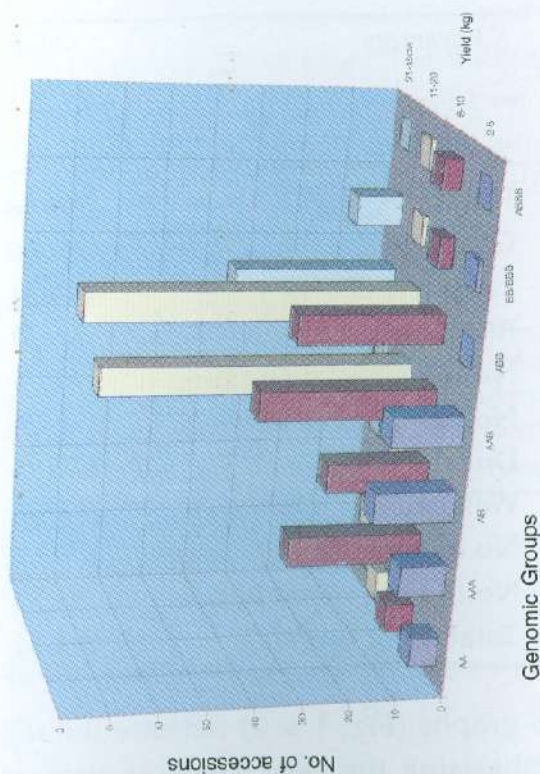


Fig. 1f - Total No. of Fingers.

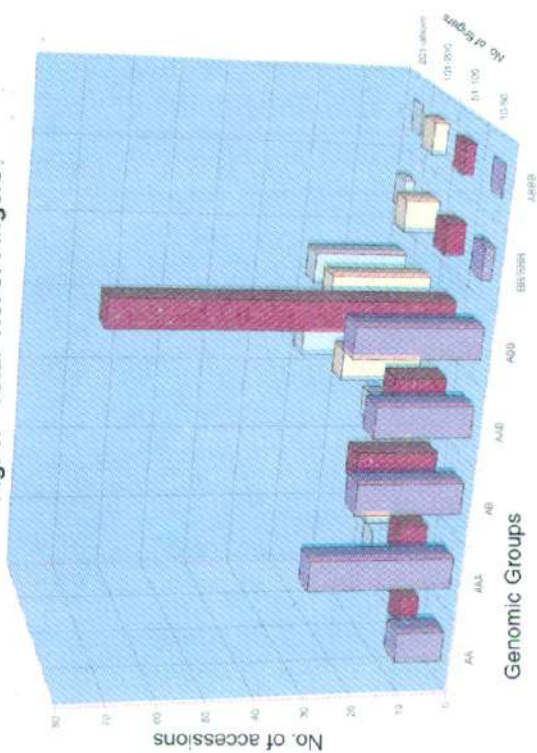
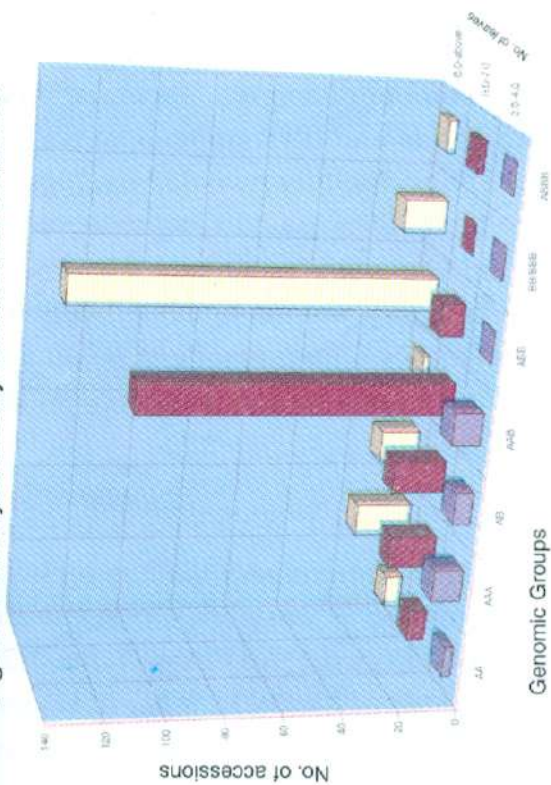


Fig. 2. Variability Among the Genomic Groups for Quality Traits

Fig. 2a - Total soluble sugars

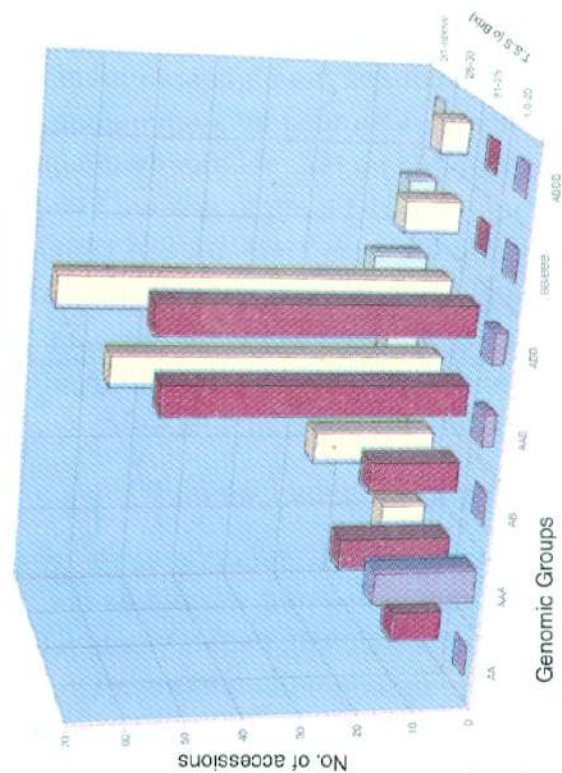
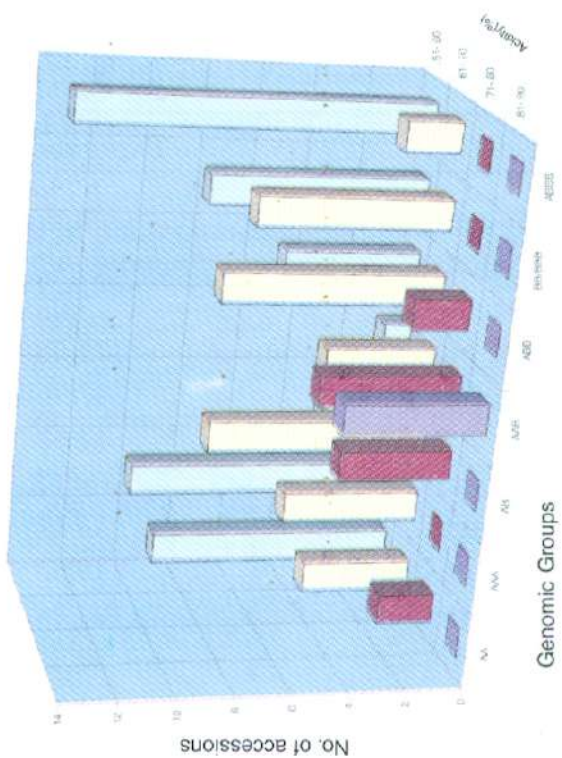


Fig. 2b - Acidity



Similarly crop duration of local Pachanadan was the longest with 397 days, while H-1 had the shortest crop duration of 302 days and FHIA-01 was closely behind H-1 with 324 days (Table-8).

Table No. 8 : Evaluation of hybrids with local cultivar for growth, yield and quality parameters

Characters	Pachanadan	FHIA-1	H-1	C.D at 5%	CV %
Plant height(m)	2.08	2.14	2.49	0.154**	3.45
Pseud. Circum(cm)	66.17	82.11	69.44	4.025**	3.34
Lvs. at harvest	5.08	7.17	6.54	0.715**	6.57
Days for bunch maturation	125.58	111.64	126.29	8.278**	4.06
Crop Duration	397.76	318.03	302.13	16.276**	3.37
Yield	14.67	21.27	13.29	3.089**	12.54
No. of hands	8.14	9.67	7.61	1.568(NS)	10.92
No. of fingers/hand	14.37	13.22	19.50	0.663(NS)	3.25
Total no. of fingers	119.50	129.84	81.19	6.419**	7.62
Fruit weight	101.14	130.83	133.03	7.093(NS)	3.91
Pulp weight	59.33	99.93	100.24	3.416(NS)	2.46
Pulp:Peel ratio	1.60	3.00	2.26	0.2835**	8.98
T.S.S	23.96	21.19	24.11	1.35**	3.54
Acidity	0.63	0.63	0.79	0.0781**	5.72
TSS/acidity	39.18	33.99	30.72	3.512	6.04
green life	4.23	4.94	5.27	0.552**	5.09
yellow life	3.06	3.76	3.09	1.193**	6.73

** Highly significant, NS - non significant

FHIA-01 recorded the highest number of hands and total number of fingers, the major yield components, followed by Pachanadan. Least number of hands and total number of fingers were exhibited by H-1. Studies on the quality aspects like TSS and acidity revealed the highest TSS content in H-1 comparable with Pachanadan. But the least TSS and acidity were recorded independently with FHIA-01. But TSS/acidity ratio was the least with H-1 followed by FHIA-01. Both FHIA-01 and H-1 ripen to an attractive golden yellow colour under all climatic conditions, while Pachanadan remains greenish yellow in most of the cases. Pulp is soft and muscilagenous in the hybrids and local cultivar. H-1 exhibited a longer green and yellow life immediately followed by FHIA-01.

4.1.1.5 Study on male bud mutations

Study conducted on the occurrence frequency of male bud mutations and their reversions revealed that these bud mutations are random and perpetuation is unstable. Except in the case of Mutheli (AAB), Padali Moongil (AB) and Kodappanilla Kunnan (AB), other accessions recorded reduced yield owing to attributes like reduced number of hands, number of fingers and total number of fingers per bunch. In NRCB genepool, all genomic groups exhibited

mutation for absence of male bud except the diploid *acuminata* genome. Accessions of bispecific origin showed more vulnerability to spontaneous mutations due to unexpected rearrangement of chromosomes of the meristem leading to structural changes. Triploid nature and different combinations of genomes adding stimulus to this phenomenon lead to a number of bud sports which are maintained through vegetative propagation. But commercial exploitation of mutation has been noticed only in some cases like Padali Moongil and Kodappanilla Kunnan (Table 9 and 10).

Table 9 : Yield parameters of normal and mutated plants among different accessions

Name of the accessions	Genomic group	No. of mutated plants observed per year			Yield (Kg)	Average no. of hands	Average no. of fingers per hand	Total no. of fingers per bunch
		'95	'96	'97				
Athiakol	BB/BBB							
(+)		8	8	8	14.3	13.2	14.8	183.2
(-)		3	4	3	7.2	5.8	8.0	45.5
C.D. at 1%					1.291	1.312	1.331	4.631
Karthobium	ABB							
(+)		8	8	8	11.8	8.0	16.8	122.6
(-)		2	4	3	4.0	4.8	9.5	34.5
C.D. at 1%					1.001	1.212	1.039	4.025
Klue Teparot	ABB							
(+)		4	4	4	11.3	9.2	9.2	88.5
(-)		3	2	3	4.3	3.6	4.0	15.8
C.D. at 1%					0.863	0.987	0.849	2.365
Rajapuri India	AAB							
(+)		6	6	6	13.8	6.2	11.5	54.3
(-)		6	6	6	10.5	4.0	5.5	29.3
C.D. at 1%					1.291	0.843	1.091	1.345
Mutheli	AAB							
(+)		8	8	8	8.5	8.5	11.5	69.5
(-)		6	8	6	15.6	28.5	13.2	224.5
C.D. at 1%					1.289	1.438	NS	4.622
Kodappanilla Kunnan	AB							
(+)		8	8	8	18.6	5.3	14.6	78.5
(-)		8	8	8	12.3	15.5	14.0	170.8
C.D. at 1%					1.367	1.381	NS	3.841
Padali Moongil	AB							
(+)		2	6	4	5.5	4.6	8.1	25.4
(-)		8	8	3	4.8	4.8	5.4	20.02
C.D. at 1%					NS	NS	0.568	1.348

+ : with male phase

- : without male phase

Table 10 : Crop duration, bunch orientation and fruit properties in normal and mutated accessions

Name of the accn.	Genomic group	Crop duration (days)	Fruit weight (g)	Pulp: peel ratio	TSS (°Brix)	Bunch orientation	
						Normal	Upon mutation
Athiakol	BB/BBB						
(+)		482	86.35	2.35	30.6	falling	Sub-horizontal
(-)		496	90.72	2.24	31.4	vertically	
C.D. at 1%		NS	NS	NS	NS		
Karthobium	ABB						
(+)		409	109.86	1.68	28.4	falling	Sub-horizontal
(-)		426	125.31	1.79	27.6	vertically	
C.D. at 1%		NS	1.521	NS	NS		
Rajapuri India	AAB						
(+)		337	127.35	1.35	28.7	falling	Sub-horizontal
(-)		357	120.86	1.42	29.2	vertically	
C.D. at 1%		NS	NS	NS	NS		
Klue Teparod	ABB/BBB						
(+)		398	90.87	1.72	19.6	falling	at an angle (25°)
(-)		379	123.53	1.98	19.8	vertically	
C.D. at 1%		NS	1.62	NS	NS		
Mutheli	AAB						
(+)		386	98.6	4.67	23.8	at an angle	At 25° angle and
(-)		438	58.7	4.01	24.2	(30-45°)	a bent at the end
C.D. at 1%		3.862	1.962	NS	NS		of female phase
Kodappanilla	AB						
Kunnan							
(+)		405	52.1	2.83	24.3	at an angle	Horizontal
(-)		376	50.1	2.56	25.8	(30°)	
C.D. at 1%		3.084	NS	NS	NS		
Padali	AB						
Moongil							
(+)		408	63.4	2.15	28.6	at an angle	Horizontal
(-)		391	54.3	2.08	29.3	(30°)	
C.D. at 1%		NS	NS	NS	NS		

+, with male phase; -, without male phase

Table 11 : Selected promising accessions for commercial exploitation

1. Amrit Sagar	(AAA)	10. Nute Pong	(ABB)
2. Palayankodan	(AAB)	11. Bangrier	(ABB)
3. Pisang Ceylon	(AAB)	12. Bainsa	(ABB)
4. Malbhog	(AAB)	13. Saba	(ABB)
5. Pisang Radjah	(AAB)	14. Burrow Cemsa	(ABB)
6. Ash Monthan	(ABB)	15. Chakia	(ABB)
7. Kachkel	(ABB)	16. Ashy Chakia	(ABB)
8. Monthan	(ABB)	17. Ashy Batheesa	(ABB)
9. Bluggoe	(ABB)	18. Pacha Bontha	
		Batheesa(ABB)	

4.1.2. Biotechnological Approaches for Improvement (B. Shyam and S. Uma)

4.1.2.1. *In-vitro* Conservation

4.1.2.2. Explant field decontamination studies for initiation

In banana micropropagation collection of suckers for shoot tip culture initiation and transportation to the laboratory is difficult owing to the size of the sucker. In order to overcome the problems of time lag in transportation, it was studied if the suckers could be pared to the required size in the field and transported to the lab for initiation without the attendant problem of contamination and desiccation of the explant, or loss of viability. Fourteen cultivars of different genomic groups (Nendran, Rasthali, Pachanadan, Karpuravalli, Robusta, Saba, Burro Camsa, Ney Poovan, Madhukar, Petite Naine, Shrimanti, Gandevi, Nanjangud Rasabale, Poovan) were used for the study with three treatments.

Treatment I

Sucker was carefully extracted using a crowbar, brought to lab, kept in running water for 1 hr. Cut to size (5 cm) just before inoculation and disinfected with 0.1% Cetrinide + Streptocycline solution for 5 minutes and transferred to HgCl_2 (0.1%) solution for 5 minutes followed by removal of a leaf sheath layer (to 1.5 cm³ size) before inoculation (conventional).

Treatment II

Extraction as treatment I, paring of sucker to 5cm³ and *in-situ* treatment with disinfectants at concentration and duration mentioned above and transported in a sterile container with sterile double distilled water to prevent desiccation, brought to lab and re-disinfected before inoculation (as in treatment I).

Treatment III

Extraction and *in-situ* disinfection as in treatment II but transport to the lab in 0.1% (Cetrinide + Streptocycline) solution, followed by re-disinfection as before and inoculation.

In treatment I, the percentage of axenic meristems which established *in vitro* were 61.9-96% across the varieties. In treatment II, the percentage of axenic meristems established were very poor <5% owing to high bacterial contamination. In treatment III, the percentage of axenic meristem established *in-vitro* were 63.15 - 87.27% across the varieties. The growth and development of the suckers treated by treatment III were normal indicating no inhibitory effect of storage in streptocycline and cetrinide solution.

4.1.2.3. Media standardisation for Pisang Awak (ABB) sub group

Karpooravalli a choice dessert variety suited to marginal conditions with high TSS (upto 32%) was sought to be multiplied *in vitro* by optimising media concentration with various combinations of cytokinin and adenine sulphate. In order to hasten the process of proliferation, the apical dominance was removed by either damaging the terminal bud leaving the base

intact or by splitting the sucker into two halves, along with various combinations of BAP and adenine sulphate. Adenine sulphate acts as a weak cytokinin exhibiting activity only in co-ordination with cytokinin by purported interference in cytokinin catabolism. The following combinations were used in the study.

T1 = MS + BAP 3mg/l + Adenine sulphate (160mg/l) + 2 vertical cuts (keeping base intact)

T2 = MS + BAP 3mg/l + Adenine sulphate (160mg/l) + 2 vertical cuts (splitting base into two halves)

T3 = MS + BAP 3 mg/l

T4 = MS + BAP 3mg/l + 2 vertical cuts

In all the above treatments, a pared sword sucker of 1.5 cm³ was used for inoculation after decontaminating in 0.1% Streptocycline + Cetremide for 5 min and 0.1% HgCl₂ for 5 min and thoroughly rinsing the sucker with sterile water.

Adenine sulphate in combination with vertical cuts increased the proliferation to 133% and in case of sucker vertically split to 150%, the number of shoots being 8-9 per subculture. Since the apical primordia occupies a very small area it was found better to split the explant into two halves, for vertical cuts may not always damage the primordia. The optimum treatment was found to be MS+BAP 3mg/l + Adenine sulphate (160 mg/l)+vertical cuts splitting the explant into 2 halves.

4.1.2.4. Proliferation in Silk (AAB) sub group

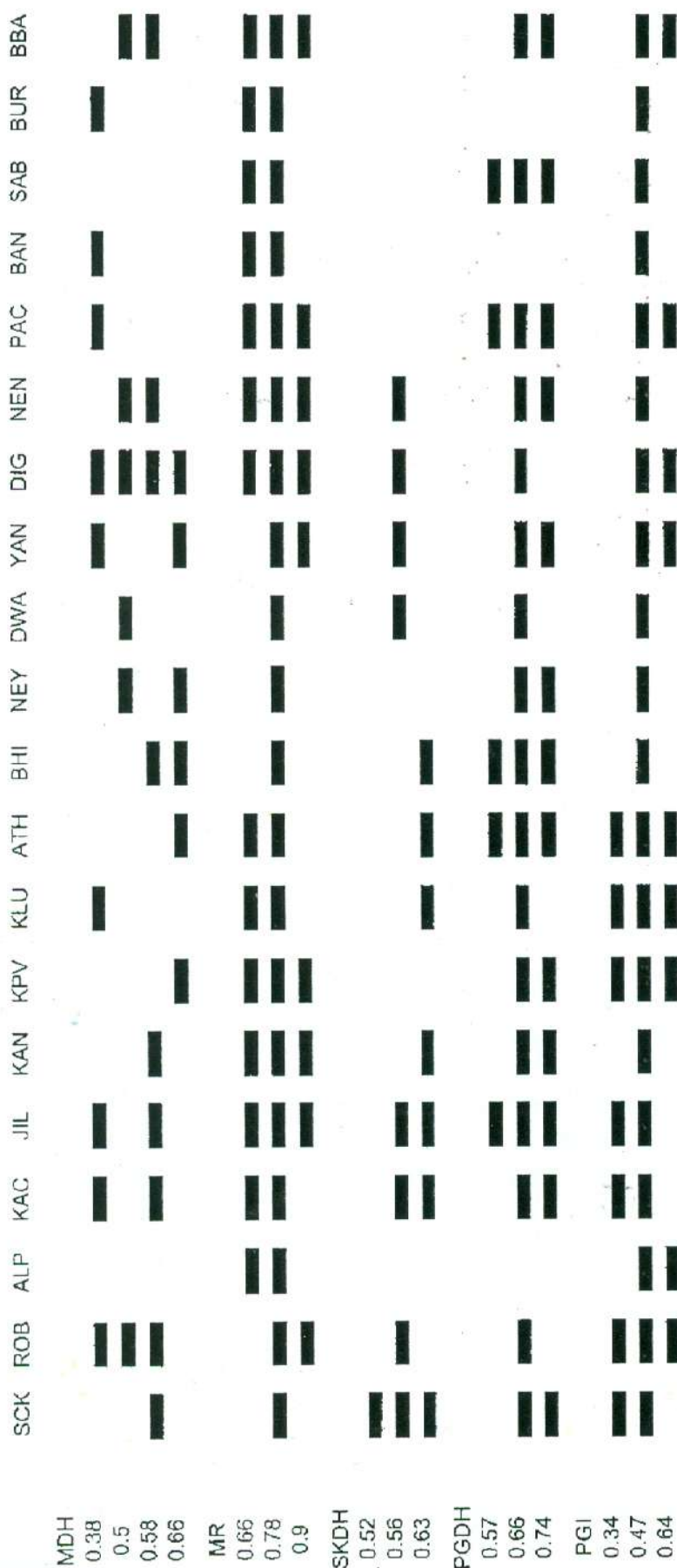
Rasthali is a problem cultivar as regards micro-propagation producing a large number of tiny buds but little development thereafter into viable shoots. An experiment was hence conducted with different concentration of MS with BAP and mesoinositol with a view to increase the size of buds to viable clumps preferred in micropropagation. Five treatments with 1/2 MS without BAP; MS + BAP 2.25mg/l; MS + BAP 3mg/l; MS + BAP 3mg/l + 100 mg mesoinositol; MS + BAP 3.25 mg/l; MS + BAP 3.25mg/l + 100mg mesoinositol.

With 1/2 MS without hormones a number of small (1mm) white non-viable buds (12-15 numbers) were produced. Addition of mesoinositol did not increase the number of buds but increased the formation of viable clumps which are larger in size (3-4mm). The plants were sturdy enough on development and transferred to soilrite thereafter. The media concentration was optimised at MS + BAP 3mg/l +100mg Mesoinositol to produce 4-5 clumps per sub culture with diameter of 3-4 mm and good establishment in the field.

4.1.2.5. Selection of plantain somaclones with salt tolerance

Nendran is a priced commercial plantain cultivar used for chips manufacture. This cultivar suffers limitation due to high susceptibility to salt causing drying of leaf along the margins. Since conventional breeding is handicapped by sterility, somaclonal variation for salt tolerance was attempted as means to achieving the aim.

Fig. 3 : ZYMOGRAM OF MUSA ACCESSIONS



SCK-Sanna Chenkadali, ROB-Robusta, ALP-Alpan, KAC-Kachkel, JIL-Jillegudem Collection, KAN-Kanthali, KPV-Karpooravalli, KLU-Klue Teparod
 ATH-Athiakol, BHI-Bhimkol, NEY-Neypoovan, DWA-Dwarf Cavendish, YAN-Yangambi KM5, DIG-Digiowa, NEN-Nendran, PAC-Pachanadan
 BAN-Bangrier, SAB-Saba, BUR-Burro Censa, BBA-Borkal Baista

Shoot tip (1.5 cm³) after decontamination was allowed to proliferate on MS + BAP 3mg/l + 250, 500, 750, 1000 ppm of NaCl solution with a control. There was no significant variation in the weight of unorganised tissue. The growth and development of shoots from the primordia were, however, affected with increasing NaCl concentration. Leaf expansion and development appeared to be the target site for injury. A concentration of 750 ppm was found to be effective screen for isolation of putative somaclones. Further work on isolation of variants is in progress.

4.1.2.6 Molecular characterisation of *Musa* isozymes

Musa exhibits a wide diversity straddling genotypes across AA, AAA, AAB, ABB and BB. Classification of the accessions as belonging to one of the above genotypes have been done using the modified Simmonds and Shepherd (1955) score card technique. Though convenient, classification of borderline accessions particularly between AAB and ABB has proved to be difficult necessitating the aid of molecular techniques. The data derived can be further used as a reference for crop improvement programme to search for further traits from diverse accessions.

In order to standardise the technique 21 accessions were selected for studying the isozyme profile of Malate Dehydrogenase (MDH), Menadione Reductase (MR), Shikimate Dehydrogenase (SKDH), Phospho Gluconic Dehydrogenase (PGPH) and Phosphoglucose Isomerase (PGI). The polymorphism in MDH has been found to be better with MR being the least (Fig. 3).

In order to standardise the leaf sampling technique for isozyme studies an experiment was designed to study the variation in isozyme profiles (if any) in the leaf stages of *Musa*. The unopened cigar leaf as well as fully opened 3rd leaf from cigar leaf was used. The results showed a difference in case of PGM with a lesser difference in ME and PGI. The experiments are to be repeated to confirm the results.

4.2 CROP PRODUCTION

General Leader : S.D. Pandey

A new type of Pachanadan having dark brown coloured pseudostem was identified in the Hi-tech model field. In a field research trial related to soil salinity aspects, the treatment, including gypsum and FYM and different levels of K requirements had significant positive effects over plant growth parameters of cultivars Rasthali and Nendran.

4.2.1. Effect of season of planting on growth, yield and quality of banana cultivars

This experiment was laid out in 1996 to know the effect of edaphic factors on growth, yield and quality attributing characters of commercial cultivars of banana and plantain. Six commercial cultivars viz., Karpuravalli, Rasthali, Nendran, Poovan, Robusta and Pachanadan were planted in February, April, June, August, October and December. On the basis of two year performance of growth yield and quality experiment was modified having six cultivars, six replication with 12 plants per replication.

4.2.1.2 Economics of banana cultivation as influenced by weeds with cultivar Karpuravalli

The comparative analysis of the data collected on the weed management of Karpuravalli crop at NRCB has revealed that banana cultivation is highly intensive and requires high capital outlay. Out of 8 treatments the one in which the plot is kept weed free upto 9 month gave maximum yield and net return in comparison to other treatments, followed by weed free condition upto six month and after 9 month to till harvest (Table). Results of the experiment indicate that weed management at critical stages of growth is important to get higher net return. As Karpuravalli is tolerant of adverse conditions, the yield reduction due to weeds (T1) was not conspicuous (Table 12).

Table 12 : Economics of banana cultivation cv. Karpuravalli as influenced by weeds:

Sl. No.	Treatment Details	Weeding man days	Weeding cost per ha. (Rs.)	Yield/ha (in tonnes)	Gross Income (Rs.)	Net Income (Rs.)	Loss/Gain (over un-weeded)
1.	No Weeding (T1)	-	-	25.47	76410/-	76410/-	-
2.	Removal of weeds by scrapping at monthly intervals (T2)	375	11250/-	28.69	86070/-	74820/-	- 1590/-
3.	Traditional weeding practices(T3)	300	9000/-	28.42	85254/-	76254/-	- 156/-
4.	Weeding done from 4th month upto 12th month (T4)	400	12000/-	32.73	98181/-	86181/-	+ 9771/-
5.	Weeding done from 7th month upto 12 month	250	7500/-	27.17	81513/-	74013/-	- 2397/-
6.	Weeding upto 3rd month followed by no weeding from 4th month to 6th month and weeding again till harvest.	375	11250/-	31.53	94575/-	83325/-	+ 6915/-
7.	Weed free till 6th month, no weeding from 6th to 9th month follwed by weed free till harvest (T7)	300	9000/-	35.90	107706/-	98706/-	+ 22296/-
8.	Control - weeding upto 9th month	375	11250/-	38.10	114306/-	103056/-	+ 26646/-

4.2.2. Soil-Plant Relationship (K.J. Jeyabaskaran)

4.2.2.1 Critical limits of soil and plant K, Na and K/Na

About 50 soil samples from the rhizosphere and corresponding banana plant tissue samples were collected randomly from saline sodic area of NRCB farm and nearby farmers' fields. The exchangeable K and Na in the soils of study area ranged from 0.31 to 2.54 c mol/kg and from 1.74 to 6.78 c mol/kg, respectively. The corresponding yield (bunch weight) data were also collected in the later stage of the experiment. The soil and tissue samples were analysed flame photometrically for Na and K concentrations and K/Na ratios. By adopting both the graphical and statistical procedures of Cate and Nelson (1965 and 1971), the critical limits for Na, K and K/Na ratios of soil and plant for optimum yield of banana in saline sodic soils, were fixed.

The correlation coefficients and linear regression equations were worked out among the parameters studied and are shown in the Table 12.

Table :13. Linear correlations among soil and plant K, Na, K/Na and yield

Sample	Yield versus	Correlation coefficient	Regression Equations.
Soil	Na	- 0.6829**	$Y = -0.02X + 18.43$
	K	+ 0.8884**	$Y = 0.02X + 1.41$
	K/Na	+ 0.7963**	$Y = 7.03X + 2.81$
Plant	Na	- 0.1946	$Y = -8.04X + 12.42$
	K	+ 0.8757**	$Y = 6.95X - 6.89$
	K/Na	+ 0.6339**	$Y = 2.69X - 4.17$

** Significant at 1 % level.

In both soil and plant, the increase in Na concentration decreased the yield significantly and the reverse was true in the cases of K and K/Na. However, a gradual increase in yield was observed with increase in plant Na upto 0.47 per cent (fig.5). This clearly indicated that Na is also very essential for banana to certain extent and beyond that it has negative effect on banana. The maximum permissible limit (critical limit) of Na concentrations of soil and banana plant were fixed at 480 ppm (fig.4) and 0.47 per cent (fig.5), respectively. The yield increased significantly with increasing K concentration of both soil and plant. The critical limits for soil and plant K concentrations for optimum yield in saline sodic soils were fixed at 710 ppm (fig.6) and 2.82 per cent (fig.7), respectively. The crop plants cultivated in saline sodic soils have the tendency to absorb more K to counteract against the highly concentrated Na in the soil, as per the thief-watchman theory of Heiman (1958). It is clear that K/Na ratio in soil and plant plays an important role in overcoming the adverse effect of salinity and sodicity. The critical K/Na ratios of soil and banana plant for optimum yield in saline sodic soils were fixed at 1.46 (fig.8) and 5.7 (fig.9), respectively.

4.2.2.2. Potassium fixing capacity of banana soils in different districts of Tamil Nadu

Banana is cultivated in different districts of Tamil Nadu where the soil texture is of wide range (sandy to clayey). The major banana growing districts are Tiruchirapalli, Karur, Tuticorin, Tirunelveli, Nagarcoil, Salem, South Arcot, Coimbatore, Madurai, Tanjore, Virudunagar etc. In all these districts, the potassium (K) fixing capacity of banana soils depends upon the texture of the soils. As leaching loss of K is low in soil of high K-fixing capacity and vice versa, the soil K-fixing capacity can be useful for standardising the splitting of K application for economic and effective K fertiliser utilisation. Hence, a soil survey was conducted in some of the major banana growing districts of Tamil Nadu for finding out the soil K-fixing capacity and the results are given in the Table 12. The soils of South Arcot district recorded the highest K fixing capacity and the soils of Trichy district recorded the lowest K fixing capacity. In general, irrespective of the soil texture and districts, the banana farmers follow 3-splitting of K fertiliser application for one banana crop. But, this study suggests that the banana farmers in the districts of medium soil, the K fixing capacity in Trichy, Salem, Coimbatore, Madurai and Virudunagar should follow >3 splitting (ie., 5-6 splitting) of K fertiliser.

Table :14. Potassium fixing capacity (%) of banana soils of Tamil Nadu

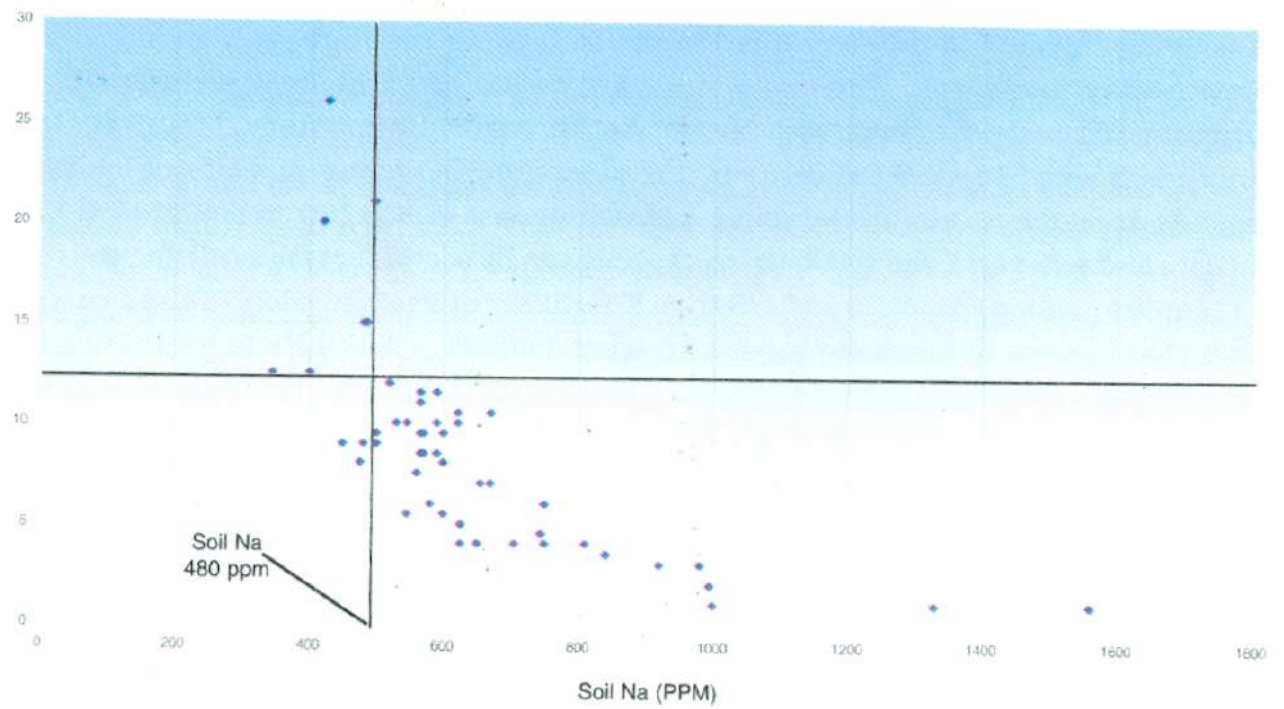
District	Number of Samples	Range	Mean	Standard Deviation	Coefficient of Variation (%)
Trichy	40	10.00-83.33	44.02	23.18	52.65
Salem	10	22.22-72.22	51.85	18.33	35.35
South Arcot	15	38.89-94.44	71.48	18.17	25.43
Coimbatore	10	38.99-61.11	50.00	11.11	22.22
Tanjore	15	72.22-88.89	67.86	14.47	21.32
Madurai & Virudunagar	15	15.00-98.89	46.02	28.74	62.46

4.2.2.3. Studies on amendments and reclamation of saline sodic soil in banana cultivation

A trial was initiated to find out effects of amendments like FYM and Gypsum on Nendran and Rasthali in saline sodic soil where the soil pH > 8.5, Electrical conductivity of saturated soil extract (ECe) > 4 dS m⁻¹, and Exchangeable Sodium Percentage (ESP) > 15. In this trial, the different combination levels of these amendments were kept as main treatments. As the soil potassium (K) is found to have the capacity to mitigate the adverse effects of soil sodium (Na), different levels of K viz. 90, 100, 110 and 120 per cent of required quantity were given as sub treatments. The whole sets of treatments were replicated thrice and the experimental design followed in this trial is split plot design. The per cent salt injury scorings (0-6 scale) was done at all the treatment combination levels. The main treatment combinations of

Yield (Kg)

Fig. 4 - Critical Limit of Soil Na for Banana



Yield (Kg)

Fig. 5 - Critical Limit of Leaf Na Concentration in Banana

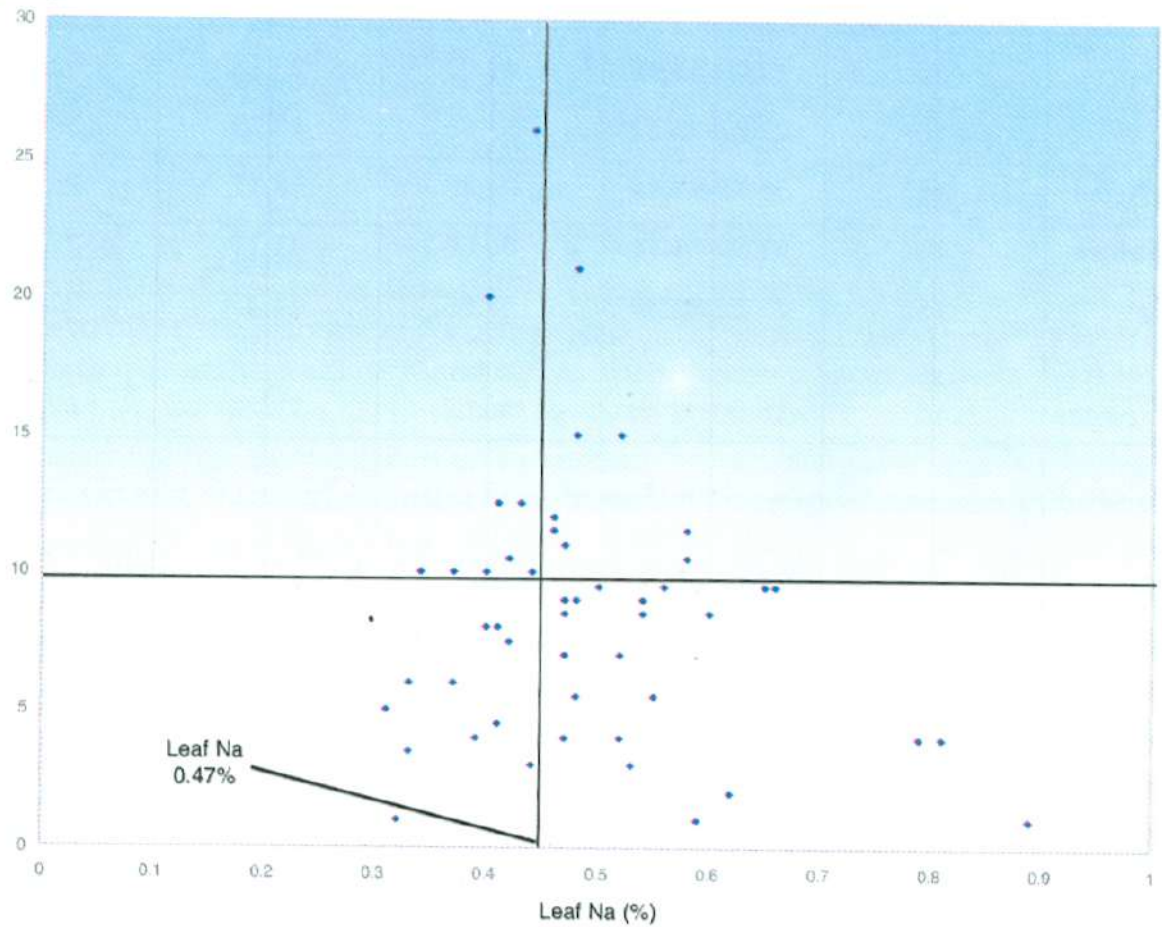


Fig. 6 - Critical Limit of Soil K for Banana

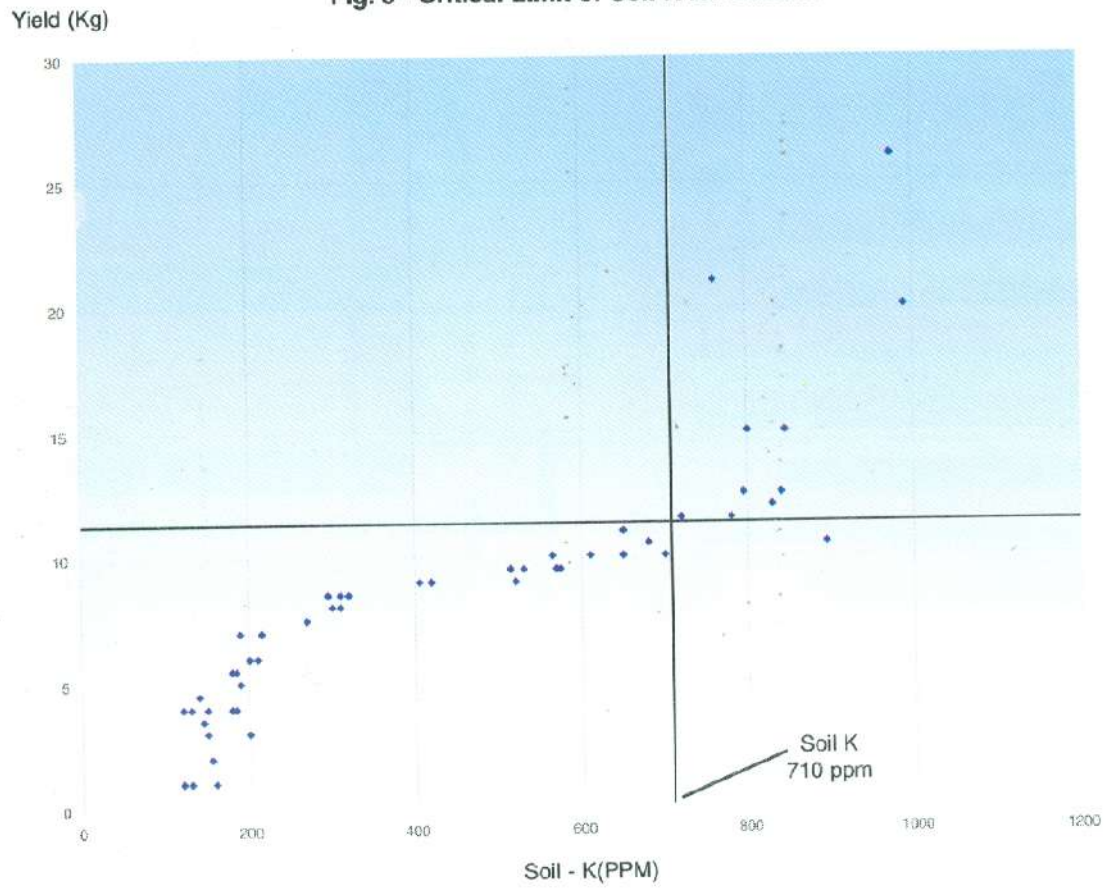


Fig. 7 - Critical Limit of Leaf K Concentration in Banana

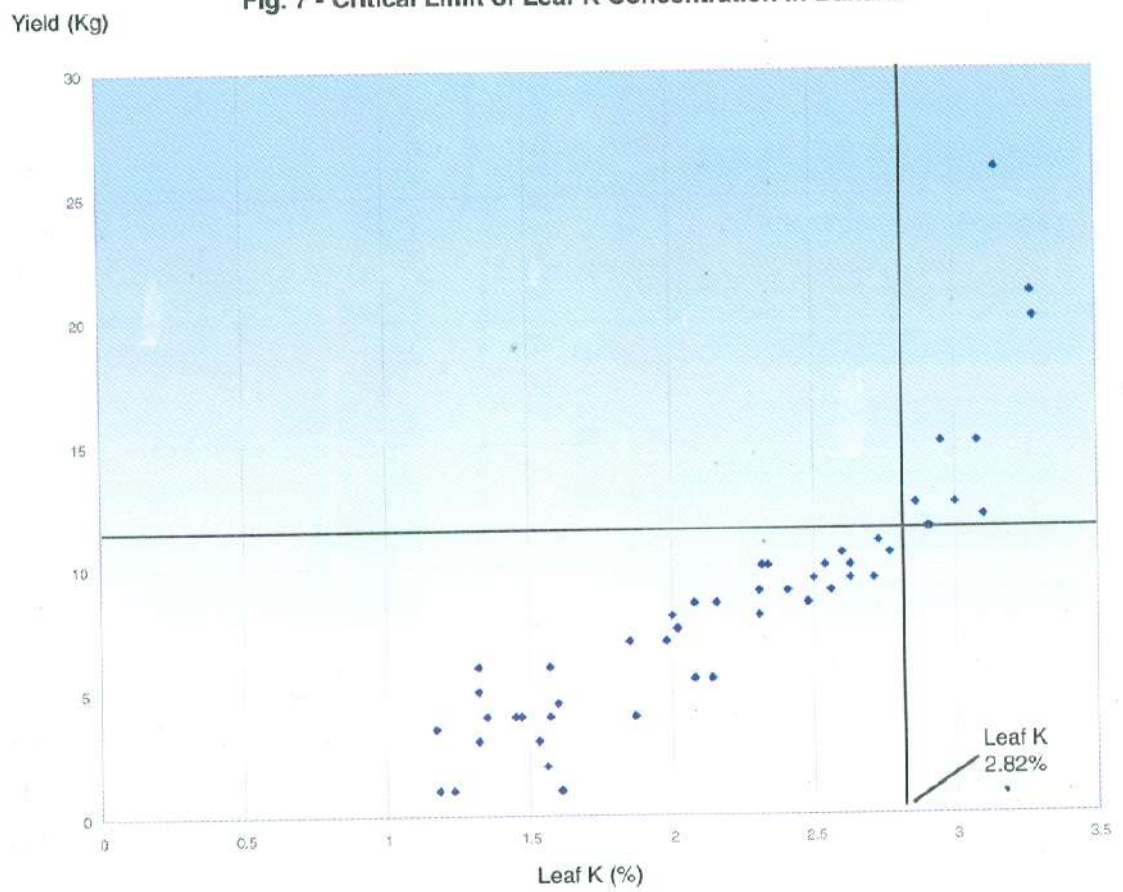


Fig. 8 - Critical Limit of Soil K/Na for Banana

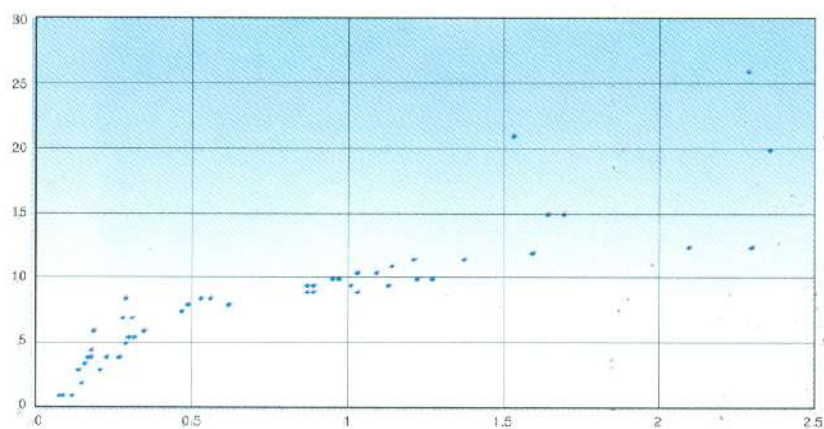


Fig. 9 - Critical Limit of Leaf K/Na Ratio in Banana

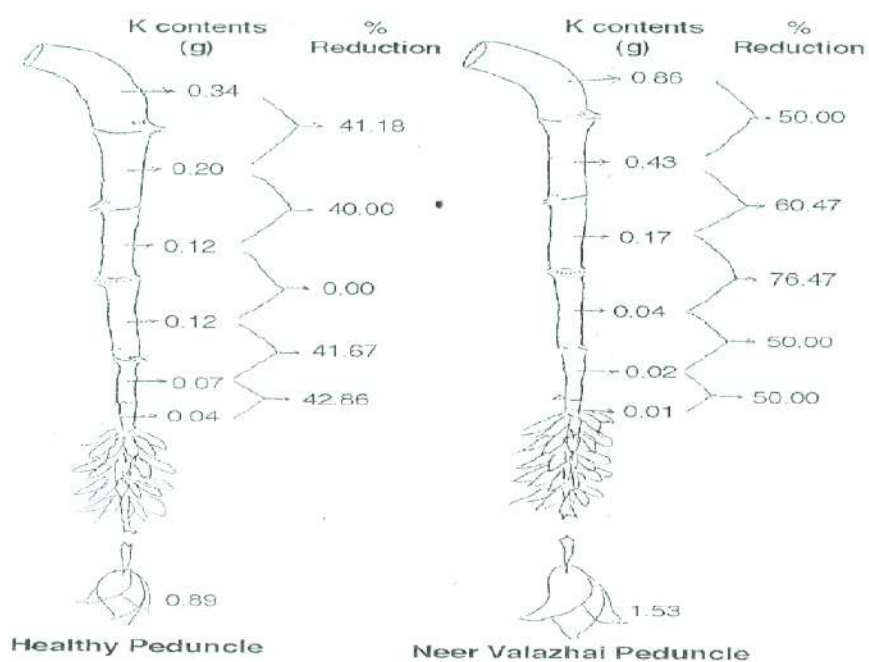
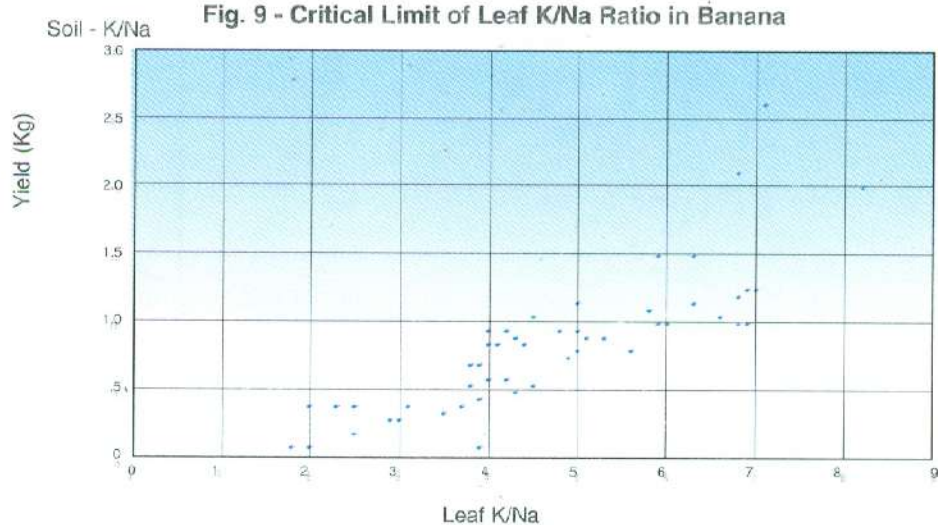


Fig. 12 : Comparison of healthy and Neer Vazhai Peduncles

Fig. 10 - Effect of Amendments and Potassium on Salt Injury (%) in Banana

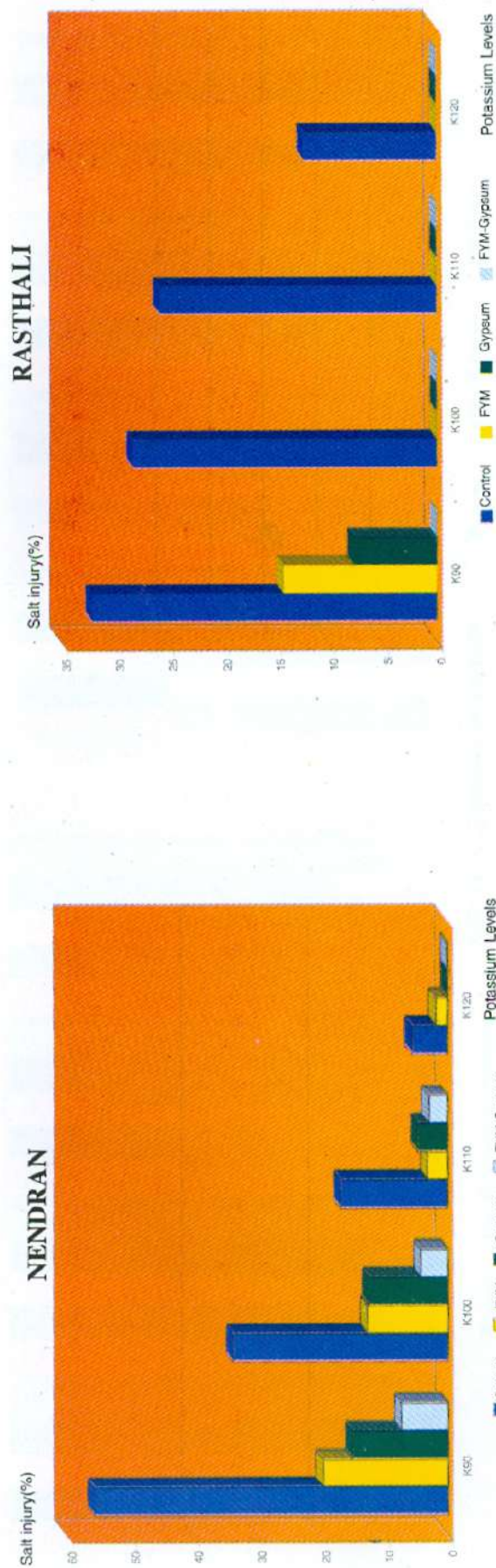


Fig. 11 - Effect of Amendments and Potassium on Growth Parameters

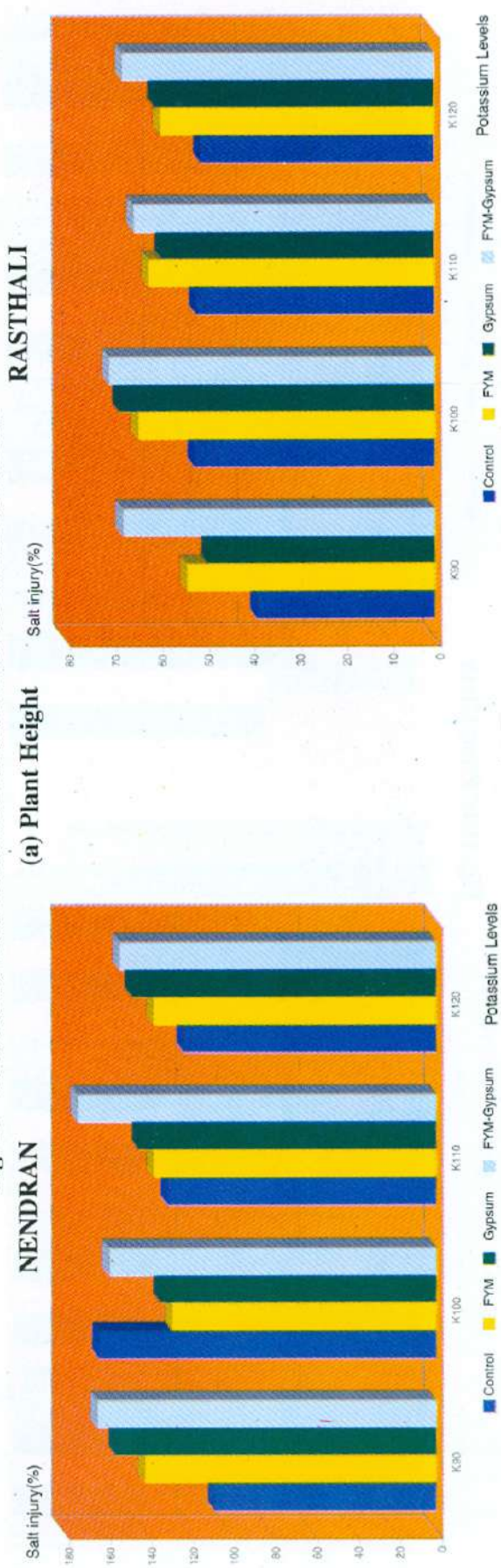


Fig. 11(b) Plant Girth

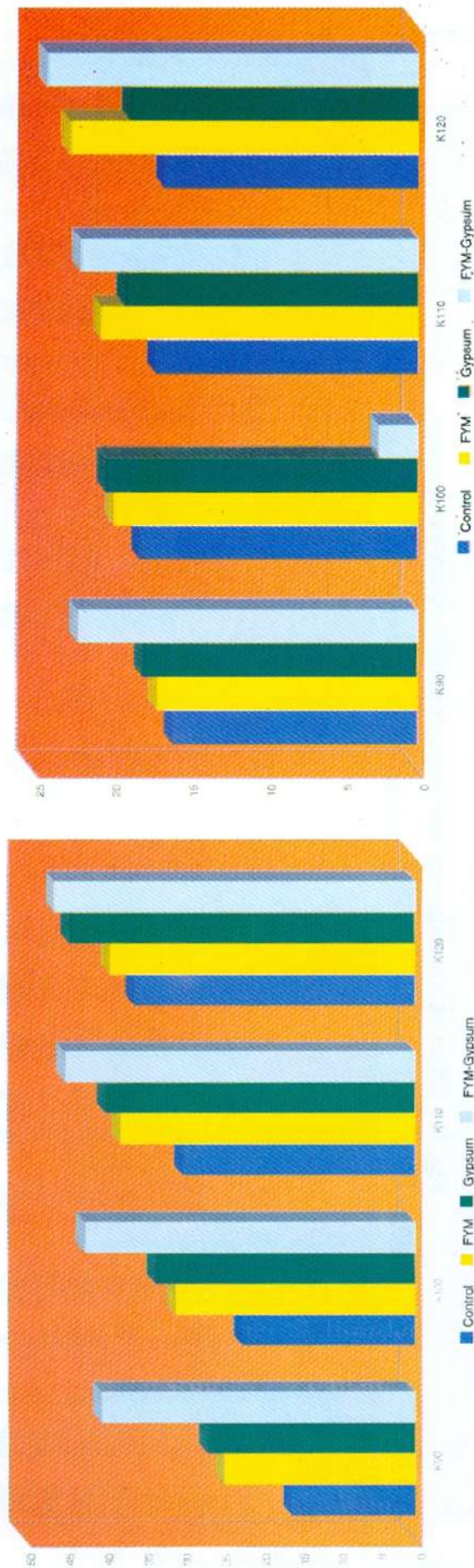


Fig. 11 (c) Number of Leaves

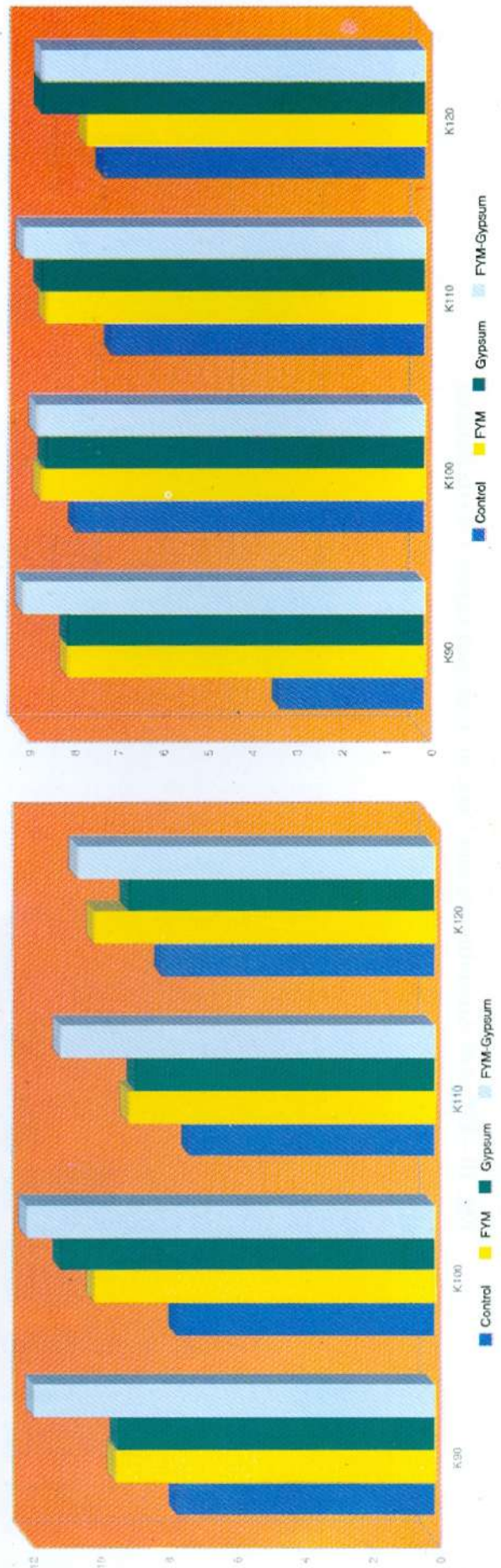


Fig. 11(b) Plant Girth

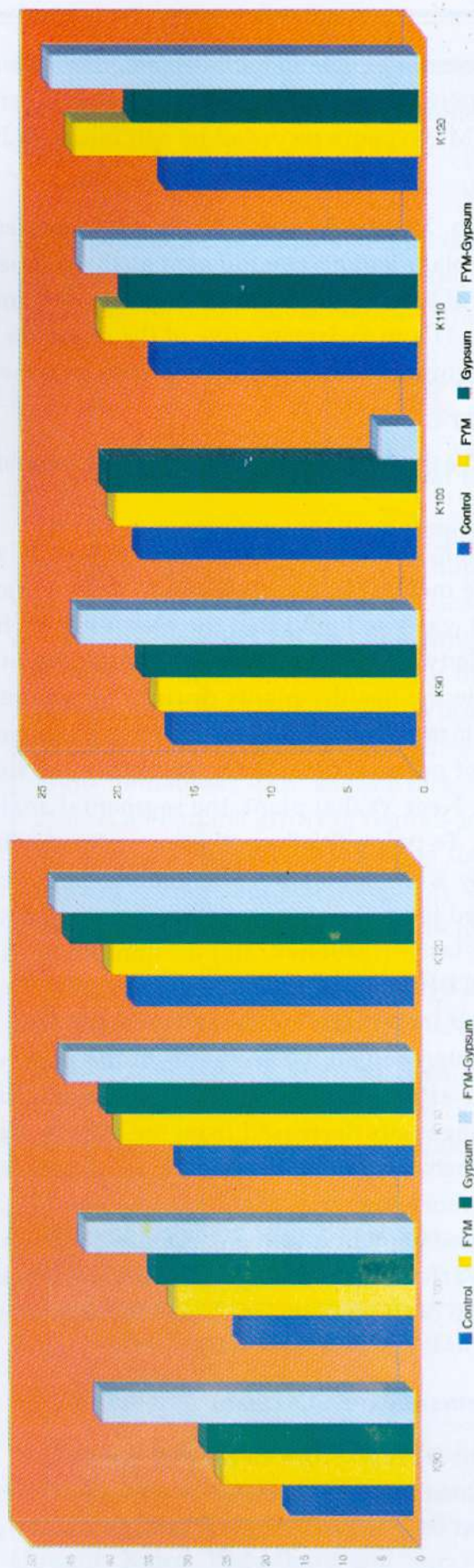
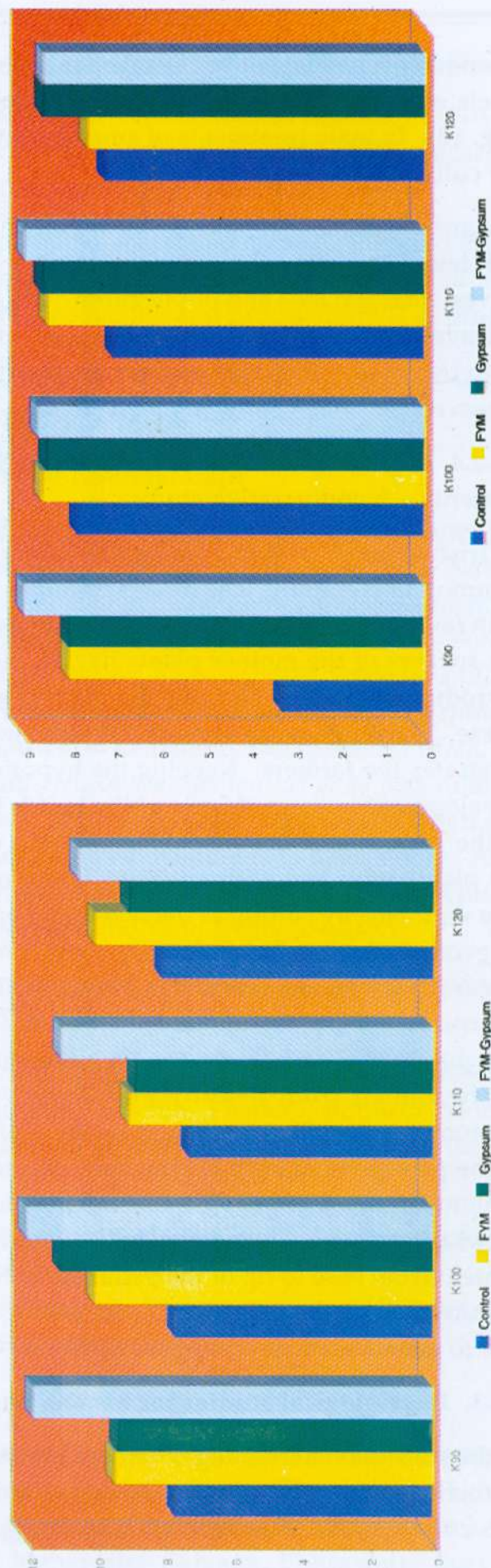


Fig. 11 (c) Number of Leaves



amendments had significant effect on salt injury percentage in both the cultivars. The different levels of K had significant effect on salt injury percentage in Nendran but not in Rasthali (Fig. 10). In main treatments of amendments, FYM+Gypsum recorded no salt injury in both the cultivars.

The growth parameters were recorded at 9th month. Irrespective of the cultivars, the increase in K levels increased the growth parameters like plant height, pseudostem girth, number of leaves, total leaf area and phyllochron. The effect of K on all these parameters except number of leaves was significant in both the cultivars (Fig.11 a to e). Irrespective of the cultivars, the main treatment combination (amendments) had significant effect in all the growth parameters observed.

4.2.2.4 Segmental analysis of peduncle of "Neer Vazhai" and healthy bunches for potassium contents – A comparative study

In Trichy district of Tamil Nadu, the "Neer Vazhai" a malady of unknown etiology is very common in Nendran. The main symptoms of the malady is development of lanky bunches with few hands and immature unfilled fingers. It was also found that the plants grown from the suckers of the mother plants having the malady developed the same symptoms in the reproductive phase. The affected plants resemble the healthy plants during the vegetative phase. The farmers can identify the plant with this malady only at reproductive phase and it frustrates the farmers. Keeping the hypothesis of nutrient blockages, restricting the finger development in the peduncle of the bunch in the Neer Vazhai plant, the segmental analysis of the peduncle of the affected bunch was done. To prove this hypothesis, peduncles from the plants with and without Neer Vazhai malady were collected. The peduncles were cut into segments by cutting at the nodes and analysed for potassium contents in each segment. In general, during finger development, proper starch (carbohydrate) accumulation in the finger is very essential which is mainly facilitated by the presence of potassium in sufficient quantity. As potassium is considered as very important nutrient for synthesis and translocation of carbohydrates, the potassium contents in all the segments of the peduncles of the bunch from healthy and Neer Vazhai affected plants were estimated flame photometrically. The potassium contents of the segments decreased from the base to the tip of the peduncles of both healthy and affected bunch. But the rate of decrease of potassium contents in the segments of affected bunch was more than that of the healthy one (Fig.12). Very high potassium content at the basal segment and higher rapidity in decrease of potassium content from base to tip of the peduncle of Neer Vazhai bunch clearly indicated the blockage of nutrients for the movement from base to the tip of the peduncles. This blockage may be due to genetical or physiological disorder.

4.2.3. Physiological studies for banana improvement (R. H. Laxman)

In the studies on hardening of tissue culture plants from test tube to the pot, anatomical and histochemical studies were conducted. The leaf sheath and root samples were collected from two cultivars viz., Karpuravalli and Bluggoe. At 75 per cent shade the leaf showed well

developed epidermal cells and parenchyma and the cells contained abundant RNA in both the cultivars. Further studies are being undertaken on anatomical and histochemical changes at different stages of banana tissue culture plantlet during hardening process.

In the evaluation of banana germplasm for physiological characteristics, there is variation in the stomatal frequency amongst the germplasm. The influence of variation in stomatal frequency on other physiological parameters, production and productivity is in progress.

4.3 CROP PROTECTION

General Leader : Dr.P.Sundararaju

Occurrence of Giant African Snail, *Achatina fulica* Boadich infesting on banana was recorded for the first time in Villuppuram and Cuddalore districts of Tamil Nadu. It appears to be a serious menace. Occurrence of banana rhizome borer, *Cosmopolites sordidus* was also recorded for the first time in Villuppuram district of Tamil Nadu. Screened several newer insecticides against the banana leaf eating caterpillar, *Spodoptera litura* on banana and found that maximum mortality was noticed in Monocrotophos and minimum in Caldan. Wide spread occurrence of root-lesion nematode, *Pratylenchus coffeae*, root-knot nematode, *Meloidogyne incognita* and *Helicotylenchus multicinctus* was noticed in almost all banana growing regions in Kerala, Tamil Nadu and Pondicherry, whereas, the burrowing nematode, *Radopholus similis* was noticed maximum in Kerala only. Among the 670 germplasm screened, only 75 cultivars were found to be highly susceptible to *P.coffeae*, 6 cultivars to *R.similis*; 54 to *M.incognita* and 14 to *H.multicinctus*.

Survey carried out in the wilt affected area revealed the maximum incidence of wilt in Thottiyam (60%) followed by Podavur (15%).

Survey conducted in parts of Tamil Nadu and Kerala revealed that the omni presence of BSV in Poovan cultivar and BBMV in cultivars Poovan, Rasthali, Robusta, Monthan, Nendran and Karpuravalli. In Pondichery and Maharastra states BSV and BBMV incidence has been recorded.

Effect of abiotic stress on symptom expression and yield loss by BSV in Poovan revealed that the incidence severity is more in October than in July.

4.3.1. Insect Pest Management in Banana (B. Padmanaban)

4.3.1.1. Survey for Insect Pests

Survey for insect pests of banana has been carried out in different banana growing regions of Tamil Nadu (Districts of Coimbatore, Thanjavur, Trichy, Karur, Chengalpet, Pudukottai, Pondicherry and Madurai), Kerala (Palghat, Thrissur, Ernakulam and Malappuram), Gujarat (Anand, Keira, Vadodhara and Surat) and Maharastra (Jalgaon, Bhusawal). Survey also

revealed the occurrence of Giant African Snail, *Achatina fulica* in Villuppuram and Cuddalore districts infesting on all crops including banana (Plate 5). It appears to be a serious menace. Occurrence of banana rhizome borer, *Cosmopolites sordidus* was recorded for the first time in Villuppuram and banana pseudostem borer, *Odoiporus longicollis* in Trichy and Karur districts of Tamil Nadu.



Plate 5: Snails on banana leaf and their feeding

4.3.1.2. Seasonal incidence of insect pests

Incidence of insect pest on the March planting revealed the occurrence of following insect pest viz., *Spodoptera litura*, *Stephanitis typica*, leaf thrips and mites on Nendran, Rasthali, Poovan, Neypoovan, Monthan and Karpuravalli cultivars. Observations indicated that there is differences in the incidence of insect pests among cultivars and seasons.

4.3.1.3. Evaluation of insecticides

The following new insecticides viz., Delfin (*Bacillus thuringiensis*), Caldan 20EC, (Cartap hydrochloride), Profenfos 50EC, Lindane 20EC and Monocrotophos 36EC were evaluated against the banana leaf eating caterpillar, *S.litura*, and found that larval mortality was higher in Monocrotophos and lowest in Caldan.

4.3.1.4. Population studies of *Spodoptera litura*

Evaluation of sex pheromone traps against *S.litura* revealed that the maximum male moth catch was during the month of October.

4.3.1.5. Banana weevil borers

Banana germplasm available at the NBPGR Regional Station, Vellanikkara evaluated against the banana pseudostem borer, *Odoiporus longicollis* revealed the occurrence of the pest on 18 accessions and the infestation was to the extent of 10-95%. (Plate 6)



Plate 6: Banana pseudostemborer feeding on leaf sheath

4.3.2. Studies on banana nematodes and their management (P. Sundararaju)

4.3.2.1. Survey for plant parasitic nematodes

An extensive survey has been carried out in banana growing regions in Kerala, Tamil Nadu, Pondicherry, Gujarat, Maharashtra and

NEH regions during July to March'99. During the survey, a total of 202 each of soil and root samples were collected from the banana plantations and nematode populations were assessed. Seventeen genera of plant parasitic nematodes were recorded from the rhizosphere of banana (Table 16). Among them, root-lesion nematode, *Pratylenchus coffeae*, was the predominant species found to occur maximum in root samples. This was followed by root-knot nematode, *Meloidogyne incognita* and *Helicotylenchus multicinctus*. The burrowing nematode, *Radopholus similis* was recorded only in few pockets of Tamil Nadu where as in Kerala almost 75% of samples collected yielded *R.similis*.

4.3.2.2. Population fluctuation studies on major nematodes

Two years data on population fluctuation of *R.similis* and *P.coffeae* on cutlvar Kalyan bale revealed an increase in the population during the months of November to February which later reduced to negligible level from June to September (Fig.13a). In Ney Poovan, nematode population was found to be maximum in the month of October to December and minimum during the months of March to September (Fig.13b).

4.3.2.3. Effect of different chemicals on the control of nematodes under field conditions

Field experiment was laid out at NRCB Farm during the month of April, 1998 to find out the effect of different chemicals on the control of nematodes and their residual toxicity in banana cultivars Nendran, Monthan and Karpuravalli. Pre and post-treatment samples of both soil and root were collected from all the treatments and the nematode population estimated. Analysis of the samples revealed that the root-lesion nematode, *P.coffeae* was the only species found to occur in roots of banana in all the three cultivars (Table 15). However, the nematode was recorded only in treatment where chemical treatment was given in later stage i.e. 3 months after planting and in some cases no chemical treatment was given.

4.3.2.4. Evaluation of *Musa* germplasm against major nematodes under field conditions

Preliminary screening of *Musa* germplasm available at NRCB was done in the field to identify the resistant/tolerant reaction to major nematode pathogens viz. *R.similis*, *P.coffeae*, *M.incognita* and *H.multicinctus*. Among the 670 germplasm screened, only 75 cultivars were found to be highly susceptible to *P.coffeae*, 6 cultivars to *R.similis*, 54 to *M.incognita* and 14 to *H.multicinctus*. The rest of the cultivars were free from nematodes. Among them, FHIA-01 in Pome group which has shown the resistant reaction to all the major nematode pathogens has proved to be commercially potential and is being tested under multilocal trial in the area where Pachanadan is commercially grown.

Fig. 13a - Population fluctuation of *Radopholus similis* in roots of Banana (cv. Kalyan Bale)

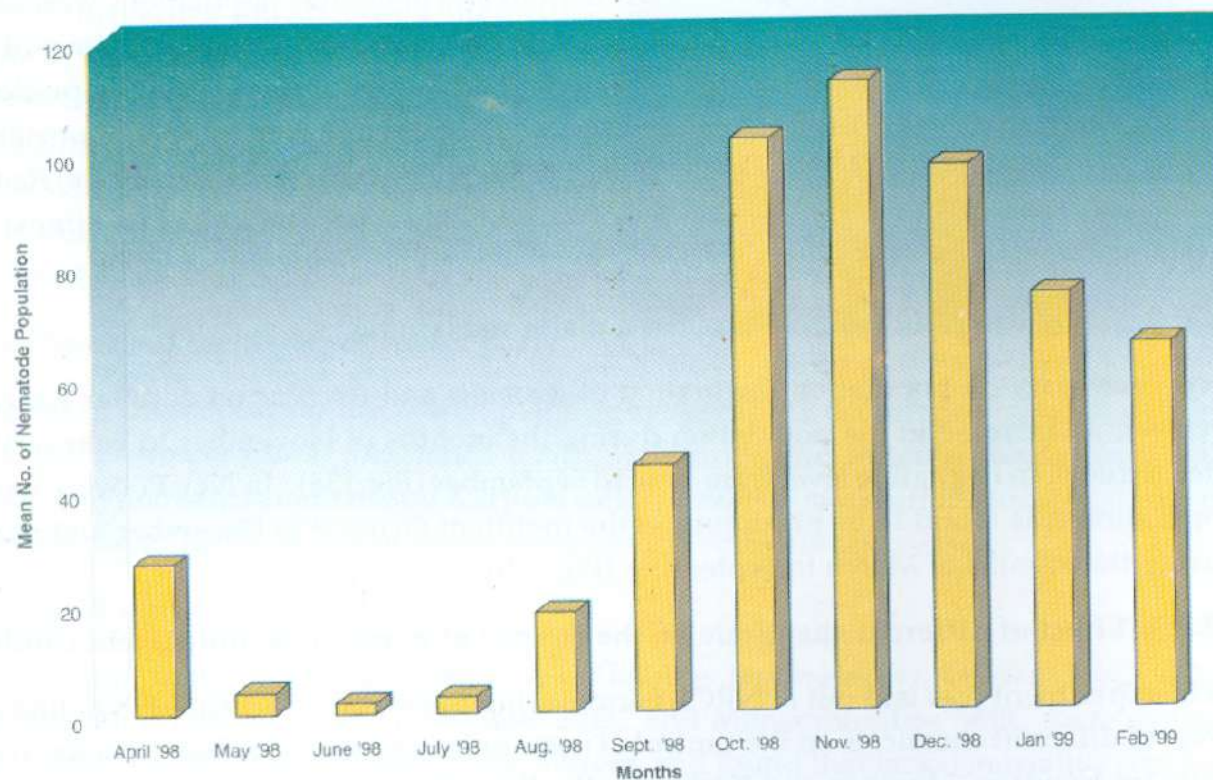


Fig. 13b - Population fluctuation of *Pratylenchus coffeae* in roots of Banana (cv. Nendran)

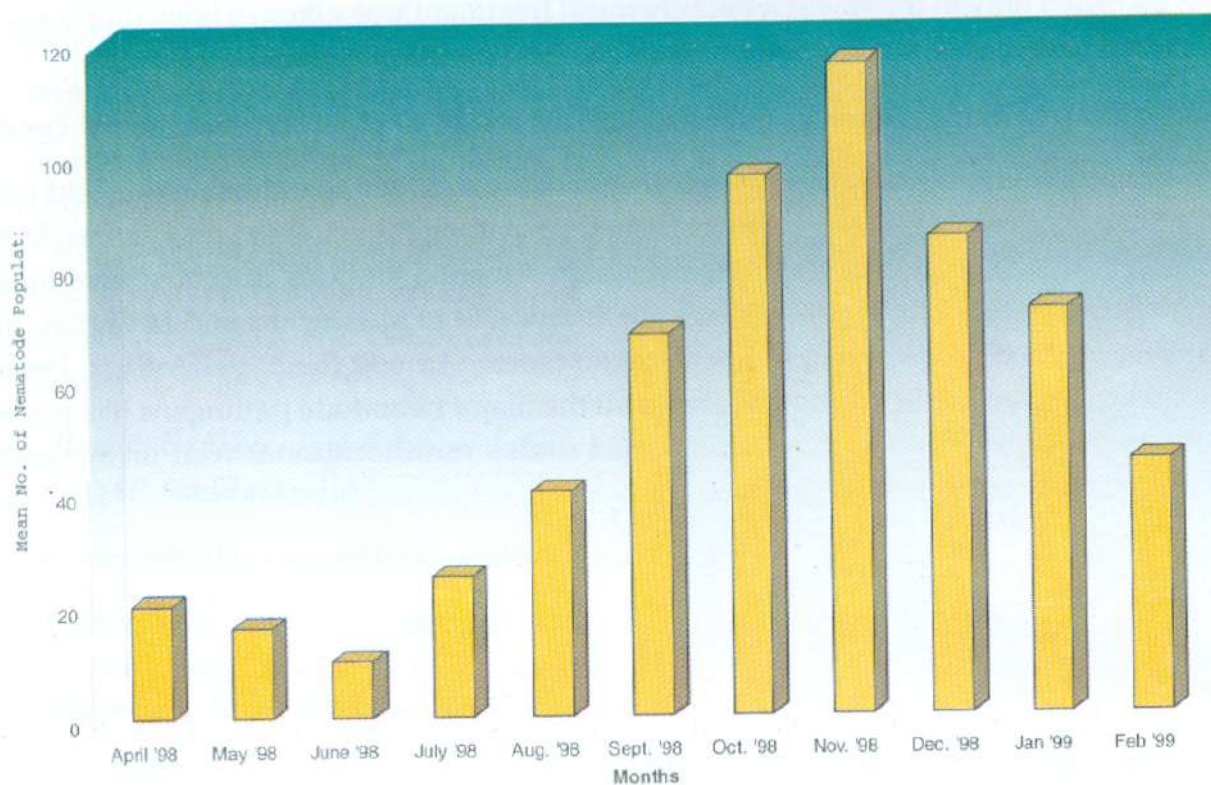


Table 15 : Effect of different chemicals on the control of nematodes in cultivars Nendran, Monthan and Karpuravalli

Treatment No.	Treatment Details	Nematode population in roots (10g) (<i>Pratylenchus coffeae</i>)*					
		Nendran		Monthan		Karpuravalli	
		Pre-treatment	Post-treatment	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
T1 -	Suckers dip with monocrotophos @ 0.5%	125	49	-	-	-	-
T2 -	Suckers dip with monocrotophos @ 0.5%+ Bavistin @ 0.1%	85	62	60	-	-	-
T3 -	T2 + Furadan @ 50g/plant after 3rd month.	110	-	45	-	-	-
T4 -	T3 + Furadan @ 50g/plant after 6th month.	105	-	-	-	52	-
T5 -	Pit treatment with Furadan @ 50g/Plant.	-	-	-	-	-	-
T6 -	T5 + Furadan @ 50g/plant after 3rd month.	-	-	-	-	40	-
T7 -	T6 + Furadan @ 50g/plant after 6th month.	75	-	78	-	-	-
T8 -	Mud slurry + sprinkle Furadan @ 50g/plant	-	-	-	-	-	-
T9 -	T8 + Furadan @ 50g/plant after 3rd month.	46	-	-	-	75	-
T10 -	T9 + Furadan @ 50g/plant after 6th month.	68	-	-	-	-	-
T11 -	Paring suckers followed by Furadan @50g/plant after 3rd month.	95	104	65	179	45	72
T12 -	T11 + Furadan @ 50g/plant after 6th month.	-	142	-	61	-	-
T13 -	Paring the sucker only.	55	100	-	-	-	-
T14 -	Check without paring (complete control)	70	185	25	56	15	25

* Mean of three replications, - Not yielded any nematodes

Table 16 : Occurrence of major plant parasitic nematodes recorded from the rhizosphere of banana

Sl. No.	District	No.of samples collected	No. of samples yielded major nematode pathogens							
			<i>Radopholus similis</i>		<i>Pratylenchus coffeae</i>		<i>Meloidogyne incognita</i>		<i>Helicotylenchus multicinctus</i>	
			Soil	Root	Soil	Root	Soil	Root	Soil	Root
I.	TAMIL NADU									
01.	Trichy	45	-	5	-	35	8	14	4	8
02.	Karur	11	-	-	-	2	2	5	2	5
03.	Salem	05	-	-	-	2	-	-	-	-
04.	Villuppuram	03	-	-	-	-	-	-	-	-
05.	Kanchipuram	04	-	-	-	-	-	2	-	2
06.	Cuddalore	10	-	-	-	5	-	3	-	2
07.	Thanjavur	10	-	-	-	7	2	3	-	2
08.	Dindigul	10	-	1	-	1	-	1	7	8
09.	Madurai	07	-	-	-	2	-	2	1	2
10.	Theni	13	-	2	-	3	1	3	6	3
11.	Virudhunagar	06	-	-	-	6	-	-	-	-
12.	Tirunelveli	13	-	-	1	7	4	-	2	1
13.	Kovilpatty	02	-	-	-	1	-	-	-	-
14.	Tuticorin	03	-	-	-	-	1	-	2	2
15.	Pudukottai	05	-	-	-	3	3	5	4	6
II	PONDICHERRY	07	-	-	-	4	3	4	-	2
III	KERALA	26	3	12	1	5	3	5	4	6
IV	GUJARAT	07	-	4	-	2	1	2	-	-
V	MAHARASHTRA	09	1	4	-	-	-	3	-	-
VI	NEH REGION	06	-	-	-	4	-	1	-	-
Total		202	4	28	2	89	28	53	32	49

- did not yield any nematodes

4.3.3. Fungal and bacterial disease management in banana (R. Thangavelu)

A trial was conducted on the incidence of Sigatoka disease in the cultivar Robusta which was planted at monthly interval from June 1997 to May 1998. The disease incidence was recorded at different stages of growth viz., vegetative (6 months after planting) flowering and harvesting stages.

Table 17 : Incidence of Sigatoka disease in Robusta planted at different months

Month of planting	Disease incidence (%) at various stages		
	Vegetative	Flowering	Harvesting
June 97	39.53	55.64	86.15
July 97	47.06	60.52	82.74
Aug 97	49.87	65.90	77.44
Sept 97	43.44	51.13	59.01
Oct 97	29.26	38.87	58.76
Nov 97	25.00	26.96	50.12
Dec 97	24.86	26.43	52.13
Jan 98	13.82	14.96	44.64
Feb 98	42.83	57.17	89.62
Mar 98	34.14	48.21	83.46
Apr 98	46.95	64.24	76.88

Generally the disease incidence was less at vegetative stage and reached the maximum at harvesting stage. Among the different months of planting, less incidence was recorded in Robusta planted in the months of November, December and January (Table 17).

4.3.4. Studies on viral diseases and their management (R. Selvarajan)

4.3.4.1. Survey

A survey was conducted for banana viral diseases in Kerala, Maharashtra, Tamil Nadu and Pondicherry. The percent infection of BBMV with respective cultivars are given in Table 18. In the cultivar Poovan, BSV was recorded in all the districts surveyed. In Trichur, Trichy and Pudukottai Black Sigatoka like symptoms were observed in cultivar Poovan, Robusta, Saba and Monthan. However, isolation of pathogen and study of morphology of conidia and ascospore are warranted to prove the existence of Black Sigatoka. Among the areas surveyed in Tamil Nadu and Kerala (Table) incidence of wilt *Fusarium oxysporum* f.sp *cubense* (Foc) was noticed only in Thichur. BSV symptom-free suckers of cultivar Poovan collected from a remote area of Tuticorin district and planted at net house of NRCB Research Farm in 1997, have not shown any symptoms till now. Incidence of BSV and BBMV in cultivars Poovan, Karpuravalli, Grand Naine were recorded in Pondicherry and Maharastra states.

Survey conducted in NEH region revealed the incidence of fungal and viral diseases; the details of the incidence is depicted in Table 19.

4.3.4.2. Symptomatology

Banana bract mosaic virus (BBMV) induces all the types of symptoms during September to March except reddish to pinkish spindle shaped streaks on pseudostem which is present throughout the season. In Red banana mottling and whitish patch along the midrib extending upto tip of the leaf have been observed. In Robusta, crinckling with wavy margin and mottling were recorded. Necrotic strain of BBMV showed similar symptoms observed during last year.

Table 18 : Banana diseases in Kerala and Tamil Nadu

Area	Cultivar	Percentage incidence			
		BBMV	BSV	BBTV	Wilt
Trichur	Nendran	1.25	-	-	-
	Ney Poovan	100	-	-	-
	Rasthali	-	-	-	yes
Ernakulam	Nendran	13.5	-	-	-
	Robusta	10.8	-	-	-
	Poovan	26.3	55.2	-	-
Melapuram	Poovan	22.5	41.5	-	-
	Ney Poovan	60.0	-	27.5	-
Palakadu	Nendran	16.1	-	2.3	-
	Robusta	50.0	-	-	-
	Poovan	10.0	40.0	2.0	-
	Ney Poovan	15.0	-	-	-
Pudukottai	Poovan	9.2	8.9	-	-
Cuddalore	Poovan	11.0	3.9	-	-
Villupuram	Monthan	10.0	-	4.5	-
	Poovan	5.0	25.0	-	-
Trichy	Nendran	33.1	-	-	-
Tanjore	Poovan	8.07	4.2	-	-
South Arcot	Poovan	45.1	4.16	-	-
	Monthan	31.3	-	-	-
	Robusta	50.0	-	-	-

4.3.4.3. BBMV in banana germplasm

Presence of BBMV in germplasm maintained in field gene bank of BRS, Kannara and NBPGR, Trichur were recorded. Fifteen accessions from NBPGR and twenty from BRS, Kannara had typical BBMV symptoms. BSV was present in almost all Mysore group of bananas. Only a few Palayankodan types were free of BSV symptom. At BRS, Kannara, accessions viz., Nendran, Kunnan, Wather, Bodles Altafort, Pachanadan, Manjeri Nendran, Thenkadali, Co-1, Rasthali, Karpuravalli, Dudhsagar, KNR 2/95, Kullam, Paloor, Chandra Bale, Dakshinsagar, Vannan and Lacatan were infected with BBMV. The 13 accessions found infected with BBTV are Saapkal (AAB), Dwarf Jahaji (AAA), Poovan (AAB), Thera Jajaji (AAA), Theren Akhi (AAA), Kanai Bansi (AA), Borjahaji (AAA), Lacatan (AAA), Karican type, Halflong, Honda and Chenichampa in the *Musa* field gene bank of Assam Agricultural University, Jorhat. The banana diseases in North Eastern Hill regions recorded by exploration

team are presented in Table.... BBTv was omni present in NEH region. Fourteen germplasm accessions added later to field gene bank of NRCB were also found to have BBMV symptom. Nine accessions belonging to Mysore group had BSV infection. Bluggoe, an IMTP wilt accession found to have infected with BBMV. Ladan Pointed (accn. 0241) had typical BSV symptoms. Accn. 0581, Wather (Rasthali) had BBMV symptoms. Teraban, a Mysore group did not exhibit any BSV symptoms.

Table 19 : Banana diseases in North-Eastern Hill Region

State	Regions	Disease	Cultivars Affected	
Assam	Dispur	BBTV	Man Jahaji Cheni Champa	Cultivated
	Marigaon	Fusarium Wilt	Monthan	Cultivated
	Nagaon	Fusarium Wilt	Kechulepa	Cultivated
	Kaziranga	BBTV	Robusta	Cultivated
			Wild <i>acuminata</i>	Wild
	Jorhat	Fusarium Wilt	Kachkel	Cultivated
	Sibsagar	Fusarium Wilt	Kachkel	Cultivated
	Dibrugarh	BBTV	Cheni Champa Robusta	Cultivated
	Tinsukia	BBTV	Cheni Champa Robusta	Cultivated
Meghalaya	Digboi	BBTV	Cheni Champa Robusta	Cultivated
	Margheretta forest range	BBTV	Cheni Champa wild types	Cultivated
	East Khasi Hill ranges	BBTV	Wild <i>balbisiana</i> diploid	Wild
	"	Fusarium wilt	Kaitlong	Cultivated
Arunachal Pradesh	Itanagar	BBTV		
		Fusarium wilt	Cheni Champa Kachkel Kechulepa	Cultivated
	Kimin Forest	Leaf spot	Acuminata diploid	Wild
	Namsai Forest range	Fusarium wilt	Unknown ABB clone	Cultivated

4.3.4.4. Serology

BBMV was detected using antisera produced by J.E. Thomas (Australia) provided by Y.S. Ahlawat (IARI). This work was done at ACPV, IARI. Five accessions which had typical BBMV symptoms showed positive reaction to BBMV antisera and PVY antisera in DAC-ELISA.

PVY antisera was provided by R.K.Jain (IARI) and the absorbance at 405 nm is presented in Table 20. As BBMV belongs to PVY group, PVY antisera also gave positive reaction. The cultivar Ney Poovan had absorbance value of 0.44 and 0.33 for BBMV and PVY antisera respectively.

Table 20 : Detection of BBMV using DAC-ELISA

Acession	Absorbance at 405nm	
	BBMV Antisera	PVY Antisera
Monthan	0.28	0.18
Pisang Awak	0.32	0.23
<i>M.balbisiana</i>	0.33	0.25
Kapur	0.32	0.30
Neypoovan	0.44	0.33
Healthy (Trichy)	0.12	0.16
Healthy (Delhi)	0.14	0.13
Buffer (control)	0.04	0.04

4.3.4.5. Effect of abiotic stress on BSV in Poovan

The symptoms of BSV were more severe in the month of October than in July. The disease rating has increased in October. Severe necrotic streak symptoms were observed in infected plants irrespective of nutrient stress. The temperature prevailed in October might have favoured more expression than in hot July temperature. Kottai vazhai symptom was recorded both in BSV infected and asymptomatic plants of Poovan.

4.3.4.6. Neer Vazhai

A field trial was laid out to find out the etiology of Neer Vazhai malady in Nendran. Treatment of suckers with Furadon, Bavistin and K_2SO_4 bagging and foliar spray did not control the Neer Vazhai malady. However, one plant out of nine yielded a healthy bunch. This showed a possible reversion of Neer vazhai malady occurs at low frequency.

4.3.4.7. Transmission studies (R. Selvarajan and B. Padmanaban)

Attempts made to transmit BBMV to Robusta, Nendran and Karpuravalli cultivars, with banana aphid *Pentalonia nigronervosa*, failed to show any transmission. However, the work is in progress with different acquisition feeding / inoculation time. The lace wing bug is also being tried for transmission of BBMV. The sugarcane mealy bug, *Sachharococcus sachharai* cock is used for transmission of BSV from Poovan to Pisang Ceylon (a virus free, INIBAP accession). The results are yet to be known.

4.4 POST HARVEST TECHNOLOGY

(General Leader : S.Shivashankar)

A total of 67 accessions were screened for post harvest storage life and fruit quality parameters. These accessions represented five major genomic groupings viz., AAA, AAB, ABB, AB and AA. The TSS values of accessions 0077 and 0066 were significantly higher at 29°C and 29.3° brix respectively. Among the 67 accessions, 19 accessions had acidity values higher than 0.80% and 6 accessions, less than 0.50%. The remaining 42 accessions possessed acidity values in the range of 0.5-0.8%. The Cumulative Physiological Loss in Weight (CPLW) of accessions 0078, 0192, 0010 (AAB), 0114, 0272 (AB) and 0161 (AAA) were significantly higher (15.98-22.60%) than control value of 7.33%. Nendran and Rasthali cultivars attained growth rate of upto 500mg dry weight per day towards the end of the maturation phase, while the other cultivars recorded an overall growth rate ranging from 300-400 mg/day during the same period. Poovan fruits stored at a storage temperature of 14°C could significantly enhance the green life. The process for the production of chocolate and banana bars was standardised. During storage 75% mature fruits were found to have maximum shelf life (14 days in Poovan and 12 days in Karpuravalli) as compared to other maturities. The post harvest loss at farmer's level was found to be in a range of 8-10% in Trichy and Karur. Out of this 3-5% was due to CPLW, 3-5% due to finger drop and 0-2% due to damage by mishandling.

4.4.1. Germplasm evaluation (S. Shivashankar and C.K. Narayana)

A total of 67 accessions were screened for postharvest storage life and fruit quality parameters (Table 21). These accessions represented five major genomic groupings viz., AAA, AAB, ABB, AB and AA and were drawn randomly from the assemblage of germplasm consisting of 670 accessions. The results were compared with the commercially important cultivar Karpuravalli as the control. Samples for the study were selected from the first two hands of fully mature bunches so as to ensure uniform age of hands. These were washed in running tap water and dried in air, packed in polythene bags with perforations and stored on the laboratory shelf for recording of shelf life data. The green life and yellow life of fruits were reckoned as the time elapsed from harvesting to ripening (change of peel colour from green to yellow) and from ripening to the end of yellow life (by visual examination of fruits) respectively. Fruit quality parameters like TSS, acidity, Brix/acid ratio were determined using standard procedures. The CPLW from harvest to ripening was determined.

There were wide and significant variations in fruit quality parameters and CPLW of accessions. The TSS values of accessions 0077 and 0066 were significantly higher at 29°C and 29.3° brix respectively. As the major component of soluble solids in banana these data showed that accessions 0066 and 0077 were comparatively rich in sugars which is one of the most important factors determining fruit quality.

Among the 67 accessions, 19 accessions had acidity values higher than 0.80% and 6 accessions, less than 0.50%. The remaining 42 accessions possessed acidity values in the range of 0.5-0.8%. Acidity in association with the TSS value are important determinants of the eating quality of the fruit. Using these data, it is, therefore, possible to select those accessions having the right mix of sweetness and acidity.

The CPLW of accessions 0078, 0192, 0010 (AAB), 0114, 0272 (AB) and 0161 (AAA) were significantly higher (15.98-22.60%) than control value of 7.33%. On the other hand accessions like 0002, 0069, 0281, 0066, 0014, 0214 (AAA), 0174, 0334 (AB), 0453 and 0079 (ABB) registered significantly lower values ranging from 1.81 to 4.80%. Since PLW represents loss of weight, accessions with high PLW which are undesirable from commercial point of view could be screened out.

Table 21 : CPLW and fruit quality parameters and shelf life of banana accessions

Genomic Group	Accn. No.	Name of Accession	CPLW (%)	TSS (°Brix)	Acidity (%)	°Brix/ Acidity	Green Life	Yellow Life
AAA	002	Gros Michel	1.81	20.30	0.48	42.57	4	6
	069	Amrit Sagar	4.80	26.50	0.48	56.06	5	3
	027	Dudh Sagar	7.01	23.13	0.56	41.23	6	4
	200	Robusta	5.78	23.20	0.53	43.53	6	3
	161	Chenkadali	22.26	25.17	0.55	45.70	18	6
	166	Thellachakkarakeli	11.65	27.40	0.60	45.87	15	6
	039	Tulsi Manohar	9.96	24.63	0.59	41.90	8	4
	105	Galanamaclu	8.79	22.33	0.62	48.60	16	5
	111	Singapuri	11.78	15.03	0.45	33.93	8	2
	009	Barjahaji	5.69	18.93	0.80	22.90	9	2
	459	Dole	7.46	17.73	0.68	24.13	8	7
	473	Petite Naine	13.32	18.87	0.63	30.17	10	7
AAB	136	Chandan	11.48	26.33	0.61	42.97	17	9
	061	Ayiranka Rajthali	5.74	22.03	0.88	25.03	8	7
	281	Lalvelchi	2.05	26.23	0.82	31.87	4	3
	066	Malbhog	4.20	29.30	0.60	48.60	6	10
	008	Saapkal	6.85	24.30	0.85	28.53	8	6
	043	Garomoina	5.24	21.43	0.96	22.37	5	9
	510	K2	13.61	21.33	0.77	27.50	6	3
	478	Pisang Mas	10.15	24.20	0.77	31.47	15	7
	006	Dudh Sagar	7.80	25.03	0.65	38.30	4	5
	241	Ladan Pointed	12.43	22.00	0.75	29.13	7	7
	328	Kali	5.29	25.50	0.66	38.53	5	9
	210	H2	7.55	24.37	0.83	29.37	6	7
	077	Malbhog	8.03	29.00	0.70	41.37	12	4
	375	Velipadathi	9.49	22.00	0.54	40.90	6	4
	133	Kaliban	7.03	25.97	0.65	39.63	9	8

	255	Chakkara Kunnan	12.85	23.57	0.76	31.03	13	7
	264	Mutheli	14.68	22.60	0.76	29.20	5	3
	156	Bersain	11.44	17.73	0.68	26.03	12	3
	279	Kullan	5.15	24.33	0.67	36.10	6	3
	048	Daaman	12.38	22.00	0.50	44.20	9	5
	360	Pey Kadali	12.87	23.67	0.86	27.40	4	3
	202	Sirumalai	12.24	22.06	0.54	41.10	6	2
	014	Digjowa	3.38	22.93	0.90	25.60	5	4
	214	Amruthpani	4.16	18.93	0.71	26.33	3	4
	078	Alpan	15.98	24.10	0.90	26.87	8	4
	197	Nendra Padathi	13.56	22.27	0.61	36.23	4	5
	192	Palayankodan	18.74	21.23	0.80	26.80	11	8
	010	Jatikal	19.32	25.60	1.05	24.33	5	4
	275	Malai Kali	10.80	24.07	0.79	30.03	6	6
AB	107	Nendra Kunnan	5.62	23.30	0.66	35.23	7	8
	174	Kodapanilla Kullan	3.62	25.93	0.56	46.67	8	4
	334	Chetty	4.80	25.40	0.58	43.53	4	6
	053	Aktoman	17.37	25.00	0.86	29.03	10	3
	113	Elakki Bale	11.39	23.93	0.77	31.17	4	5
	114	Adukkam	18.99	26.07	0.93	28.03	8	2
	234	Valia Kunnan	6.58	25.70	0.59	43.40	6	4
	232	Nattu Poovan	9.41	23.97	0.40	59.87	6	3
	272	Kijnan	19.32	25.03	0.60	41.43	5	2
ABB	089	Bartis Piro	7.59	26.17	0.51	51.60	7	8
	231	Jammulapalem collection	7.02	27.20	0.65	41.73	9	8
	517	Boodibale	8.72	27.30	0.60	44.97	10	7
	004	Kechulepa	8.60	26.03	0.57	45.50	12	7
	353	Calananul	7.54	28.43	0.46	61.47	11	3
	108	Kachkela	7.45	26.40	0.61	43.43	12	6
	453	Bankela	3.55	26.37	0.58	47.17	3	3
	079	Kanthali	4.26	26.23	0.60	43.33	8	6
	090	Bersain	6.40	25.67	0.92	27.53	3	7
	267	Singalal	6.29	21.90	0.67	32.80	6	4
	051	Silver Monthan	11.36	21.07	0.93	22.63	8	5
	084	Bankel	8.90	20.07	0.87	23.10	8	5
	416	Sakkai	14.32	20.93	1.10	18.90	10	6
	087	Chinia	7.21	21.00	0.90	23.10	3	5
AA	013	Amrit Sagar	11.73	22.20	1.03	21.40	4	3
	064	Kanai Bansi	13.44	17.40	0.86	20.13	8	2
	208	Anai Kombar	6.10	18.97	1.08	17.47	2	3

4.4.1.1. Studies on the pattern of fruit growth

The study was conducted on six commercially important cultivars of banana namely, Karpuravalli, Poovan, Pachanadan, Rasthali, Robusta and Nendran. The rate of fruit growth was monitored by recording fruit growth parameters at regular intervals from flowering emergence to maturity. The rate of fruit growth was computed as the increase in dry weight per unit time. The rate of growth registered a linear increase with increase age of fruit till maturation. There were marked differences in the rate of fruit growth among the cultivars. Nendran and Rasthali cultivars attained growth rates of upto 500mg dry weight per day towards the end of the maturation phase, while the other cultivars recorded an overall growth rate ranging from 300-400 mg/day during the same period. The growth of the banana fruit followed the pattern of single sigmoidal type of growth curve (Fig.14).

Data presented in Table 22 clearly indicate that the fruit density, though significantly different at various growth stages, did not show any definite trend during the course of fruit development. The fruit density did not show a marked change during fruit development phase confirmed that the proportion of intercellular space remained almost the same during fruit growth. However, the pulp:peel ratio of 3.321 in Rasthali at full maturity followed by 2.015 in Poovan. A higher pulp:peel ratio at maturity represents a greater partitioning of dry matter towards the pulp and is desirable from the point of view of its postharvest performance. The cultivar Rasthali is characterized by a thin peel and showed a higher apportionment of dry matter towards the pulp, as confirmed by its higher pulp:peel ratio. On the other hand, Pachanadan is characterized by low pulp:peel ratio of 1.141 at maturity, a clearly undesirable attribute in term of its postharvest quality. The pulp:peel ratio in all the six cultivars increased with increasing fruit maturity, thereby indicating its utility in fixing the harvest maturity in banana.

Table :22 Pulp:peel ratio and fruit density in developing fruits of banana varieties

Days after shooting	Karpuravalli		Poovan		Nendran		Pachanadan		Rasthali		Robusta	
	Pulp: peel ratio	fruit density	Pulp: peel ratio	fruit density	Pulp: peel ratio	fruit density	Pulp: peel ratio	fruit density	Pulp: peel ratio	fruit density	Pulp: peel ratio	fruit density
40	0.569	1.009	0.704	0.932	0.655	0.890	0.309	0.835	0.977	0.952	0.389	0.901
55	0.859	0.855	1.069	0.975	0.985	0.935	0.434	0.867	1.510	0.986	0.647	0.916
70	0.893	0.958	1.292	1.003	1.019	0.989	0.645	0.932	1.747	1.005	0.889	0.960
85	1.214	0.947	1.606	1.026	1.460	0.981	0.871	0.935	2.823	0.999	1.152	0.981
100	1.364	0.971	1.907	1.037	1.510	0.969	1.074	0.966	3.113	0.991	1.392	0.978
115	1.773	0.975	2.015	1.026	-	-	1.141	0.972	3.321	0.983	1.618	0.989
C.D.	0.040	0.034	0.043	0.058	0.094	NS	0.019	0.040	0.070	NS	0.043	0.046

(P=0.05)

The figures are the mean of six values

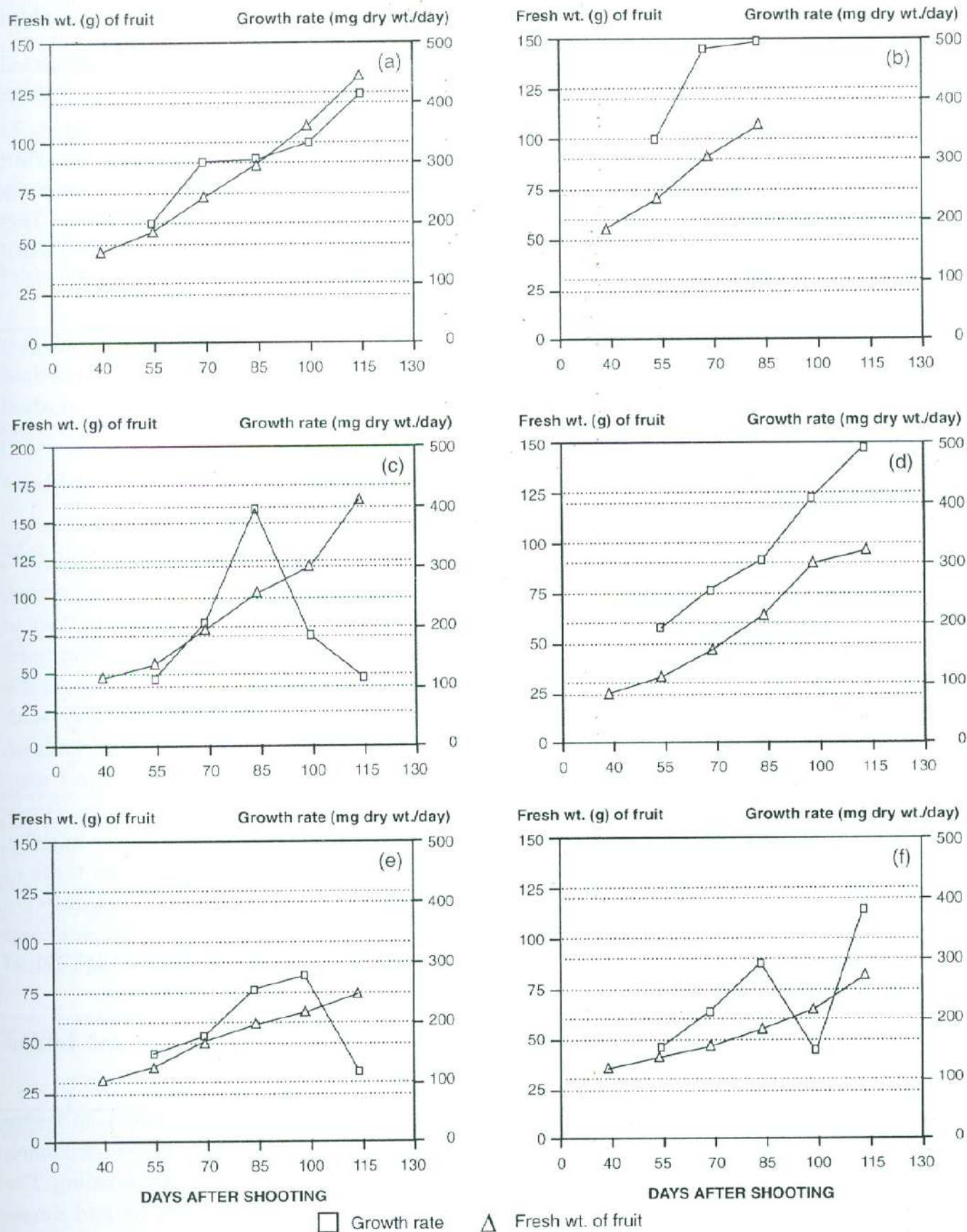


Fig. 14 : Pattern of development of banana fruit varieties
a) Pachandan b) Nendran c) Robusta d) Rasthali e) Poovan and f) Karpuravalli

4.4.1.2. Experiments on extension of shelf life of banana

In an attempt to extend the green life of harvested banana, an experiment was conducted using ethylene absorbent. KMnO_4 impregnated on soilrite carrier and packed into sachets was introduced into sealed polythene bags containing mature fruits of Poovan cultivar. As the quantity of ethylene absorbent increased in proportion to the weight of fruit, the green life increased from 44 days to 73 days as against 22 days in control. Thus, Poovan fruits stored at a storage temperature of 14°C could significantly enhance the green life. This experiment shows that removal of liberated ethylene from the vicinity of banana as and when formed, is an effective method of extending the green life of banana.

4.4.1.3. Standardization of process for making Banana bars and Chocolates

The process for the production of chocolate and banana bars was standardised. The method involves blending the fruit homogenate with atta and sugar at $80-90^\circ\text{C}$ followed by gradual dehydration. The products were stable at room temperature for two weeks.

4.4.1.4. Effect of stage of maturity on shelf life, ripening and quality of Banana cultivars Karpuravalli and Poovan (C.K. Narayana)

Fruits of three different maturities in Poovan (75%, 90% and 100%) and two maturities (75% and 90%) in Karpuravalli were stored at ambient conditions ($26-31^\circ\text{C}$) without any treatments. During storage 75% mature fruits were found to have maximum shelf life (14 days in Poovan and 12 days in Karpuravalli) as compared to other maturities. The CPLW was found to be more (25-37) in 75% mature fruits than others at the end of shelf life. The pulp to peel ratio was more in Poovan (2.32, 2.21 & 1.95) than Karpuravalli (1.71 and 1.56) and it increased with increase in maturity and ripening. The peel thickness was more in Karpuravalli than Poovan. The total soluble solids had no correlation with maturity. All maturities attained almost same level of T.S.S. (21.73 to 24.27° Brix) at the end of shelf life. The total sugars were inversely correlated with maturity. The acidity did not show any correlation with maturity initially, but at the end of shelf life, fruits of higher maturity had more titrable acids than those of lower maturity. Poovan had almost double the acidity of Karpuravalli. Reducing sugars were more than non-reducing sugars throughout the storage life. Ripening was normal and complete in all maturity grades and organoleptic quality was acceptable at the end of shelf life (Table 23, 24 and 25).

4.4.1.5. Survey for postharvest loss assessment in Banana (Karpuravalli) in and around Trichy (C.K. Narayana)

Assessment of postharvest losses in banana was carried out by interviewing farmers in Trichy and Karur districts according to a structured questionnaire covering various aspects of banana like preharvest practices, harvesting, grading, packaging, transportation and marketing. The postharvest loss at farmer's level was found to be in a range of 8-10% in Trichy and Karur. Out of this 3-5% was due to physiological loss in weight, 3-5% due to finger drop and 0-2% due to damage by mishandling.

Table 23 : Effect of maturity on shelf life (days) of Poovan and Karpuravalli banana during storage at ambient conditions

Maturity	Shelf life		Green life		Yellow life	
	Poovan	Karpuravalli	Poovan	Karpuravalli	Poovan	Karpuravalli
100%	11	-	5	-	6	-
90%	11	11	5	7	6	4
75%	14	12	10	6	4	6

Table 24 : Effect of maturity on physico-chemical quality of Poovan banana during storage at ambient conditions

Maturity	Storage period (days)	Quality parameters					
		CPLW (%)	Pulp:peel ratio	T.S.S. (°Brix)	Acidity (%)	Reducing Sugars (%)	Total Sugars(%)
100%	0	-	2.32	2.83	0.116	0.497	0.680
	5	6.62	2.42	8.98	0.238	1.192	1.205
	11	16.90	7.43	24.47	0.396	17.152	17.753
90%	0	-	2.21	6.27	0.175	0.135	0.540
	5	8.39	2.60	13.77	0.469	3.895	6.917
	11	18.95	4.47	21.73	0.429	20.834	21.773
75%	0	-	1.95	7.71	0.128	0.446	0.491
	5	7.17	2.34	11.00	0.214	1.440	2.142
	10	16.53	4.12	20.40	0.363	10.879	13.813
	11	18.89	4.72	24.65	0.444	17.576	22.283
	14	25.37	5.40	24.27	0.524	18.419	23.027
C.D. at 5%							
Maturity		0.995	0.215	0.668	0.006	1.099	1.782
Storage period		1.626	1.905	1.157	0.011	0.953	3.086
Maturity X period		2.815	3.300	2.004	0.019	3.299	5.345

Table 25 :Effect of maturity on physio-chemical quality of Karpuravalli banana during storage at ambient conditons

Maturity	Storage period (days)	Quality parameters					
		CPLW (%)	Pulp:peel ratio	T.S.S. (°Brix)	Acidity (%)	Reducing Sugars (%)	Total Sugars(%)
90%	0	-	1.71	3.27	0.052	0.680	0.840
	7	5.99	2.23	12.186	0.134	7.700	7.860
	11	15.77	4.38	26.89	0.310	21.72	27.77
75%	0	-	1.56	3.04	0.098	0.360	0.410
	6	8.84	1.97	14.32	0.152	6.030	7.640
	12	18.93	3.77	28.07	0.268	15.87	22.50

5. TECHNOLOGY ASSESSED AND TRANSFERRED

Through evaluation of germplasm, NRCB has identified 8 promising accessions with superior traits like yield, quality and suitability to marginal lands. These being assessed in multilocation trials under various agro-ecological conditions. The details of selected accessions are as follows

Table 26 : Promising accessions under evaluation:

Accession Number	Genomic group/ Sub group	Superiority of traits
0016	ABB-Monthan (Culinary)	High yielding. Shorter crop cycles of both main crop and ratoon, yield stability over years.
0030	AAB-Silk (dessert)	High yielding and good fruit quality
0079	AAB-Pisang Awak (dual)	Dwarf stature, High Yielding, Yield stability over years & tolerance to yellow Sigatoka
0052	AAB-Ash Monthan (Culinary)	Highly tolerant to sodicity, Yield stability over years & Good quality fruits.
0252	AAB-Bontha (Unique) (Culinary)	Consistent high yielding & Good quality fruits

6. EDUCATION AND TRAINING

NRCB is actively involved in educating the local farming community either at institutes farm level or at farmer's field. NRCB participated in Kissan Mela and the interface with farmers programmes held at Thottiam. Local farming community is regularly educated through All India Radio (AIR) Programmes.

7. AWARDS AND RECOGNITIONS

Dr. P.Sundararaju, Sr. Scientist Dr. S. Scientist Dr. S. Shivashankar, Sr. Scientist, Dr. B. Padmanaban, Sr. Scientist, Dr. S. Uma, Scientist (SS), Dr. R. Selvarajan, Scientist, Dr. K.J. Jeyabaskaran, recognised as advisory committee members of to guide the M. Phil. students.

Dr. B. Padmanaban, Sr. Scientist (Entomology) has been declared as Fellow by the Plant Protection Association of India, Hyderabad, 500 030 during December 1998.

Dr. B. Padmanaban, Sr. Scientist (Entomology) has been admitted to the Fellowship of the Indian Academy of Entomology, Chennai 600 032 from January 1999.

8. LINKAGES AND COLLABORATION IN INDIA AND ABOARD

NRCB has strong linkages with International Network for the Improvement of Banana and Plantains (INIBAP), France with respect to exchange of Germplasm. Till date 52 exotic accessions have been introduced through NBPGR, New Delhi, which are under different stages of field evaluation and characterisation. Three of the introduced accessions have been found suitable for cultivation in marginal conditions and these are under multilocation trails.

The NRCB genebank curator, Dr. S.Uma was invited by INIBAP to undergo training on 'Musa Germplasm Information System' at Guadeloupe, France. With this training she is in the global germplasm information network wherein we can access the details of accessions of any global genebank and useful accessions can be requested through INIBAP for utilization in Indian Breeding Programmes. The database has been developed for 400 Indian Musa accessions and the first batch of details on 50 Indian accessions has been submitted to the MGIS coordinator, France through the regional Co-ordinator for global information network.

NRCB has been one of the major collaborating centre with INIBAP in the area of Banana Research and developments at global level. INIBAP has funded a project entitled "Collection, Characterisation of Banana and Plantains of North-eastern India" operative at NRCB with Dr. S.Uma as a Principle Investigator. Under this project an amount of Rs. 13,20,000/- has been provided for a period of three years (1998-2001) to carryout exploration programme in the North-Eastern states of Assam, Meghalaya, Arunachal Pradesh, Tripura, Mizora, Manipur and Nagaland.

As one of the global collaborative networking programme, NRCB is involved in the International Musa Testing Programme (IMTP) as the nodal agency for India, funded by INIBAP. India has three test sites each for testing Sigatoka Leaf Spot and Fusarium Wilt resistance. The new global hybrids and cultivars are tested for their suitability to our conditions as new introductions and resistance to two major diseases i.e., Fusarium wilt (*Fusarium oxysporum* fsp. *cubense*) and Yellow Sigatoka (*mycosphaerella musicola*). 23 exotic introductions have been tested for their yield and quality traits apart from reaction to Wilt and Sigatoka. This led to the identification of 3 promising accessions which have promise to replace local Pachanadan (dessert type) and bulggoe varieties one each with culinary and dual utility.

9. AICRP/COORDINATION UNIT/NATIONAL CENTRES

NRCB is an active participant under All India Coordinated Research Project (AICRP-Tropical Fruits) undertaking research under following programmes

1. Collection, Conservation and evaluation of Musa germplasm
2. Evaluation of FHIA hybrids
3. Evaluation of FHIA hybrids for resistance to Sigatoka
4. Evaluation of FHIA hybrids for resistance to fusarium wilt.

10. PUBLICATIONS

Papers presented in Symposium / Seminar/Workshop

Sundararaju, P., and Uma, S. 1998. Evaluation of Promising Hybrids and Cultivars of Banana against Major Nematode Pathogens. *Abst. III International Symposium of Afro-Asian Society of Nematologists*, April 16-19, 1998, Coimbatore. pp. 46

Selvarajan, R., Thangavelu, R. and Sundararaju, P. 1998. A Status report on BBMV and BSV diseases of Banana in India. Paper presented in "IV Institute Management Committee Meeting" held at NRC on Banana, Trichy on 23rd June, 1998.

Sundararaju, P. 1998. Banana Research and Development in India. Paper presented in the "8th Annual Meeting of INIBAP/ASPNET Regional Advisory Committee" at Brisbane, Australia on 21-23, October, 1998.

Singh, H. P., I.S. Yadav and S. Uma, 1998. Current Status of tropical fruits in India, *Indian J Agril Sci.* 68 (8 special issue): 494-507.

Singh, H.P., S. Uma and M. Dayarani, 1998. Marketing channels and processing chains of platin chips in South India. In the proceedings of International Symposium on Banana and Food Security held on 10-14 November at Doula, Cameroon. Pg 19-20

Uma, S., H.P. Singh and M. Dayarani, 1998. Organisation Structure of Banana Supply and marketing in India- A case study. 'ibid.' pg. 21-22

Jeyabaskaran, K.J., S. Uma and H.P. Singh, 1998. Salt tolerance mechanism in Banana. 'ibid' pg. 33-34

Uma, S., H.P. Singh and M. Dayarani, 1998. Transportation Time Lag and Culture Initiation Efficiency in Banana. In the proceedings of New Horizons in production and Post harvest Management of tropical and subtropical fruits at IARI, New Delhi. pg. 15

Singh, H. P., S. Uma and M. Dayarani, 1998. Explant Disinfection strategies for In-vitro culture Initiation on Musa Genomes. In the proceedings of New Horizons in Production and Post harvest management of tropical and subtropical fruits at IARI, New Delhi. pg. 17

Uma.S, H.P. Singh and M. Dayarani, 1998. Studies on In-vitro Rooting Response of Banana Cultures. In the proceedings of New Horizons in production and Post harvest management of tropical and subtropical fruits at IARI, New Delhi. pg. 19

Uma.S, H.P. Singh, Shyam.B and M.Dayarani, 1998. Musa Genetic Resource Management Programme at NRCB, Trichy. In the proceedings of National Dialogue: Issues in management of Plant Genetic Resources held on 1.2 Dec., 1998 at NBPGR, New Delhi. pg. 18

Singh, H.P., S. Ua and P. Sundararaju, 1998. Status paper on Banana growing scenario in India and Export Perspective. In the Proceedings of National Academy of Agricultural Science held on Feb 21-24, 1999 at Jaipur. p. 121.

Technical Bulletins

Sundararaju, P. and Thangavelu, R. 1998. Banana Cultivation Technical Know How and Do How (English). Technical Bull.No.1. NRC on Banana, Trichy, pp.28.

Sundararaju, P. and Thangavelu, R. 1998. Banana Cultivation Technical Know How and Do How (Tamil). Technical Bull. No.2, NRC on Banana, Trichy, pp.30.

Sundararaju, P., Padmanaban, B., Selvarajan, R., Thangavelu, R. and Jeyabaskaran, K.J. (Eds.) 1998. NRCB at a Glance - National Research Centre on Banana, Trichy. pp.18

Book Chapters

Sundararaju, P. 1998. National Research Centre for Banana. Fifty Years of Horticultural Research (Eds. S.P.Ghosh, P.S.Bhatnagar and N.P.Sukumaran-Divn.of Horticulture, ICAR, N.Delhi). pp.107-111.

Sundararaju, P. 1998. New Initiatives - National Research Centre on Banana, ICAR News Vol.4(3); pp 4-5.

Popular Articles

Jeyabaskaran, K.J., Thangavelu, R. and Sundararaju, P. 1998. Kalar Uvar Nilangalil Vazhaiyil Ilay Karukalai Kattupaduthuvathu Eppadi (Tamil). Valarum Velanmai. 24(10): 42-45

Sundararaju, P., Thangavelu, R. and Padmanaban, B. 1998. Hill Banana : Problems and Solutions. In : Vezhanmani of Dinamani (Tamil), 10th August, 1998.

Reports

Sundararaju, P. and Padmanaban, B. (Eds.) 1998. Proceedings of the Third Annual Staff Research Council Meeting held on 12th June 1998 at National REsearch Centre on Banana, Trichy. pp. 55

Sundararaju, P., Padmanaban, B., Selvarajan, R. and Thangavelu, R. (Eds.) 1998. Annual Report of NRC on Banana, Trichy for the year 1997-98. pp. 78.

Invited Lectures

Dr. P. Sundararaju, Acting Director invited to deliver a Special Lecture on "*Integrated Nematode Management in Plantation Crops*" in the Training Course on Research Advancement for Economic Management of Phytonematodes in Agriculture at GAU, Anand on 11th August, 1998.

Dr. P. Sundararaju, Acting Director invited to deliver a Special Lecture on "*Conservation of Plant Genetic Resources*" at St. Joseph College, Trichy on 15th Nov., 1998.

Dr. P. Sundararaju, Acting Director invited to deliver a Presidential Address on "*Banana Cultivation Practices*" in the Banana Seminar jointly organised by Tamil Nadu Agril. Dept. and FACT at Perugamani, Trichy on 28th December, 1998.

Dr. P. Sundararaju, Acting Director invited to deliver a Special Lecture on "*Recent Trends in Plant Biotechnology*" at Jamal Mohamed College, Trichy on 3rd March, 1999.

Dr. P. Sundararaju, Acting Director invited to deliver a Special Lecture on "*Integrated Insect Pests, Nematode and Disease Management of Banana in India*" in the Seminar on "*Technological Advancement in Banana Production, Handling and Processing Management*" organised by M/s. Pralshar Bio-Products Pvt. Ltd., at Jalgaon on 27-28th March, 1999.

11. LIST OF APPROVED ON-GOING PROJECTS

- | | |
|-------------------|--|
| GERM.I (101) | : Banana Crop Improvement through germplasm management and enhancement. |
| GERM.II (101) | : Crop Improvement through conventional breeding of banana germplasm. |
| BIOTECH. III(101) | : Improving banana cultivars through biotechnological approaches for yield quality, biotic and abiotic stress resistance |
| HORT.I (201) | : Standardisation of Agrotechniques for banana production and productivity. |
| PHY.I (201) | : Studies on flowering behaviour and its regulation in banana germplasm accessions. |
| SOILS. I (201) | : Studies on Amendment and Reclamation of saline sodic soil for banana. |
| SOILS. III(201) | : Efficiency analysis of Nendran banana orchards in Tamil Nadu. |
| ENT. I (301) | : Insect Pest Management in Banana |
| NEMT.I (301) | : Studies on Banana Nematodes and their Management. |
| PATH. I (301) | : Studies on fungal and bacterial diseases and their management. |
| PATH. II (301) | : Bio-control of fusarium wilt of banana in wetland production system |
| VIROL. I (301) | : Studies on viral diseases of banana and their management. |
| PHT. I (401) | : Post harvest management, evaluation and processing of banana. |
| PHT. I (402) | : Studies on Process and Product development, value addition and Waste Utilization in banana. |
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12. CONSULTANCY, PATENTS, COMMERCIALISATION OF TECHNOLOGY

Consultancy

The CPC of the centre took up three product evaluation trials during the year. The total revenue from the trails runned up to Rs. 1,10,000/- The Products under evaluation one PLANTOZYME (Pralshar Biproducts Ltd, Goa), SANJIBAN (PRANTIK International, Pondichery) and Roundup (Monanto Co.,) Dr. S. Shivashankar, Senior Scientist has been designated as in-charge of these trails. Project reports in respect of plantozyme and Sanjiban have been completed and sent to the clients while the 'Round up' work is in progress.

13. RAC, INSTITUTE MANAGEMENT COMMITTEE, SRC, IJSC, ETC. MEETINGS WITH SIGNIFICANT DECISIONS

Fourth Research Advisory Committee meeting

The Fourth Research Advisory Committee (RAC) meeting was held on 20th March,, 1999, to review the progress made and provide focus on future research Dr. S.P. Ghosh (DDG) chaired the session in the absence of Dr. I. Irulappan, Chairman RAC who has expressed his inability to attend the meeting on 20th March 1999.

Dr. P. Sundararaju, Acting Director NRCB while welcoming the Chairman and other RAC members he breifed the research achievements of NRCB to the RAC members. Subsequently, RAC members clarified their points with the concerned scientists. Dr. S. Uma, Member Secretary RAC presented the action taken report on third RAC meeting proceedings and Dr. B. Padmanaban, Member Secretary, SRC presented the action taken report of Third Annual Research Council meeting. After detailed discussion, action taken of both RAC and SRC were approved. The meeting concluded with the remarks by the chairman with appreciation to the Ating Director and his team of scientists for their excellent work and team spirit to develop the institute as a centre of excellence.

i. Research Advisory Committee

Members

Dr. I. Irullappan, Ex-Dean, TNAU. Vice President, Maxworth, Chennai.	- Chairman
Asst. Director General (Hort.) ICAR, New Delhi.	- Member
Dr. P. Sundararaju, Director I/c. NRC on Banana, Trichy.	- Member
Dr. S. Sambandhamurthy Dean (Rtd.), Hort. College & Res. Instt. TNAU., Periyakulam.	- Member

Dr. A.K. Roy Director of Research, A.A.U., Jorhat.	- Member
Dr. A. Summanwar Head, IARI. Regional Station, Agricultural College, Pune.	- Member
Dr. Rajani Nadegowda Tissue Culture Division, National Chemical Laboratory, Pune.	- Member
Dr.P.R.Mahajan Ex-Associate Director of Research, MPKV., Jain Irrigation, Jalgaon.	- Member
Shri Maniram Singh Guruji CPI Office, Bhagalpur, Bihar.	- Member
Shri Baba Saheb Thube Ex-MLA, At & PO: Kauneer Pathar, Taluka Barner, Dist.: Ahmednagar,(M.S.)	- Member
Dr. S. Uma Scientist(SS), NRCB., Trichy.	- Member Secretary

Fifth Institute Management Committee Meeting

The Fifth Institute Management Committee Meeting of NRCB was held on 17th February , 1999 under the chairmanship of Dr. P. Sundararaju, Acting Director, NRCB and took some important decisions like purchase of equipments for the research work and recognition of private hospitals for the benefits of NRCB staff members. The proceedings of the meeting were brought out in time and was approved by the council.

ii. Institute Management Committee

Members

Dr. P. Sundararaju, Director I/c. NRC on Banana, Trichy	- Chairman
Asst.Director General ICAR, New Delhi.	- Member
Mr. Vasudevan, IAS. Dir.of Hort.& Plantation crops, State Govt.of Tamil Nadu, Chennai.	- Member
Director of Horticulture State Govt.of Karnataka, Bangalore.	- Member

Dean-Horticultural College & Research Institute
Periyakulam, Tamil Nadu.

- Member

Shri Maniram Singh Guruji
CPI Office, Bhagalpur, Bihar.

- Member

Shri Baba Saheb Thube
Ex-MLA, At & PO: Kauneer Pathar,
Taluka Barner, Dist.: Ahmednagar, (M.S.)

- Member

Dr. B.M.C. Reddy
Principal Scientist, IIHR., Bangalore.

- Member

Dr. R.D. Rawal
Principal Scientist, IIHR., Bangalore.

- Member

Dr. S.Uma
Scientist (SS), NRCB, Trichy.

- Member

Finance & Accounts Officer
Sugarcane Breeding Institute, Coimbatore.

- Member

Mr.N.Viswambharan
A.A.O., NRCB, Trichy.

- Member Secretary



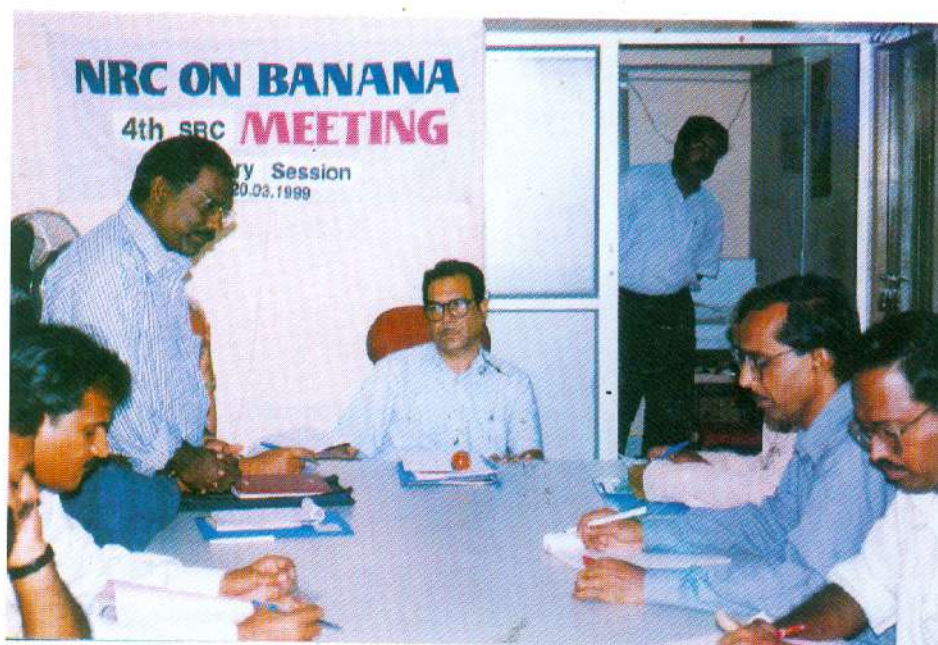
Dr. P. Sundararaju, Acting Director
Chairing IMC meeting of NRCB

Members of IMC visits NRCB Farm



Fourth Staff Research Council meeting

The Fourth Staff Research Council meeting of NRCB was held on 15th March, 1999 at the conference hall of NRCB under the Chairmanship of Dr. P. Sundararaju, Acting Director. All the scientists have participated in the meeting. Dr. P. Sundararaju, in his inaugural address highlighted the institute research programmes and advised the scientists to prepare adhoc projects under NATP for getting external fundings. Subsequently all the scientists presented the salient research findings of their research project for the year 1998-99 and the technical programme for 1999-2000. New projects presented by Drs. C.K.Narayana, S.D. Pandey and R. Selvarajan before the meeting were also got approved by the Staff Research Council meeting. The plenary session of fourth SRC held under the chairmanship of Dr. S.P. Ghosh, Dy. Director General (Hort.), ICAR on 20th March 1999, were modified the research programme as per the valuable suggestion given by DDG (Hort.).



Dr. S.P. Ghosh, DDG (Hort.) Chairing the plenary session of
4th SRC meeting of NRCB.

14. PARTICIPATION OF SCIENTISTS IN CONFERENCES, MEETINGS, WORKSHOPS, SYMPOSIA ETC. IN INDIA AND ABROAD

HUMAN RESOURCE DEVELOPMENT

Participation in Symposia/ Conference/Workshop

National

Dr. P. Sundararaju, Sr. Scientist, Dr. S. Shivashankar, Sr. Scientist and Dr. R. Selvarajan, Scientist, attended the Seminar on "Technological Advancement in Banana Production, Handling and Processing Management" held from 27 to 28 March 1999 at Jalgaon.

Dr. P. Sundararaju, Acting Director attended "III International Symposium of Afro-Asian Society of Nematologists" held at Hotel The Residency, Coimbatore from 16-19th April, 1998.

Dr. P. Sundararaju, Acting Director attended "National Consultative Seminar on Horticultural Research and Development and Export" held at IVRI, Hebbal, Bangalore organised by IIHR, Bangalore on 6th August, 1998.

Mr. S. Karthikeyan, Tech. Asst.(Journalism) attended the "ARIS Incharge's Workshop" held at NBPGR, New Delhi from 17-18th August, 1998.

Dr. K.J. Jeyabaskaran, Scientist attended "National Symposium on Future Goals of Physiological Research for the Improvement of Plant Resources" held at Annamalai University, Chidambaram from 18-20th December, 1998.

International

Dr. S. Shivashankar, Senior Scientist and Dr. S.Uma, Scientist (SS) attended an "International Symposium on Bananas and Food Security" held at Douala (Cameroon) from 10-14th November, 1998.

Training courses attended

Dr. S. Uma, Scientist (SS) and Dr.K.J.Jeyabaskaran, Scientist attended a training programme on "Design and Analysis of Field Experiments" held at IASRI, New Delhi from March 30-April 14, 1998.



Asian delegates participating in the International Conference on 'Banana and Food Security' held at Cameroon from 10-14 Nov. 1998.

Dr. R.H. Laxman, Scientist attended training programme on "Internet for Agricultural Information - Communication" held at MANAGE, Hyderabad from 15-18th April, 1998.

Mr. T. Sekar, Technician attended a training programme on "Identification of *Radopholus similis* and *Heterodera oryzicola*" at C.P.C.R.I. (Regional Station), Kayangulam from 27-31 October, 1998.

Dr. B. Padmanaban, Dr. S. Uma, Scientists (SS) and Dr.R.H.Laxman, Scientist attended the "Intensive Training Course in Official Hindi (Pragya)" conducted by the Central Hindi Teaching Scheme during November, 1998.

Mr. M. Krishnamoorthy, PA to Director and Mr.R.Sridhar, Junior Stenographer attended the computer training course "Introduction to MS Office" conducted by Indian Agricultural Statistics Institute, New Delhi from 11-23rd January, 1999.

Meetings attended

National

Dr. P. Sundararaju, Acting Director presided over the function of M/s. Kothari Biotech, Iyermai, Kulithalai to release the launching of *in-vitro* propagated banana plants on 03.04.1998 and delivered presidential address on the importance of tissue cultured banana. Dr.R.Selvarajan, Scientist delivered a talk on "Vazhayil Virus" and Dr.S.Shivashankar, Sr. Scientist delivered a talk on "Aruvadai Pinsar Thozhilnutpam".

Dr. P. Sundararaju, Acting Director attended the "Introduction Meeting of NATP" concerning crop germplasm exploration and collection at NBPGR, Shillong on 8th May, 1998.

Dr. P. Sundararaju, Acting Director attended Hort.-98 Exhibition held at Yercaud Library and Sports Club, Yercaud from 26-27th September, 1998.

Dr. P. Sundararaju, Acting Director attended the ICAR Regional Committee No.VIII Meeting at IMAGE Building, Chennai on 5-6 January, 1999.

Dr. B. Padmanaban and R.Thangavelu attended the Rural Programme Advisory Committee Meeting organised by All India Radio, Tiruchirapalli held at Joint Director's (Agriculture) Office.

International

Dr. P. Sundararaju, Acting Director attended VIII Regional Advisory Committee Meeting of ASPNET/INIBAP held at Brisbane, Australia from 21-23th October, 1998.



Dr. P. Sundararaju along with RAC members visits banana plantation at Wamuran, Australia.

15. WORKSHOPS, SEMINARS, SUMMER INSTITUTES, FARMER'S DAY ETC. ORGANISED AT THE INSTITUTE

Radio Talks

Selvarajan, R. Vazhaiyin Virus Noigalum Kattuppaduthum muraigalum on 27th August, 1998.

Selvarajan, R. Vazhai Kandru thervu saiyum muraigal - Nibunarudan Ner Kanal on 11th Jan. 99.

Jeyabaskaran, K.J. Kalar Uvar Nilathil Vazhai Sagupadi on 19th October, 1998.

Padmanaban, B. Vazhayil Ilaithinum Puzhukkalum athanai kattuppaduthum muraigalum on 28th February, 1999.

16. DISTINGUISHED VISITORS

Dr. S.P. Ghosh, Deputy Director General, ICAR, New Delhi.

Dr. A.B. Molina, Regional Co-ordinator, INIBAP & ASPNET Philippines.

Dr. A. Abdul Kareem, Vice Chancellor, Tamil Nadu Agril. University, Coimbatore.

Dr. Usha K. Metha, Head, Division of Crop Protection, Sugarcane Breeding Instt., Coimbatore.

Dr. P. Parvatha Reddy, Head, Division of Crop Protection, Indian Instt. of Hortl. Research, Bangalore.

Mr. P. Venkatesan, Joint Director (Agriculture), Dept. of Agriculture, Tiruchirapalli.

Prof. A.K. Kadirvel, Ex-Dean, TNAU.

Shri A.S. Sukumaran, Senior Scientist, Central Plantation Crops Research Instt., Kasaragod.

Dr. K. Kannappan, Head, KVK, Sirugamani.

Dr. D.S. Rathore, Project Co-ordinator, AICRP on Sub tropical fruits & DRISNET, CISH, Lucknow.



Dr. A.B. Molina
Regional Co-ordinator
ASPNET/INIBAP
at NRCB Farm

D.S. Rathore
(Project Co-ordinator, AICRP
on sub tropical fruits)
is being received by
Dr. S. Shivshankar, Sr. Scientist, NRCB



17. PERSONNEL

PERSONALIA

Dr. S.D. Pandey appointed as Senior Scientist (Horticulture)

Dr.C.K.Narayana appointed Senior Scientist (Postharvest Technology) on 16th Oct. 1998.

Ms. V.P. Shanthi, Research Associate

Mr. G. Rajagopal, Senior Research Fellow



Dr. P. Sundararaju addressing at Hindi Fortnight Celebration

TRANSFERS

Mr.C.Thangaraj, Messenger transferred to CPCRI Regional Station, Palode on 12.06.98.

Mr.C.Kumaran, Mazdoor tranferred from CPCRI Regional Station, Palode to NRCB, Trichy

PERSONNEL

RESEARCH MANAGEMENT

Dr. P. Sundararaju, M.Sc.,Ph.D.

Director I/c.

SCIENTIFIC

Dr. S. Shivashankar, M.Sc.,Ph.D.

Senior Scientist (PHT)

Dr. B. Padmanaban, M.Sc.,Ph.D.

Senior Scientist (Ento.)

Dr. S.D. Pandey, M.Sc., (Hort.) Ph.D.

Senior Scientist (Hort.)

Dr. C.K.Narayana, M.Sc., (Hort.) Ph.D.

Senior Scientist (Hort.)

Dr. S.Uma, M.Sc.(Hort.), Ph.D.

Scientist (SS)(Hort.)

Mr. V. Kumar, M.Sc.(Hort.)
(on study leave)

Scientist (Hort.)

Mr. R. Thangavelu, M.Sc.(Ag.)
(on study leave)

Scientist (Pl.Path.)

Dr. R.H. Laxman, M.Sc.(Ag.),Ph.D.

Scientist (Pl.Physiol.)

Dr. R. Selvarajan, M.Sc.(Ag.), Ph.D.

Scientist (Pl.Path.)

Dr. K.J.Jeyabhaskaran,M.Sc.(Ag.),Ph.D.

Scientist (Soils)

Mr. B.Shyam,M.Sc.(Ag.),

Scientist (Biotechnology)

TECHNICAL

Mr. Raghuraman

Junior Garden Supdt.

ADMINISTRATION

Mr. N. Viswambharan

Asst. Admn. Officer

AUDIT AND ACCOUNTS

Mr. C.J. Stephen

Asst. Fin. & Accts. Officer

METEROROLOGICAL DATA

Month/Year	Temperature		Relative Humidity(%)	Rainfall (mm)
	Minimum	Maximum		
Apr 98	25.68	37.71	60.31	7.2
May 98	26.59	37.30	58.02	51.0
June 98	26.80	36.75	55.73	-
July 98	25.61	35.19	56.18	-
Aug 98	24.04	33.85	59.55	175.5
Sept 98	24.11	34.28	61.45	29.10
Oct 98	22.74	32.96	64.28	26.00
Nov 98	21.35	30.96	72.10	249.4
Dec 98	21.38	29.62	76.99	-
Jan 99	20.98	31.43	76.56	-
Feb 99	22.00	33.48	68.38	-
Mar 99	24.08	36.72	64.85	-

PERCENTAGE OF SC, ST AND WOMEN EMPLOYEES AT NRCB

Class of posts	Total no. of posts sanctioned	Total no. of posts filled	% of SC employees	% of ST employees	% of Woman employees
1. Research Management	1	-	-	-	vacant w.e.f. 16.12.97
2. Scientific	15	12	20.00	-	10.00
3. Technical	15	15	33.00	13.00	7.00
4. Administration	9	9	33.00	-	11.00
5. Supporting Staff	7	7	57.14	14.29	-
Total	47	43	34.14	7.31	4.87

18. ANY OTHER RELEVANT INFORMATION SUCH AS SPECIAL INFRASTRUCTURAL DEVELOPMENT

During the period under report the following building constructions have been completed. (1) Plant Quarantine Laboratory (2) ARIS Cell (3) Fruit ripening chamber (4) Zero energy cool chamber and (5) Diesel generator shed. Overhead tank work which is in completion stage.



*Inauguration of Plant Quarantin building by Hon'ble DDG (Hort.)
Dr. S.P. Ghosh*

कार्यकारी सारंश

देश में केले के बढ़ते हुए महत्व एवं अनुसंधान की जटिलता को ध्यान में रखते हुए राष्ट्रीय केला अनुसंधान केन्द्र की स्थापना दिनांक 21 अगस्त, 1993 को भारतीय कृषि अनुसंधान परिषद् द्वारा टास्क फोर्स की अनुशंसा से हुई, और यह केन्द्र 1 अप्रैल, 1994 से आधारभूत विकास एवं अनुसंधान कार्य में पूर्ण रूप से कार्यरत है। इस केन्द्र का मुख्य उद्देश्य मूलभूत तथा योजनाबद्ध अनुसंधान द्वारा केले के उत्पादन एवं उत्पादकता में वृद्धि करना है। पीछले पांच वर्षों में केन्द्र के आधारभूत ढाचें और अनुसंधान कार्यों में सराहनीय प्रगति हुई है।

अनुसंधान उपलब्धियां

इस वर्ष पूर्वोत्तर क्षेत्र से 31 नये केले के नमूनों का संग्रह किया गया, जिनमें मूसा 'बल्बिसियाना' की अपेक्षा अधिक विभिन्नता पायी गई थी। चार विभिन्न 'बल्बिसियाना' कृन्तकों का चसन किया गया, जिनमें कुछ विशेष लक्षण थे जैसे तने का काला रंग व चमकीलापन, असाधारण रूप से 5 फुट लंबी नर फूल की स्थिति का होना, एक अनुक्रम में फलने का लक्षण और नर फूल का बड़ा होना। जनन द्रव्य को फफूंदी बिमारियों एवं कीटों के प्रकोप के प्रति सहनशीलता के लिए मूल्यांकन किया गया है। अन्य मूल्यांकनों में पैदावार एवं गुणवत्ता की दृष्टि से 18 नमूनों का चयन किया गया है जो लगातार 4-5 वर्षों से अच्छा उत्पादन दे रहे हैं। पिछले वर्ष 'डिपलायड अक्यूमिनेटा' नमूने पहचाने गये, जिनका उपयोग प्रजनन कार्य कार्य में किया जा सकता है।

डिपलायड – ट्रिपलायड प्रजनन कार्य के लिए 35 मादा उपजाऊ नमूने पहचाने गये हैं। एक उच्च तकनीकी आदर्श प्रक्षेत्र भी विकसित किया गया था जिनमें द्वः व्यवसायिक केले की किस्में जैसे – रस्थाली, पूवन, नेपूवन, पच्चनाडन, नेन्द्रन एवं मोन्दन का उत्पादन लिया गया था।

72 केले के नमूनों को 'इन-विट्रो' संरक्षण में सफलता मिली, INIBAP से मंगवाये गये विदेशी केले के नमूनों में से 12 अक्यूमिनाटा डिपलायड 7 'अक्यूमिनाटा ट्रिपलायट' 2ABB किस्मों एवं 2BBB किस्मों को सबकल्चर किया गया।

गुणन दर के अध्ययन से यह पता चला है कि 'सबा' और 'पिसांग माडू' किस्मों की वृद्धिदर अधिक है जो 1: 8 अनुपात में पायी गयी। जब कि अन्य किस्मों में यह दर 1: 1 से 1: 4 तक ही पायी गयी।

ऊतक संवर्धन में पौधों की वृद्धि पर BAP की मात्रा का अध्ययन किया गया और पाया गया कि 'साई सिल्क' किस्मों में कलिकाओं का परिमाण अर्द्ध शक्ति एम एस माध्यम और मिसोइनसीटाल एवं वीएपी (३ मिगा/लीटर) के मिश्रण से बढ़ा सकते हैं।

प्राथमिक उत्पत्ति प्रारम्भ करने में तरल मीडिया के उपयोग में सफलता नहीं मिली जब कि द्वितीय एवं तदनन्तर सबकल्चर में ट्रिपलायड एक्यूमिनेटा और 'पिसांग अवाक' किस्मों में तरल माध्यम के उपयोग से पौधवृद्धि एवं विकास में बढ़ोत्तरी पायी गयी।

एक अन्य परीक्षण में यह पाया गया कि क्रास एवं ओपन परागनित बीजों को आई ए ए एवं बी ए (50 पीपीएम अलग-अलग) उपचार करने से बीजों की सुषुप्तावस्था में कमी आती है और शीघ्र बीजांकुरण होता है।

दो केले की किस्मों के बीजों का टेट्राजोलियम की सहायता से बीज जीवन योग्यता का परीक्षण किया गया, जिसमें यह पाया गया कि बीजों को नम तथा तर स्थिति में सामान्य तापमान पर भंडारण करने से उनकी जीवन योग्यता अवधि 4 से 5 माह तक बढ़ायी जा सकती है।

चार विभिन्न उपजाऊं मादा नमूनों में भ्रूण उत्पत्ति विधि के द्वारा भ्रूण विकास का प्रयास किया गया, जिसमें अयोग्य अवस्था में फल को तोड़ने के कारण माध्यम में भ्रूण का विकास नहीं हुआ। जनन द्रव्य अन्वेषण के दौरान संग्रहित किए गये अक्व्यूमिनेटा डिपलायड को भी प्रयोगशाला में भ्रूण उत्पत्ति विधि से विकसित करने में सफलता नहीं मिली।

व्यवसायिक प्रजातियों के 'ऊतकसंवर्धन' विधि से तैयार किये गये पौधों में दृढ़ बनते समय होने वाले शल्यकीय एवं शुल्परसायनकीय प्रक्रियाओं का अध्ययन किया गया। इस अध्ययन में यह पाया गया कि 75 प्रतिशत चाया में दृढ़ किये पौधों में प्रोटीन की मात्रा अधिक है।

पच्चनाडन केले के एक नमूने को चिन्हित किया गया है जिसके तने का रंग गहरा भूरा है। मृदा क्षारीयता से संबंधित अनुसंधान परीक्षा में पाया गया कि जिप्सम, गोबर एवं पोटाश का प्रयोग क्षारीय को कम करता है, रस्थाली एवं नेन्द्रन किस्मों में इसके प्रयोग से क्षारीय भूमियों में पौधों में अच्छी वृद्धि और अधिक उत्पादन पाया गया।

पहली बार तमिलनाडु के विलूपुरम तथा कडलूर क्षेत्रों में केले पर 'जाइन्ट अफ्रीकन स्ट्रेल' का प्रकोप पाया गया। विलूपुरम जिले में राइजोम बोरर का प्रकोप भी पहली बार दर्ज किया गया है। केले के पत्ती रवाने वाले किड़ों की रोकथाम के लिए मोनोक्रोटोफास काफी प्रभावशाली पाया गया। 'प्राटीलेंकस कोफिया' जड़ को हानि पहुँचाने वाला, मेलायडोगइन इनकागनिटा एवं हेलिकोटिलेनकस मल्टीकिंकटस

जड़ों में गांठ बनाने वाले निमेटोड (सूत्रकृमि) केरल, तमिलनाडु एवं पांडिचेरी में स्थित सभी केले के बागों में व्यापक रूप से पाया गया। रोडोफैलस सिमिलिस का प्रकोप केवल केरल में ही पाया गया। जनन द्रव्यों के परीक्षण में, 75 नमूने प्रा. कोफिया, 6 नमूने रो. सिमिलिस, 54 नमूने मे. इनकागनिटा एवं 14 नमूने हे. मलटीकिंकटस के प्रति अति ग्रहणशील पाये गये।

मुरझाव रोग पीड़ित (विल्ट) क्षेत्रों के सर्वेक्षण में यह पाया गया कि इस बीमारी का प्रकोप अधिकतम तोटिंटयम में और न्यूनतम पोदावूर में है। एक अन्य सर्वेक्षण से पता चला कि तमिलनाडु और केरल में बी एस वी (BSB) बीमारी पूवन प्रजाति में और बी बी एम वी (BBMV) बीमारी, पूवन, रस्थाली, नेन्द्रन, रोबस्टा, करपूरवल्ली एवं मोन्दन प्रजातियों में विस्तृत रूप से फैली हुई है। रोगलक्षण के दर्शन पर अजीवात्मक दबाव का प्रभाव एवं पैदावार के आधार पर यह देखा गया है कि पूवन प्रजाति में बी एस वी का प्रकोप जुलाई माह की अपेक्षा अक्टूबर माह में अत्यधिक होता है। केला जनन द्रव्य सस्योत्तर गुणवत्ता के लिए मूल्यांकन किया गया, जिसमें यह पाया गया कि हर प्रजाति/नमूनों में भार क्षति, मिठास, अम्लीयता एवं मिठास/अम्लीयता अनुपात विभिन्न है। मूल्यांकन किए गये 67 नमूनों में नमूना 066 एवं नमूना 077 में मिठास की मात्रा अधिकतम क्रमशः 29.3° एवं 29° ब्रिक्स पायी गयी। इथलीन सोखने वाले पदार्थ की मात्रा बढ़ाने से 13° से. तापमान पर कच्चे केले की भंडारण क्षमता में बढ़ोत्तरी पाई गयी।

केले की परिपक्वता से संबंधित विभिन्न स्थूल लक्षणों में से कवल फल की गोलाई की नाप एवं लंबाई के अनुपात से ही परिपक्वता का सीधा संबंध दिखाई दिया। विभिन्न परिपक्वताओं (75, 90 और 100 प्रतिशत) पर तोड़े गये फलों की भंडारण क्षमता के परीक्षण से यह पाया गया कि 75 प्रतिशत परिपक्वता का पूवन केला 14 दिन एवं करपूरवल्ली 12 दिन तक सामान्य तापमान पर भंडारित किया जा सकता है। 90% एवं 100% परिपक्वता के फलों की भंडारण क्षमता कम रही है। दैहिकी क्षतिभार 90% और 100% परिपक्वता की तुलना में 75% परिपक्वता के फल में अधिक रहा है। पूवन की अपेक्षा करपूरवल्ली में गूदे की मात्रा ज्यादा रही और फल के पकने के अनुसार यह बढ़ती गई। फल में अम्लीयता, परिपक्वता और पकने के स्वभाव के साथ साथ बढ़ती रही। पकने के बाद तीनों प्रकार के फल स्वीकार योग्य पाये गये।

