



वार्षिक प्रतिवेदन
ANNUAL REPORT
2001 - 2002

NATIONAL RESEARCH CENTRE FOR BANANA

(Indian Council of Agricultural Research)

Thogamalai Road, Thayanur Post
Tiruchirapalli -620 102, Tamil Nadu, India

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PREFACE



I am delighted to present the Annual report 2001-2002 of the National Research Centre for Banana in which the activities of the Centre are highlighted. During the period, the Centre has made significant achievements in the field of research, extension, training, infrastructure development etc. The activities were reoriented in the era of economic liberalization and opening up of the International trade. To achieve this, higher productivity, cost reduction, value addition and export technology are the major focus of the research activities.

Notable achievement of the Research Centre is the identification of a superior selection in the 'Pisang Awak' group with high yielding and good edible quality, besides exhibiting field tolerance to *Mycosphaerella* leaf spot diseases. In addition, frontier areas like biotechnology, post-harvest technology and information technology are the thrust areas of the Centre and the research activities are streamlined in this direction.

Being the National Repository of banana, the Centre is making concerted efforts in eliminating the confusing synonyms existing in the *Musa* germplasm. Accordingly, an one day Workshop was organized in collaboration with the International Network for Improvement of Bananas and Plantains (INIBAP). The national banana germplasm curators were given training on Musa Germplasm Information System (MGIS). A technical bulletin entitled "A Tentative key for identification and classification of Indian Bananas" was released on that occasion. In addition, efforts were in progress towards molecular characterization of banana germplasm and to identify the genomic status of certain doubtful genotypes in collaboration with IAEA, Austria.

The production division has been evolving different technologies for reducing the production cost, integrated nutrient management and organic farming. The Centre is also concentrating in integrated pests and disease management strategies to control the weevils, nematodes and major diseases. Use of kairomone traps under field conditions has shown encouraging results in containing the banana pseudostem weevil attack. Use of botanicals and bio-control agents are also being tested for nematodes and diseases as IPM practices.

The transfer of technology in banana value addition has created notable awareness and many small entrepreneurs have shown keen interest and certain products have already attained commercial status.

I sincerely thank Dr.M.M.Mustaffa and members of the Editorial Committee for compiling and editing the Annual report 2001-2002.



S. Sathiamoorthy
Director



Executive Summary

Germplasm management

Survey was conducted in the north eastern areas namely Nagaland and Manipur to study *Musa* diversity. 45 accessions were collected during the exploration. Forty two new accessions were characterised morpho-taxonomically based on INIBAP 'Musa Descriptor'. Ten BB diploids, *acuminata* (AA) diploids and 40 ABB triploids were analysed for four isozymes: malate dehydrogenase, glutamate dehydrogenase, shikimate dehydrogenase and phosphoglucosomerase to study their genetic relatedness. The recently unfurled leaf from top (cigar leaf) was used for isozyme analysis. Highest polymorphism was recorded in malate dehydrogenase and shikimate dehydrogenase exhibiting five different band zones. All the 10 *acuminata* diploids were grouped into two distinct clusters and each diploid accession is distinct by itself and has no other synonyms. The triploid cultivars grouped into 6-7 small clusters.

Screening indicated that accessions No.047, 07, 011, 167, IC-84809, IC-84863, and IC-84889 were resistant to banana stem weevil while accessions 047, 007, 021, 425, 440 were resistant to banana corm weevil. Namarai, Pisang Mas and *Musa ornata* were found to be tolerant to major nematode pathogens viz., *R. similis*, *P. coffeae*, *H. multicinctus* and *M. incognita* at vegetative stage. However, at flowering stage, all diploids were found to be susceptible to all major nematodes. Out of 275 accessions having B genomes, 12 were highly resistant, 35 were partially resistant as per IITA reaction grouping while 70 were grouped as highly resistant, 17 belong to resistant and only 13 accessions were grouped as very susceptible as per Daniells *et al.* (1996). The resistant varieties to *Mycospharella* leaf spot diseases had high

content of wax, tannin, phenol, total sugar, reducing and non-reducing sugar. The activity of defense related enzyme, the peroxidase was more in susceptible cultivars than resistant varieties. The stomata count and protein content did not have any correlation with resistance or susceptibility in selected cultivars/hybrids. Banana streak virus symptoms were recorded in 35 accessions of Mysore group. Out of which, only 14 accessions did not show the symptoms. An accession 'Poovan' did not exhibit the symptom.

Improvement

To develop synthetic diploids, 19369 pollinations were made involving 7 diploids as male parents and 3 diploids and 3 triploids as female parents. Crosses involving H-201 with Pisang Lilin (male parent) produced viable 5-7 seeds per fruit. Crosses involving Matti with Matti have produced healthy seeds up to 3 per fruit only in first 3 hands of the bunch. Young leaf whorls around meristem and young male flower buds of Matti, Sanna Chenkadali, Anaikomban, Cultivar Rose, Nendran and Robusta were tried for callus induction and regeneration. Percentage of callus was more and time taken for callus initiation was less in MS semisolid medium fortified with 2mg/l, 2,4-D/CPA or 1mg/l of picloram.

Production

The combination of distillery sludge 2.5 kg + 1 kg vermicompost + 1 kg neemcake + 2.5 kg poultry manure pl^{-1} recorded the highest plant height, girth, total leaf area at flowering and chlorophyll content in Rasthali and Karpuravalli bananas. In addition, it also significantly suppressed root population of root lesion nematode (*Pratylenchus coffeae*), root knot nematode and spiral nematode to the extent of 52.87

%, 64.89 % and 84.47 % respectively. Vermicompost was least effective in controlling nematodes among individual organic manures. Control recorded the lowest values for all the growth characters and also recorded the severe infestation of nematodes. Organic treatments recorded fewer incidences of Sigatoka leaf spot disease and more YLS-0 and YLS-31 than the inorganic fertilizer application.

Banana leaf mulch along with 75% of recommended N and K recorded maximum plant height, stem girth and number of functional leaves at 3rd and 5th month. The 75% of N and K with banana mulch recorded significantly higher contents of Na, K and Mg in Poovan banana leaf. Maximum sodium content was found in 50% N and K with no mulching. The leaf Zn, Fe and Cu concentrations were maximum in F₂M₁ treatment combination. Leaf Mn concentration in Poovan showed inconsistent trend while F₁M₁ treatment recorded the maximum. The paired row system in Robusta with 100% N and K fertigation recorded maximum plant height and girth of pseudostem at all stages whereas, 3 suckers/hill significantly recorded less pseudostem height in both fertigation level. Increasing K levels reduced the plant growth rate in the early stages and increased during the later stages. Optimum levels of soil and leaf nutrients were found at 0.5 kg CKFD level. The highest bunch weight (13.1 kg) was obtained at 60% rec. K + 0.5 kg CKFD/plant and it was on par with only 100% rec. K. Therefore, application of 0.5 kg CKFD/plant + 60% rec. K could save 40% of the K with optimum yield. FeZnB combination recorded the maximum height, pseudostem girth, number of leaves, leaf area and phyllochron. Soil application of Fe in high pH soil found to be better than foliar spray. Foliar application of Zn and B was found to be better than soil application, in high pH soil.

Post harvest Technology

Karpuravalli banana flower was cut into

pieces after removing the pistil and blanched in hot water at 80° C for 15 minutes. Pickle made with 8% salt + 0.1% citric acid was best with maximum organoleptic score for color, flavor, texture and taste. Karpuravalli banana thokku was also prepared from male flower. Thokku with oil + vinegar and thokku with oil + vinegar + citric acid were best. A ready-to-serve banana snack was prepared using Monthan banana fruit. Starch was extracted from Rasthali corm. The percentage recovery of starch was 3.57%. Production of sweet candy from central core of pseudostem of Rasthali banana was standardized.

Protection

Entomopathogenic nematode *Heterorhabditis indica* (PDBC EN 13.3) was pathogenic against adults and grubs of banana stem weevil. Trapping of weevils using banana pseudostem was very effective and also revealed the occurrence of medium sized corm weevil. Swabbing of Chlorpyrifos (0.1%) and stem injection of Monocrotophos at 5, 6, 7 months gave effective control of banana stem weevil. Monocrotophos (14ml/l for 30 minutes) sucker treatment and soil application of Carbofuran 60g/plant at 4 and 7th month after planting protected the crop from weevil attack.

Seventeen genera of plant parasitic nematodes were recorded from the rhizosphere of banana. Among them, root-lesion nematode, was found to be the predominant species followed by root-knot nematode, and spiral nematode. In paired row system, nematode population was minimum both in soil and root samples. Highest spore load of 8×10^6 *Paecilomyces lilacinus* per g of substrate was harvested in banana petiole and castor leaf mixture. However, sorghum grains registered maximum spore load per g of substrate. Neem 80 per cent concentrated extract exerted 73.4 per cent mortality of root lason nematode when exposed to 20 h and was followed by *Vitex negundo* and *Crotalaria juncea* extracts.

Two *Trichoderma harzianum* isolates and

one *Pseudomonas* sp. isolate have recorded more than 70% inhibition of mycelial growth of both Foc race-1 and race-2, besides exhibiting inhibition zone ranging from 40 mm to 60 mm. Two isolates of fungi, one yeast isolate and one bacterial antagonist were effective against *C. musae* under *in vitro* condition. One fungal, three bacterial and two actinomycetes antagonists were identified against *B. theobromae*. Propiconazole was very effective at 0.5 to 0.005% for *C. musae* and up to 0.05% for both *F. oxysporum* f.sp. *cubense* and *B. theobromae*. The extract from *Solanum* sp. was more inhibitory to mycelial growth of *Fusarium oxysporum* f.sp. *cubense*, *Colletotrichum musae* and *B. theobroma*. Plant extract (*Solanum* sp.), two bio-agents viz., *T. harzianum* and *Pseudomonas* sp. and one fungicide Propiconazole were very effective in reducing the anthracnose disease incidence but also in increasing both green and yellow life of banana fruits. Petroleum oil 5% + Propiconazole 0.05% spraying at vegetative stage significantly reduced Sigatoka leaf spot diseases in Robusta banana. Alternate spray of Tilt: Kavach and Anvil: Kavach gave good control of leaf spot diseases in Robusta with respect to Infection Index. The YLS was significantly low in control (7.0) compared to all the fungicide treatments. There was significant reduction in the growth and yield parameters in Ney Poovan due to BBMV infected plants. Reduction in bunch weight (19.1%) was recorded as compared to control. Infected plants took 45 to 60 days more to flower and the number of leaves at flowering was less by 9.98 percent. Nearly 50 percent of infected

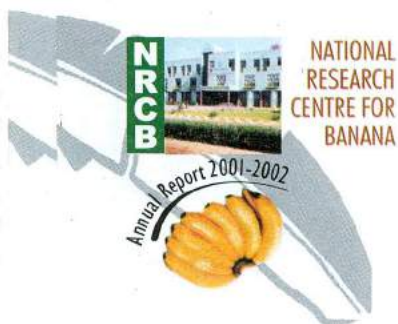
bunches had broken at the point where the peduncle joins with the stem. DAC-ELISA was found better for BBTV detection where as DIBA was more precise in detecting BBMV. For BSV, both the methods were equally better. Midrib tissues from young leaves are a better source for detection of BBTV, whereas old highly symptomatic leaves are better for detecting BSV. For BBMV youngest fully opened leaf midrib should be used for indexing. BBMV found to be transmitted through banana aphid *Pentalonia nigronervosa* in a non-persistent manner. The acquisition access and inoculation feeding time were 5 and 30 min respectively and 70 % transmission was observed in cultivar Nendran.

Transfer of Technology

On-Farm advise, Farmers' Meeting, lectures were given to popularise clean, disease free planting material, identification of diseased suckers, improved production technologies for reducing cost of cultivation, improved protection technologies for control of new pests and diseases. In addition, training was imparted to the small farmers and women entrepreneurs in processing and value added products including fibres. Musa Genetic Information System training has been organised at International level.

Human Resource Development

Scientists and Technical personnel were deputed for short and medium term training to upgrade their knowledge in different areas of specialisation. Consultancy projects were also carried out to test various commercial formulations.



Introduction

The National Research Centre for 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 and 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 a precipitation of 800-900 mm annually both from North-East and South-West monsoons. Climate is tropical with highest mean maximum temperature in April-May. The farm has a total area of 38 ha. In the last seven years, the centre has made appreciable progress with respect to infrastructural development as well as in the research.

Salient Research Achievements in the past

I. BANANA GENETIC CONSERVATION AND IMPROVEMENT

The research centre has the mandate to collect the available indigenous and exotic germplasm in *Musa* genome for genetic enhancement, utilization and conservation. In this connection, a total of 907 indigenous and exotic accessions of *Musa* are pooled at this centre. A database has been developed for 545 *Musa* accessions for 121 characters based on INIBAP/IPGRI descriptor. The evaluation of the accessions to various biotic and abiotic stresses are in progress. The germplasm was screened for salt tolerance using Tetrazolium and found that Saba, Burro Cemsas, Pisang Ceylon, Bluggoe, Pisang Awak, Monthan, Robusta and Rasthali were found to be resistant. Among the germplasm accessions evaluated for Pseudostem weevil, Bhimkol, Athiakol, Elavazhai, Saapkal, Dudh Sagar, Pisang Lilin and Pisang Jari Buaya were found to be field tolerant.

Evaluation of IMTP (International *Musa* Testing Programme) accessions from INIBAP, France, for their resistance to Sigatoka leaf spot diseases have resulted in identification of six accessions tolerant to Sigatoka leaf spot diseases.

Protocols have been standardised for *in vitro* conservation of different genomes of the selected germplasm. The embryo culture protocol has been standardised successfully for ABB cultivars. Standardised regeneration of meristematic tissues of Silk (AAB) group by optimising the BAP concentration for proliferation of viable shoots. Isozyme characterisation of the *Musa* germplasm is in progress. Under *Musa* Germplasm Information System (MGIS), passport data for 809 accessions have been done while complete evaluation and characterisation have been updated for 100 accessions.

II. BANANA PRODUCTION

Various experiments have been carried out to increase the production and productivity of banana under wetland system of cultivation. Application of 75% substitution organic manures favoured better plant growth, reduced crop duration, increased bunch weight and TSS in eight varieties of banana. Inorganic application of 100% nitrogen extended the crop duration. Maintenance of banana fields up to 6 months without weed enhanced the vegetative growth, produced better bunches with reduced crop duration. The loss due to weed is estimated to be 33%. Application of Glyphosate @3.5 Kg a.i. per ha controlled the weeds upto 6 months and increased the bunch weight. Planting of suckers during February for Rasthali, Poovan and Nendran varieties and planting of Karpuravalli during December gave



maximum bunch weight than other seasons of planting.

Salt tolerance in banana was due to high Na selectivity in leaves and roots, high average leaf area, low Na concentration in the roots and low compartmentation of Na in the leaves. Application of 15kg FYM + Gypsum 2kg + 360g K increased the yield and quality in cv. Nendran and Rasthali bananas in salt affected sodic soils. Application of cement factory flue dust @0.5Kg per plant could save 60% of Potassium in Karpuravalli variety. The critical level was found to be 710 ppm K and 480 ppm Na and K/Na 1.46 for the banana soil and for banana leaf K 2.82%, Na 0.47% and K/Na ratio 5.7%. The leaf Na concentration increased from lamina base to top and from margin towards midrib and the reverse trend was observed for leaf K. K/Na ratio was >1 in leaf and <1 in sodic injured leaf.

Application of 15kg poultry manure with 160g N; 40g P and 240g K (80% of the recommended dose) through inorganic fertilisers increased yield. Application of 25% N as FYM + 50% N as neem cake + 25% N as Urea was found to be optimum for improving the soil physical properties with increased bunch weight.

III. CROP PROTECTION

Electron microscopic studies of pseudostem weevil indicated substantial layers of variously shaped sensillae in the antenna tip and segment, proboscis and elytra, which were used as sensory receptors. BSW showed a high degree of host preference for Nendran variety. Disc on stump and longitudinal split traps @ 40 traps per acre were optimum for weevil trapping. Commercially available sex pheromone on leaf eating caterpillars indicated maximum male moth catch during 14-17 standard week. Wide spread occurrence of burrowing nematode, root lesion nematode, root knot nematode and spiral nematode were recorded in all banana growing regions of India. Cyst nematode was recorded for the first time in Robusta banana in Tamil Nadu. Neem

cake application along with 50g Carbofuran in 2 splits considerably reduced the root lesion nematode in susceptible Nendran banana. Neem extracts caused 74% mortality of root lesion nematode when exposed for 20 hours. Banana waste i.e. petiole and pseudostem could be successfully utilised for mass multiplication of nematode egg parasitic fungi, *Paecilomyces lilacinus* and *Trichoderma harzianum*. Two applications of *Trichoderma viride* @ 20g per plant was effective in controlling the nematode and Panama wilt in Rasthali and Virupakshi varieties.

Wide spread occurrence of Banana Bract Mosaic Virus (BBMV) and Banana Streak Virus (BSV) was found in the entire banana growing regions of India. Electron microscopy and serological analysis have confirmed their identity. 'Kokkan' disease of unknown etiology seriously affecting the plantains in Kerala has now been identified to due to BBMV. The yield loss due to BBMV and BSV has been ranging from 48 to 70%. DIBA, DAC-ELISA tests have been standardised for BBMV and BSV. BSV expression in Poovan is highly influenced by the temperature.

Fusarium wilt (Foc) of banana still continues to be serious in cvs. Silk, Red banana, Virupakshi, Karpuravalli and cooking bananas. *Trichoderma viride* and *Pseudomonas fluorescence* were found to inhibit wilt pathogen in dual culture. Cultivar Poovan, the known wilt resistant clone, is now being found to be susceptible to wilt in certain areas. Occurrence of new race is suspected.

Occurrence of Black Sigatoka and Septoria leaf spots has been recorded, isolated and pure-cultured for the first time in India. These are found to be more aggressive in many of the commercial cultivars, caused severe defoliation and loss of yield and quality. Propiconazole or Hexaconazole @0.1% was found to be effective in the control of Sigatoka and Septoria leaf spot diseases. Pitting disease caused by *Pyricularia grisea* has been reported for the first time in India.



IV. CROP PHYSIOLOGY AND BIO-CHEMISTRY

Higher number of leaves and leaf area induced early flowering. The dehanding of the first one to three hands did not have any effect on fruit filling of the subsequent female flowers indicating that fruit filling is not dependant on photosynthates alone. The evaluation of germplasm accessions of AB, BB, AAB and ABB genomes for growth parameters revealed that the 'B' genome contributes for more vigorous growth, tolerance to drought and high temperature and starchiness to fruits, while 'A' genome offers quality traits like flavour and taste.

V. POST HARVEST TECHNOLOGY

The post harvest loss of banana 8-9% at farmers level, 20-25% at wholesalers level and 15% at retailers level were observed. The processing technology for jam, fruit bar, papad, biscuits, wine, alcohol, fig, health drink, baby food and spiced pickle were developed using different banana varieties. Osmotic dehydration technique improved the quality and storage life of banana fig.

75% matured Karpuravalli and Poovan varieties showed higher shelf life of 12 & 14 days respectively under ambient conditions. Pre-harvest spray of K_2SO_4 0.5-1% and urea 1-2% in Poovan and GA 20-25ppm in Ney Poovan variety applied

between 30-60 days after flowering significantly increased the bunch weight. Soilrite with $KMNO_4$ enhanced the storage life of Karpuravalli banana upto 21 days at 14°C. Sealed packaging of banana in 400 gauge polyethylene packs stored at 13°C extended the storage life upto 30 days in Poovan and 19 days in Karpuravalli fruits. Propylene glycol 100ppm and citric acid 200ppm were effective in reducing the peroxide value and acidic value in Nendran banana chips.

VI. TRANSFER OF TECHNOLOGY

On-Farm advise, Farmers Meeting, lectures were given to popularise clean disease free planting material, identification of diseased suckers, improved production technologies for reducing cost of cultivation, improved protection technologies for control of new pests and diseases. In addition, training was imparted to the small farmers and women entrepreneurs in processing and value added products including fibres. Musa Genetic Information System training has been organised at International level.

VII. HUMAN RESOURCE DEVELOPMENT

Scientists and Technical personnel were deputed for short and medium term training to upgrade their knowledge in different areas of specialisation. Consultancy projects were also carried out to test various commercial formulations.



MANDATE

- ♦ To undertake the basic and strategic research for developing the technologies to enhance the productivity and utilisation 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 co-ordinate the network researches for generating location specific variety technology and for solving specific constraints on banana and plantain production.
- ♦ To collaborate with relevant National and International agencies in achieving the above objectives.

BUDGET

Budget and Expenditure for 2001-2002 (Rupees in lakhs)

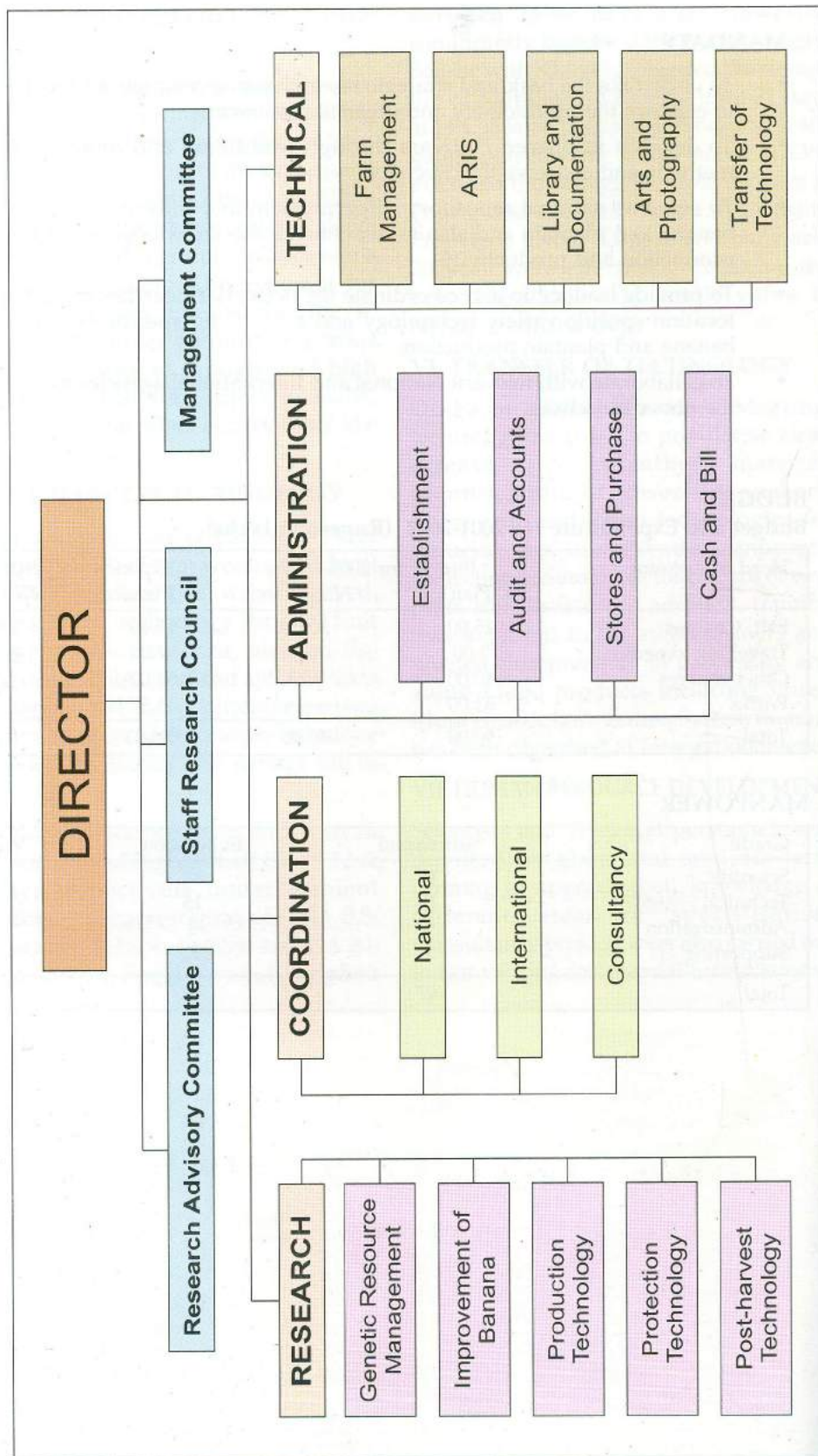
Head of Account	Budget for 2001-2002		Expenditure Plan	2001- 2002 Non-Plan
	Plan	Non-Plan		
Estt. Charges	15.00	50.00	15.19	39.47
Travelling expense	2.00	00.75	57.02	00.75
Other charges	40.00	9.25	57.02	10.04
Works	33.00	—	31.37	—
Total	90.00	60.00	105.01	50.01

MANPOWER

Grade	Sanctioned	In position	Vacant
Scientific	16	14	2
Technical	15	15	—
Administration	9	9	—
Supporting	7	7	—
Total	47	45	2



ORGANOGRAM



Research Achievements

I. Crop Improvement

1. Management of genetic resources of banana

(S.Uma and S.Sathiamoorthy)

1.1. Exploration

During the present year Nagaland and Manipur states were explored for *Musa* diversity. Survey was also conducted to study the varietal situation in North Karnataka and Kerala. Forty five accessions have been collected during the explorations. The details of germplasm collected during the explorations in North-Eastern states, Kerala and Northern Karnataka are given in Table 1.

1.2. Conservation

Accessions collected from higher elevations did not establish well at NRCB under wetland conditions. Hence efforts were made to maintain these valuable germplasm collected from North-Eastern states at higher elevations near Gudalur, Tamil Nadu. After establishment, a duplicate set will be multiplied and maintained at NRCB.

1.3. Characterisation

1.3.1. Morphotaxonomic characterisation

Forty two new accessions were characterised morphotaxonomically for 121 traits based on IPGRI/INIBAP's '*Musa*

Descriptor' and included in the NRCB genebank database.

1.3.2. Molecular Characterisation

Isozyme enzymes namely malate dehydrogenase(MDH), glutamate dehydrogenase (GDH), shikimate dehydrogenase (SKDH) and phosphoglucosomerase (PGI) were used for characterizing diploid and triploid genomes of pure *acuminata* accessions.

Ten samples of pure *balbisiana* diploids(BB) and 40 samples of ABB were analysed separately and also collectively for their genetic relatedness. The ten *balbisiana* diploids were grouped into 4 distinct clusters. The extent of relatedness is presented in the dendrogram (Fig.1) and the members of each cluster in Table 2. The following accessions were grouped as synonyms : (1) Bhimkol-1 and Athiakol-1; (2) Athiakol-2 and *Musa balbisiana*; (3) Nendra Padathi and Manguthamg due to the co-efficient of 1.0.

The 40 accessions of ABB genome were clustered into 8 groups (Table 3) and their relatedness is presented in the dendrogram (Fig.2). Synonyms were observed in (1)Pacha Bontha Batheesa and Ashy Batheesa; (2) Mauritius, Pey Kunnan, Sambrani Poovan and Malai Monthan; (3) Ankur-II and Boddida Bukisa; (4) Boodhi

Table1: Accessions collected during explorations in the current year

Exploration	Genomic groups							Unclassified accessions collected	No. of
	AA	AAA	AAB	AB	ABB	BB	Ensete		
North-Eastern states	9	1	2	-	9	7	-	2	30
Northern Karnataka	-	-	2	2	2	4	1	-	11
Kerala	3	-	-	1	-	-	-	-	4
Total	12	1	4	3	11	11	1	2	45

Bale, Ginde and Foconah; (5) Kallu Monthan, Monthan and Yenugu Bontha; (6) Bainsa and Birbutia; (7) Vennutu Mannan and Govakkai and (8) Boodhi Bale, Chetty and Chirapunji.

The pure *acuminata* diploids were clustered into 5 groups (Table 4) and the relatedness is presented in the dendrogram (Fig.3). Synonymity was recorded between Matti, Anaikomban and Hatidat and Pisang Berlin and Sanna Chenkadali. This needs further study as morphotaxonomic characterization did not confirm the results.

Twenty six pure *acuminata* triploid accessions were grouped into 5 major clusters (Table 5) and their relatedness is presented in the dendrogram (Fig.4). The accessions having similarity are: (1) Gros Michel and Monsmorie; (2) Robusta-1 and Champa;

(3) Pedda Pacha Arati and Sapumal Anamalu; (4) Dwarf Cavendish, Grande Naine, Shrimanti and Borjahaji; (5) Jahaji and Basrai-1 and (6) Gandevi Collection, Williams and Grand Naine-2.

The pooled analysis of AA and AAA *acuminata* accessions indicated that AA accessions clustered in two extreme ends denoting polymorphism. The Rf value of triploid *acuminata* accessions were in between the two *acuminata* clusters indicating that they might have originated from two different 'A' genome during the process of banana evolution, which needs further study.

Malate dehydrogenase and shikimate dehydrogenase exhibited high level of polymorphism. Glutamate dehydrogenase exhibited moderate level of polymorphism and phosphoglucosomerase showed only low level of polymorphism (Fig. 5a, 5b and Fig. 6a, 6b).

Table 2: Cluster members of pure *balbisiana* (BB)

Clusters	Members
1.	Bhimkol-1, Athiakol-1
2.	Athiakol-2, <i>Musa balbisiana</i> , Bachariya Malbhog
3.	Bhimkol-2, Borkal Baista
4.	Nendra Padathi, Manguthamg, Elavazhai

Table 3: Cluster members of B- rich genomes(ABB)

Clusters	Members
1.	Bangrier, Pacha Bontha Batheesa, Ashy Batheesa, Cuba, Saba
2.	Dakshinsagar, Mauritius, Pey Kunnan, Sambrani Poovan, Malai Monthan
3.	Figue Pome Geante, Goukar, Karibale, Ney Poovan, Jatikal.
4.	Bankela, Kanthali, Nepali Vannan, Ankur-II, Boddida Bukkisa.
5.	Kechulepa, Boothi Bale, Ginde, Foconah, Karthobiumthamg
6.	Kali Bale, Kallu Monthan, Monthan, Yengu Bontha, Kostha Bontha
7.	Nute Pong, Bainsa, Birbutia, Vennuttu Mannan, Govakkai
8.	Lamby, Bluggoe, Boodhi bale, Chetty, Chirapunji.



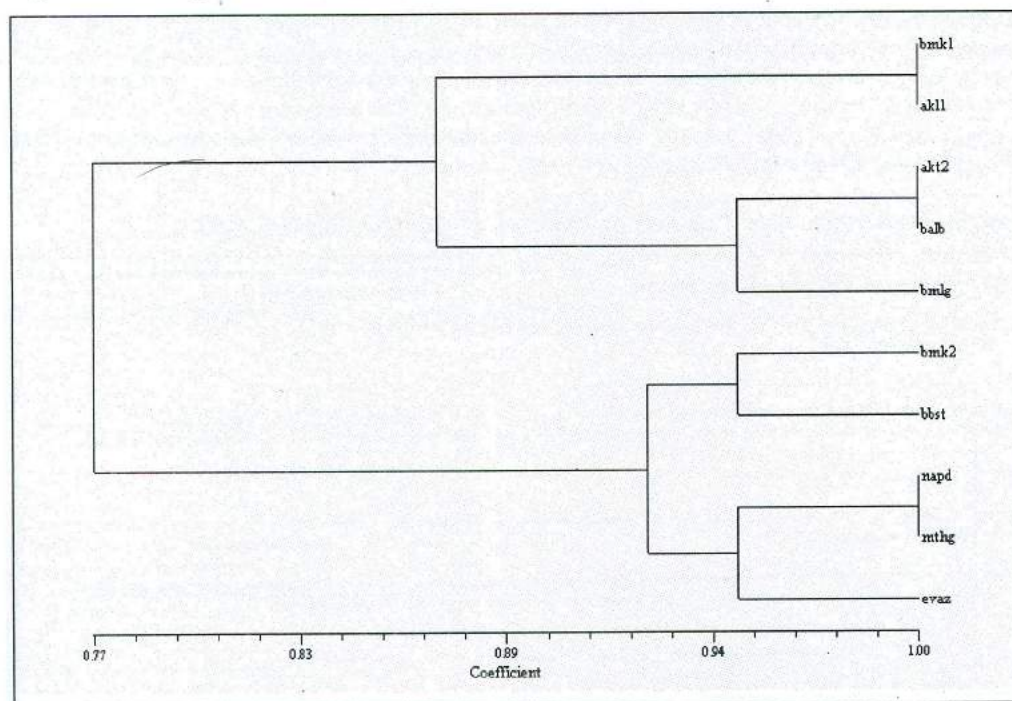
Table 4: Cluster members of *acuminata* diploid (AA)

Clusters	Members
1.	Matti, Hatidat, Anaikomban
2.	Namarai, Pisang Lilin
3.	Tongat
4.	Pisang Berlin, Sanna Chenkadali, Pisang Jari Buaya
5.	Cultivar Rose

Table 5: Cluster members of *acuminata* triploid (AAA)

Clusters	Members
1.	Gros Michel, Monsmorie, Robusta-1, Champa, Cheenabale, Robusta-2, Pedda Pacha Arati, Sapumal Anamalu, Lacatan, Robusta-3.
2.	Dwarf Cavendish, Grand Naine-1, Shrimanti, Borjahaji, Harichal
3.	Jahaji, Basrai-1, Manjahaji, Gros Michel-2, Basrai-2
4.	Ardhपुरi, Mas, Gandeви Collection, Williams, Grand Naine-2
5.	Yangambi KM-5

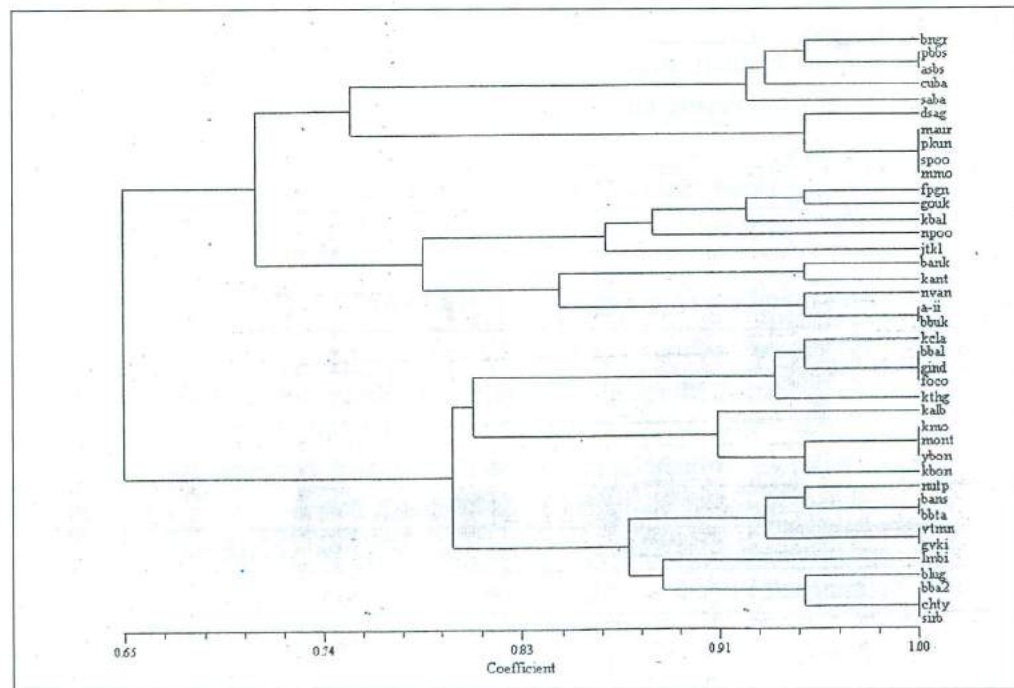
Fig. 1. Dendrogram and cluster analysis of BB accessions



bmk1-Bhimkol-1 ; akt1 - Athiakol-1; akt2- Athiakol-2; balb - *Musa balbisiana*; bmlg-Bacharia Malbhog; bmk2-Bhimkol-2; bbst-Borkal Baista; napd-Nendra Padathi; mthg-Manguthamng; eva2-Elavazhai.

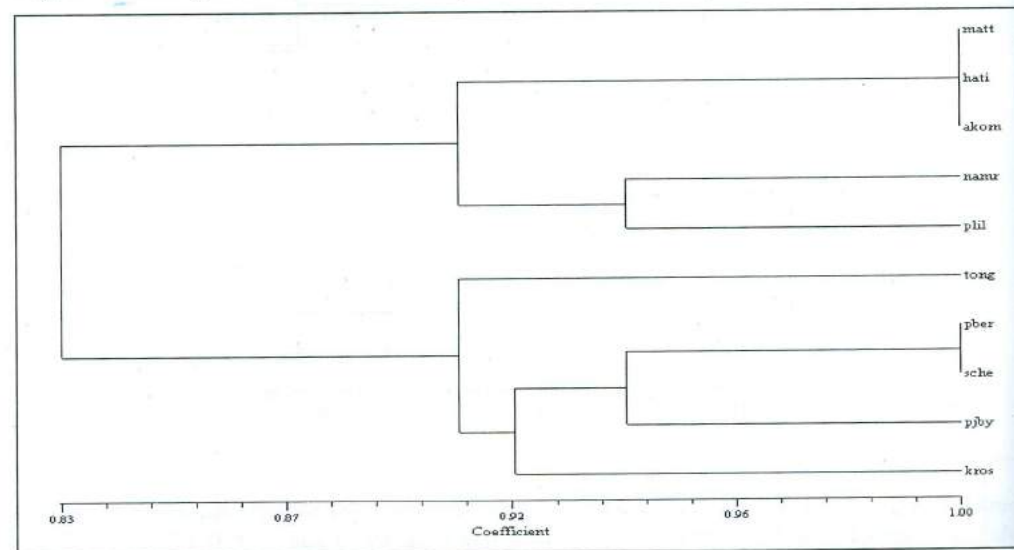


Fig. 2. Dendrogram and cluster analysis of ABB accessions



bngr-Bangrier; pbbs-Pacha Bontha Patheesa; asbs-Ashy Batheesa; cuba-Cuba; saba-Saba; dsag-Dakshinsagar; maur-Mauritius; pkun-Pey Kunnan; spoo-Sambrani Poovan; mmo-Malai Monthan; fpgn-Figue Pome Geante; gouk-Goukar; kbal-Karibale; npoo-Ney Poovan; jtkl-Jatikal; bank-Bankela; kant-Kanthali; nvan-Nepali Vannan; a-ii-Ankur-II; bbuk-Boddida Bukkisa; kcla-Kechulepa; bbal-Boothibale; gind-Ginde; foco-Foconah; kthg-Karthobiumthamg; kalb-Kalibale; kmo-Kallu Monthan; mont-Monthan; ybon-Yenugu Bontha; kbon-Kostha Bontha; nutp-Nute Pong; bans-Bainsa; bbta-Birbutia; vtmm-Venuttu Mannan; gvki-Govakkai; lmbl-Lambi; blug-Blugoe; bba2-Boodhi Bale-2; chty-Chetty; sirb-Chirapunji.

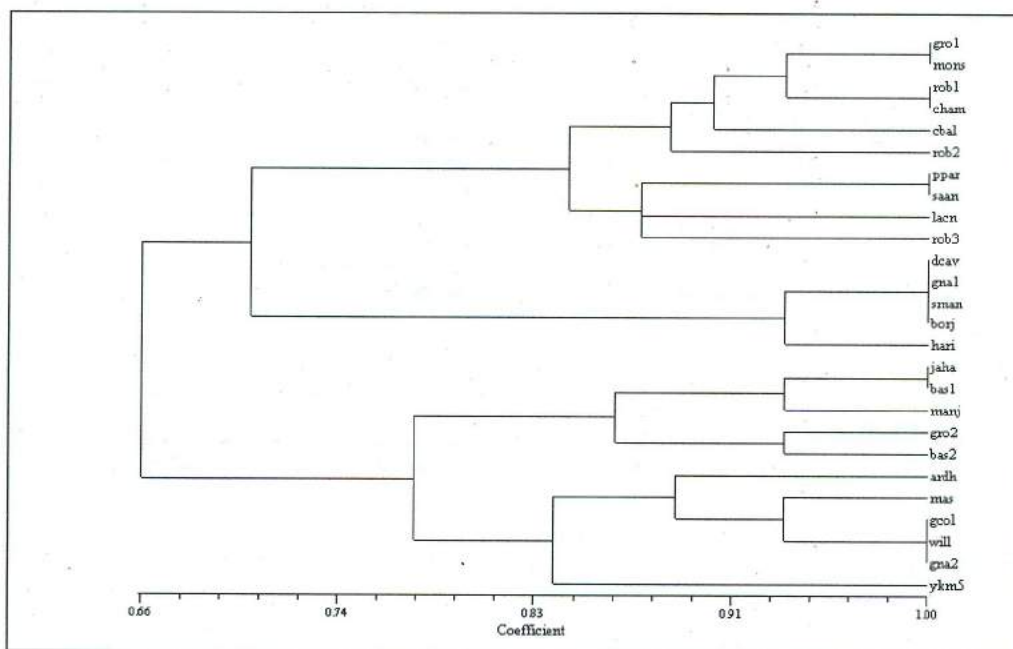
Fig. 3. Dendrogram and cluster analysis of *acuminata* diploid (AA)



matt-Matti; hati-Hatidat; akom-Anaikomban; namr-Namarai; plil-Pisang Lilin; tong-Tongat; pber-Pisang Berlin; sche-Sannachenkadali; pjby-Pisang Jari Bauya; kros-Cultivar Rose

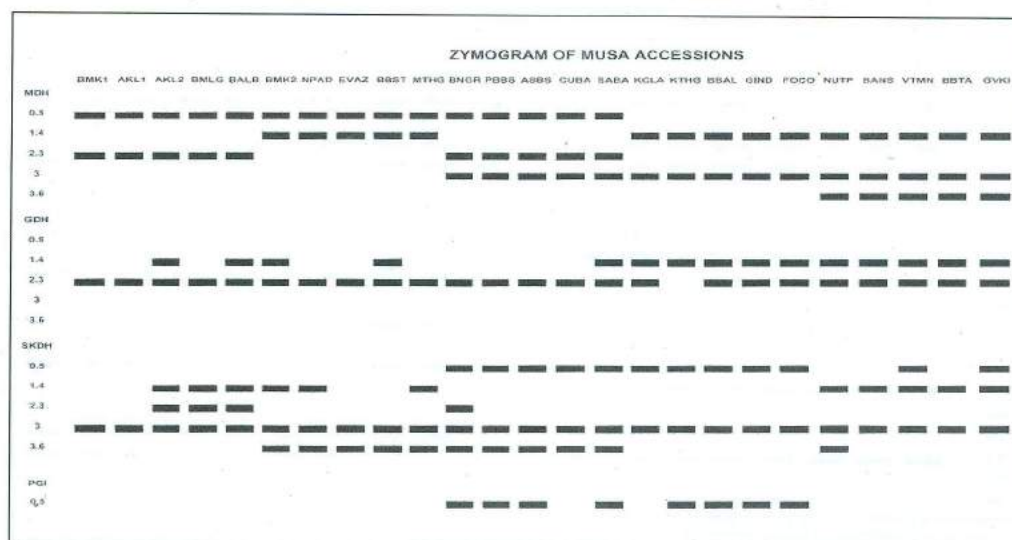


Fig. 4. Dendrogram and cluster analysis of *acuminata* triploid (AAA)



gro1-Gros Michel; mons-Monsmorie; rob1-Robusta; cham-Champa;cbal-Cheenabale; rob2-Robusta; ppar-Pedda Pacha Arati; saan-Sapumal Anamalu; lacn-Lacatan; rob3-Robusta; dcav-Dwarf Cavendish; gna1-Grand Naine; sman-Shrimanti; borj-Borjahaji; hari-Harichal; jaha-Jahaji; bas1-Basrai; manj-Manjahaji; gro2-Gros Michel; bas2-Basrai; ardh-Ardhapuri; mas-Mas; gcol-Gandevi Collection; will-Williams; gna2-Grand Naine; ykm5-Yangambi KM5.

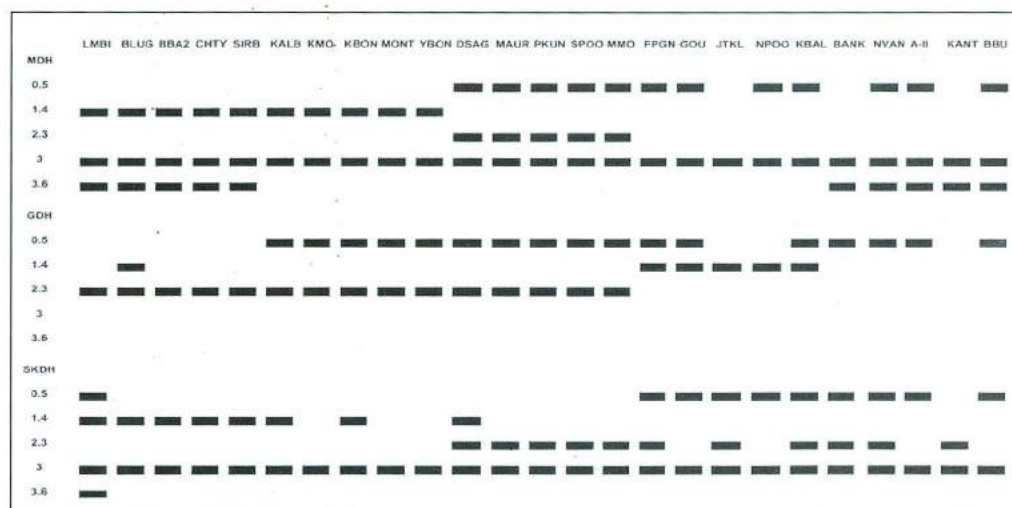
Fig. 5a. Zymogram of *Musa balbisiana* accessions



BMK1-Bhimkol; AKL1-Athiakol; AKL2-Attikol; BMLG-Bacharia Malbhog; BALB-Musa balbisiana; BMK2-Bhimkol; NPAD-Nendra Padathi; EVAZ-Elavazhai; BBS1-Borkal Baista; MTHG-Mangutham; BNGR-Bangrier; PBBS-Pacha Bontha Batheesa; ASBS-Ashy Batheesa; CUBA-Cuba; SABA-Saba; KCLA-Kechulepa; KTHG-Karthobiumtham; BBAL-Boothibale; GIND-Ginde; FOCO-Foconah; NUTP-Nutepong; BANS-Bainsa; VTMN-Vennutu Mannan; BBTA-Birbutia; GUKI-Govakkai

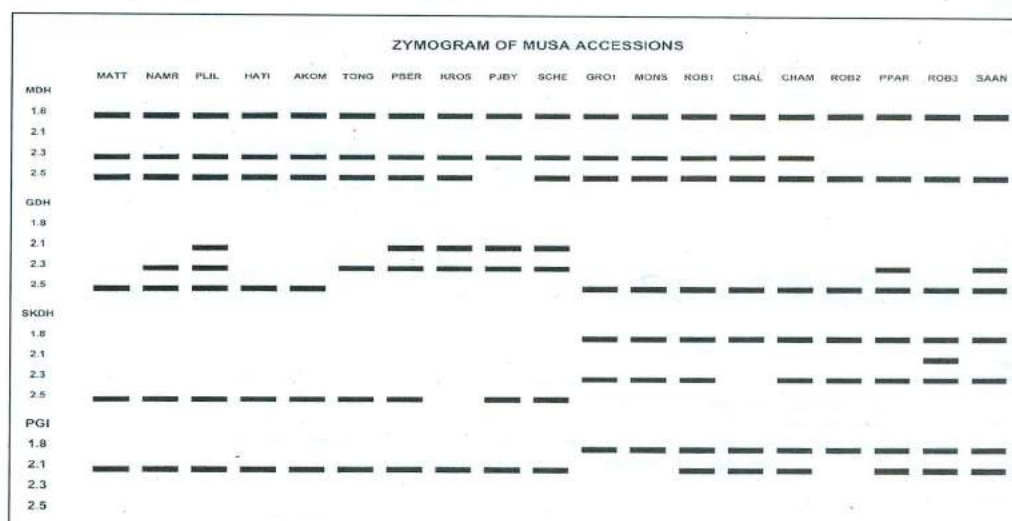


Fig. 5b



LMBI-Lamby; BLUG-Bluggoe; BBA2-Boothi Bale; CHTY-Chetti; SIRB-Cherapunji; KALB-Kalibale; KMON-Kallumonthan; KBON-Kosthabontha; MONT-Monthan; YBON-Yenugu Bontha; DSAG-Dakshing Sagar; MARU-Mauritius; PKUN-Peykunnan; SPOO-Sambrani Poovan; MMON-Malaimonthan; FPGN-Figue Pome Geante ; GOUK-Goukar; JTKI-Jatikal; NPOO-Neypoovan; KBAL-Karibale; BANK-Bankela; NVAN-Nepali Vannan; A-II-Ankur-II; KANT-Kanthali; BBUK-Boddida Bukkisa

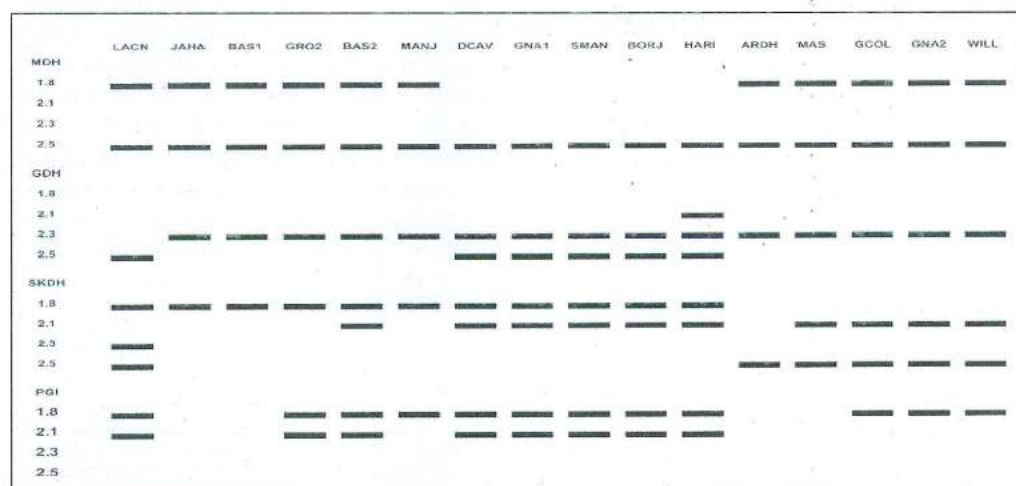
Fig. 6a. Zymogram of *Musa acuminata* accessions



MATT-Matti; NAMR-Namarai; PLIL-Pisang Lilin; HATI-Hatidat; AKOM-Anai Kombar; TONG-Tongat; PBER-Pisang Berlin; KROS-Cultivar Rose; PJBY-Pisang Jari Bauya; SCHE-Sanna Chenkadali; GRO1-Gros Michel; MONS-Monsmarie; ROB1-Robusta; CBAL-Cheenabale; CHAM-Champa; ROB2-Robusta; PPAR-Pedda Pacha Arati; ROB3-Robusta; SAAN-Sapumal Anamalu



Fig. 6b



LACN-Lacatan; JAHA-Jahaji; BAS1-Basrai; GRO2-Gros Michel; BAS2-Basrai; MANJ-Manjahaji; DCAV-Dwarf Cavendish; GNA1-Grand Naine; SMAN-Shrimanti; BORJ-Borjahaji; HARI-Harichal; ARDH-Ardhapuri; MAS-Mas; GCOL-Gandevi Collection; GNA2-Grand naine; WILL-Williams

Characterisation and ploidy analysis of selected accessions

The morphotaxonomic characterization and ploidy analysis of 32 wild and semi wild (pherals) accessions using flow

cytometry was carried out in collaboration with IAEA, Vienna, Austria. Seven accessions whose doubtful identity was also confirmed. The ploidy status of 20 accessions have been confirmed (Table 6).

Table 6: Ploidy status *Musa* accessions using Flow cytometry

Name	Accn. No.	<i>Musa</i>	CRBC	Ratio (M/C)	SD	Ploidy assigned	Ploidy measured
Pisang Lilin	0195	56.36	99.26	0.568	0.003	2x	2x
Rasthali	0297	81.05	97.31	0.833	0.006	3x	3x
FHIA-03	0627	116.97	102.12	1.145	0.003	4x	4x
Kechulepa-1	0004	83.88	99.89	0.840	0.001	3x	3x
Bhimkol	0007	52.93	98.83	0.535	0.002	2x	2x
Athiakol- 1	0011	54.39	100.46	0.541	0.001	2x	2x
Borkal Baista	0018	82.62	99.75	0.828	0.002	2x	3x
Kechulepa-II	0024	53.58	99.34	0.539	0.003	2x	2x
Manohar	0047	53.54	99.58	0.538	0.001	2x	2x
Karthobium Thamg	0050	82.63	99.49	0.830	0.003	3x	3x
Mangu Thamg	0067	78.44	94.50	0.830	0.003	2x	3x
Bhat Manohar	0075	109.22	98.33	1.111	0.003	3x	4x
Boothi Bale	0132	82.23	98.93	0.831	0.005	3x	3x
Elavazhai-1	0167	53.31	100.50	0.532	0.002	2x	2x
Attikol	0444	53.40	99.98	0.534	0.001	2x	2x
Bacharia Malbhog	0446	53.67	99.05	0.542	0.004	2x	2x
Foconah	0471	82.69	99.39	0.832	0.002	4x	3x
<i>Musa balbisiana</i>	0508	51.69	96.82	0.534	0.002	2x	2x
Elavazhai-II	0555	52.66	99.45	0.530	0.002	2x	2x
Athiakol-II	0598	53.99	100.74	0.536	0.006	2x	2x

CRBC – Chicken Red Blood Cell nuclei

1.4. Evaluation

1.4.1. Evaluation of NRCB Selection

The performance of NRCB Selection - 001 was compared with Karpuravalli of Tamil Nadu, Kanthali of Bihar, Boodida Bokkisa of Andhra Pradesh and Boodi Bale of Karnataka (Table 7) belonging to same group.

The selection was significantly shorter as

compared to other cultivars with maximum girth (0.97m). The photosynthetic leaf area was also maximum (138.5 sq.m) in Selection-001 resulting in higher yield as expressed in terms of higher bunch weight (32.2kg), more number of hands per bunch (18.4) and more number of fingers/hand (17.3). The selection also exhibited tolerance to Sigatoka leaf spot diseases on par with other test cultivars (Plate 1).

Table 7: Growth and bunch parameters of NRCB Selection-001

Characters	NRCB Selecti- on-001	Kanthali	Karpura valli	Boodida Bukkisa	Boodhi Bale	CD (5%)	CD (1%)	CV (%)
Plant height (cm)	377.7	361.2	399.8	358.1	394.2	12.44	17.45	2.13
Pseudostem girth (cm)	96.8	90.9	85.7	87.2	85.1	2.30	3.23	1.68
Petiole length (cm)	87.3	86.1	77.0	77.2	75.4	2.48	3.48	2.00
No. of leaves at shooting	17.9	16.9	17.3	17.2	17.3	NS	NS	4.45
No. of leaves at harvest	10.0	7.9	9.3	9.5	9.4	0.89	NS	6.29
Leaf area (sq.cm)	13852.0	11892.4	11240.6	11632.2	10940.4	639.19	896.16	3.48
Days taken for shooting	414.2	427.8	350.8	421.7	348.3	9.64	13.52	1.59
Days taken for bunch maturity	136.5	137.0	131.2	135.2	129.3	NS	NS	2.75
Bunch weight(kg)	32.2	23.9	18.2	13.8	18.0	2.28	3.20	6.97
No. of hands / Bunch	18.4	14.4	11.1	13.6	11.1	0.77	1.08	3.65
No. of fingers / Hand	17.3	14.9	14.7	15.0	14.6	0.88	1.24	3.74
Total no. of fingers / Bunch	314.2	216.4	160.5	200.5	155.4	14.97	20.99	4.64
Duration of the crop (days)	550.8	564.8	482.1	557.0	477.7	12.58	17.64	1.55
TSS (°B)	31.55	30.25	26.24	26.75	25.63	0.663	0.814	-
Acidity(%)	0.42	0.45	0.37	0.62	0.55	0.006	0.009	-
Shelf life	8.32	6.22	4.67	5.6	7.15	0.312	0.533	-
Pulp peel ratio	3.98	3.77	4.05	3.90	3.69	0.215	0.426	-

Table 8: Reaction to Sigatoka Leaf Spot diseases

Sigatoka at maturity	NRCB Selection-001	Kanthali	Karpuravalli	Boodida Bukkisa	Boodhi Bale
Youngest Leaf Spot	35.89	34.33	31.61	36.58	41.12
Disease Severity	9.05	9.3	12.0	8.1	4.50
Photosynthetically active leaves	12.35	11.12	13.1	12.38	8.06



Plate 1. NRCB Selection 001

Evaluation of FHIA-01

The performance of the exotic introduction FHIA - 01 was compared with BRS - 01 (Kerala) (Pome type), Pachanadan and Robusta owing to its mixed parentage of Cavendish and Pome types. FHIA - 01 was slightly taller than Robusta with maximum girth (0.82 m) (Table 9). Though Robusta excelled FHIA - 01 in terms of number of hands / bunch (13.0) and number of fingers / hand (15.2), FHIA - 01 recorded the maximum bunch weight of 20.5 kg and had a comparatively shorter duration (Plate 2).

Screening of Diploids for nematode resistance (P. Sundararaju)

- ♦ Samples of both soil and root was collected at vegetative stage and flowering stage from 11 diploids grown under field conditions.

- ♦ Namarai, Pisang Mas and *Musa ornata* were field tolerant where as the remaining diploids were susceptible to major nematode pathogens viz., *R. similis*, *P. coffeae*, *H. multicinctus* and *M. incognita* at vegetative stage. However, at flowering stage, all diploids were found to be susceptible to all major nematode pathogens.

Screening diploids against Corm weevil and Stem weevil (B. Padmanaban)

A new rapid screening procedure was developed using banana leaf sheath as a testing material. Out of 22 diploid accessions screened against corm weevil, the accessions 047,007,444 and 011 were found resistant to corm weevil. Out of seven NBPGR *Musa* accessions, IC-84809, IC-84863, IC 84889 were found resistant to stem weevil.



Plate 2. FHIA-01 (Gold finger)

Table 9: Growth and bunch parameters of the Global hybrid (FHIA-01)

Characters	T1	T2	T3	T4	CD (5%)	CD (%)	CV (1%)
Plant height(cm)	220.8	239.4	279.6	180.4	19.39	27.86	5.27
Pseudostem girth (cm)	82.1	73.7	69.1	57.4	6.72	NS	5.95
Petiole length (cm)	48.9	62.6	66.5	47.1	1.45	2.08	1.61
No. of leaves at shooting	14.8	13.5	13.9	14.2	NS	NS	2.59
No. of leaves at harvest	7.4	7.0	7.1	7.4	NS	NS	2.21
Leaf area / leaf (cm ²)	10808.4	9104.0	10867.6	7724.0	NS	NS	11.95
Time taken for shooting (days)	233.4	355.5	233.7	362.5	22.39	32.17	4.72
Time taken for bunch maturity (days)	124.8	121.5	97.0	103.2	11.59	NS	6.49
Bunch weight(kg)	20.5	11.1	13.2	15.5	1.38	1.98	5.72
No. of hands / Bunch	10.9	7.9	9.0	13.0	0.89	1.29	5.48
No. of fingers /Hand	14.9	12.6	14.8	15.2	1.00	NS	4.35
Total No. of fingers/Bunch	132.0	95.6	133.2	190.4	15.99	22.98	7.25
Duration of the crop (days)	358.2	464.5	328.2	467.7	27.14	38.99	4.19

T1- FHIA-01; T2- Pachanadan; T3-H-01; T4-Robusta

Germplasm screening for *Mycosphaerella* leaf pathogens (R. Selvarajan)

Septoria and *Sigatoka* pathogens have been isolated and pure cultured. All the available germplasm and exotic accessions in the field gene bank were screened for leaf spot diseases caused by *Mycosphaerella* spp. 275 accessions having B genomes were

screened and grouped based on two different reaction ratings for leaf spot diseases. As per IITA reaction grouping 12 were highly resistant, 35 were partially resistant. As per Daniells *et al.* (1966), 70 were grouped as highly resistant, 17 as resistant and only 13 accessions were grouped as very susceptible (Table 10).

Table10: Grouping of Indian banana accessions having one or more B genomes based on reaction ratings followed by IITA and Daniells *et al.* (1966).

Genomic group	Reaction rating based on								Total
	IITA protocol				Daniells <i>et al.</i> (1966)				
	HR	PR	LS	S	HR	R	S	VS	
ABB	-	21	38	58	40	14	61	2	117
AAB	9	-	11	99	10	3	95	11	119
AB	-	3	4	13	4	-	16	-	20
AAAB	2	-	-	-	2	-	-	-	2
AABB	1	-	-	-	1	-	-	-	1
ABBB	-	-	1	3	1	-	3	-	4
BB	-	11	1	-	12	-	-	-	12
Total	12	35	55	173	70	17	175	13	275



2. Improvement through conventional breeding

(S.Sathiamoorthy, S.Uma and R.Natarajan)

Breeding

The development of synthetic diploids is in progress. 19369 pollinations were made involving 7 diploids as male parents and 3 diploids and 3 triploids as female parents. *M.ornata* was also involved in these crosses both as male and female parents. Seed set was observed only in two cases (Table 11).

Crosses involving H-201 with Pisang Lilin (male parent) has (3 way hybrid), produced viable seeds with 5-7 per fruit. Crosses involving same accessions like Matti with Matti have produced healthy seeds up to 3 per fruit, in the first 3 hands of the bunch.

Owing to extreme temperature, seed set was poor in Trichy. Hence planting was also undertaken in Yercaud, Salem district.

The following viz., Cultivar Rose, Pisang Berlin, Pisang Lilin, Pisang Jaji, Anaikomban, Kanaibansi, H-1, FHIA-01, Saba, Kanthali, Burro Camsa and Kachkel were planted at Yercaud for future breeding programme.

Callus induction and regeneration

Accessions namely Matti, Sanna Chenkadali, Anaikomban, Cultivar Rose, Nendran and Robusta were tried for callus induction and regeneration (Table 12). The explants tried were young leaf whorls around meristem and young male flower buds. Explants after sterilization were inoculated in MS semisolid medium fortified with various concentrations of auxins like 2,4-D, CPA and picloram. Percentage of callus was more and time taken for callus initiation was less in MS semisolid medium fortified with 2mg/l 2,4-D/ CPA or 1mg/l of picloram. However time taken for callus initiation was more in picloram rather than 2,4-D / CPA. Similarly maximum response was recorded in Cultivar Rose and minimum in Matti.

Table 11: Parental combination of crosses made during 2001.

Sl.No.	Name of parents	No. of crosses made
1.	Anaikomban x Anaikomban	1620
	Anaikomban x Matti	1560
2.	Pisang Lilin x Anaikomban	1518
	Pisang Lilin x Matti	945
	Pisang Lilin x Kanthali	1440
	H-201x Pisang Lilin	60
3.	<i>Musa ornata</i> x Anaikomban	924
	<i>Musa ornata</i> x Matti	1056
4.	Hatidat x Anaikomban	432
	Hatidat x Matti	1240
5.	Cultivar Rose x Matti	1280
	Cutlivar Rose x Hatidat	932
6.	Pisang Jari Bauya x Hatidat	440
7.	Matti x Matti **	1782
8.	Pisang Jajee x Saba	336
9.	Pisang Jajee x Hatidat	72
10.	Pisang Jajee x <i>Musa ornata</i>	80
11.	Pisang Jajee x Manoranjitham	72
12.	Pisang Jajee x Matti	1680
13.	Pisang Jajee x Kanthali	1800



Table 12: Effect of different growth regulators on callus induction of banana leaf explant

Growth regulator concentration (mg/L)	Matti (d) %	Sanna Chenkadali (d) %	Anai komban (d) %	Cultivar Rose (d) %	Saba (d) %	Nendran (d) %	Robusta (d) %
2,4-D							
1.0	47 62.4	45 69.0	41 67.4	44 69.2	42 70.0	44 66.6	43 67.6
2.0	39 75.6	37 82.2	30 84.8	32 87.2	30 85.8	33 82.6	31 86.6
3.0	34 32.4	31 34.8	27 33.2	28 37.6	28 33.4	30 34.2	30 36.8
4.0	37 7.4	33 9.2	31 9.4	34 11.6	32 10.4	35 10.2	37 9.8
Picloram							
1.0	62 63	59 70.4	55 72.4	58 80.2	55 77.0	57 76.6	55 79.8
2.0	51 23.6	49 32.2	45 31.4	47 47.8	46 31.6	47 29.8	46 31.6
3.0	55 5.7	54 6.2	49 7.2	51 8.8	49 6.8	50 7.6	49 8.0
CPA							
1.0	28 55.6	25 62.2	21 61.4	23 68.8	22 62	24 60.4	23 59.6
2.0	23 75.2	20 81	17 82.2	18 83.4	18 80.2	19 78.8	19 76.6
3.0	21 36.4	19 40.4	15 42.6	17 47.6	17 43.4	18 41.4	17 44.8
4.0	25 7.4	22 8.8	20 8.0	22 9.2	23 8.0	23 7.8	24 8.8

(d) No. of days taken for the initial appearance of callus (± 2)

%- Percentage of explants responded (data represents the average of five replications)



II. Crop Production And Postharvest Technology

2.1. PRODUCTION TECHNOLOGY

2.1.1. Standardisation of Agrotechniques for banana production and productivity

Effect of fertigation levels and mulching on growth, yield and quality of Poovan banana. (S.D.Pandey, M.M.Mustaffa and K.J.Jeyabaskaran)

Growth Parameters

The effect of two levels of fertigation and different mulches was studied in Poovan banana. The observations on growth parameters viz., plant height, girth, number of leaves and leaf area were recorded. Banana leaf mulch along with 75% of recommended N and K recorded the maximum plant height (57.33 cm and 139.05 cm) at 3rd and 5th month respectively. F_2M_1 treatment combination recorded maximum plant girth (41.22cm) followed by F_2M_2 treatment at 5th month stage. Maximum number of functional leaves (9.86) was observed in F_2M_1 followed by the treatment F_1M_1 (50% recommended N and K and banana leaf mulching) at 3rd month stage.

Growth observations at flowering stage indicated significant maximum plant height 253.62 cm in F_2M_2 (75% fertigation and paddy straw mulch) followed by F_1M_1 (50% fertigation and banana leaf mulch) whereas stem girth (61.44cm) and number of functional leaves (12.22) were recorded in F_2M_1 (75% fertigation and banana leaf mulch) Fig. 7.

Phyllochron

Leaf emergence was faster in F_2M_1 at all stages of observations. Faster leaf emergence was recorded in August as compared to other months. Dried banana

leaf mulch with 75% N and K fertigation flowered earliest (290.33 days) followed by 50% N and K fertigation with banana dried leaf mulching. Highest bunch weight (17.43kg) was also recorded in F_2M_1 followed by F_2M_2 (15.88kg) treatment combination (75% N and K fertigation with paddy straw mulching) Table 13.

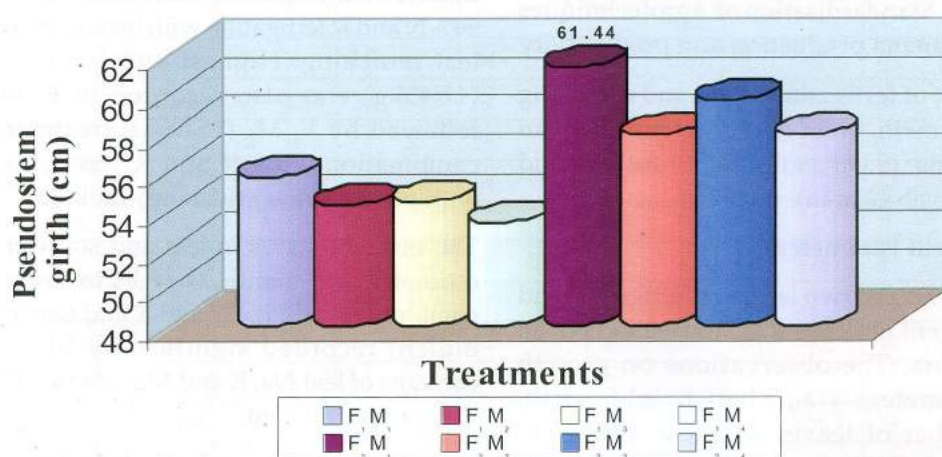
The nutrient status in leaf and soil were estimated at 5th month. The F_2M_1 treatment combination (75% of N and K and banana mulch) recorded significantly higher contents of leaf Na, K and Mg whereas Ca was non-significant.

N content of soil was not affected whereas Na, K, Ca and Mg contents were significantly different. Sodium content was significantly less in mulching treatments and minimum 1.0% Na content was found in F_2M_1 treatment combination. K, Ca and Mg were higher in F_2M_1 treatment combination. Zn, Fe and Cu concentrations was found maximum in F_2M_1 treatment combination while F_1M_1 treatment recorded the maximum Mn concentration.

Table 13: Effect of fertigation levels and mulching on days to shooting and bunchweight cv. Poovan.

Treatments	Days to shooting	Bunch weight Kg
F_1M_1	294.00	13.99
F_1M_2	304.00	13.22
F_1M_3	320.00	10.71
F_1M_4	306.66	11.66
F_2M_1	290.33	17.43
F_2M_2	294.67	15.88
F_2M_3	315.66	12.10
F_2M_4	305.67	15.33
CD at 5%	15.69	1.31

Fig. 7. Effect of fertigation levels and mulches on pseudostem girth of banana cv. Poovan (AAB)



Effect of fertigation levels and mulches on number of functional leaves of banana cv. Poovan (AAB)

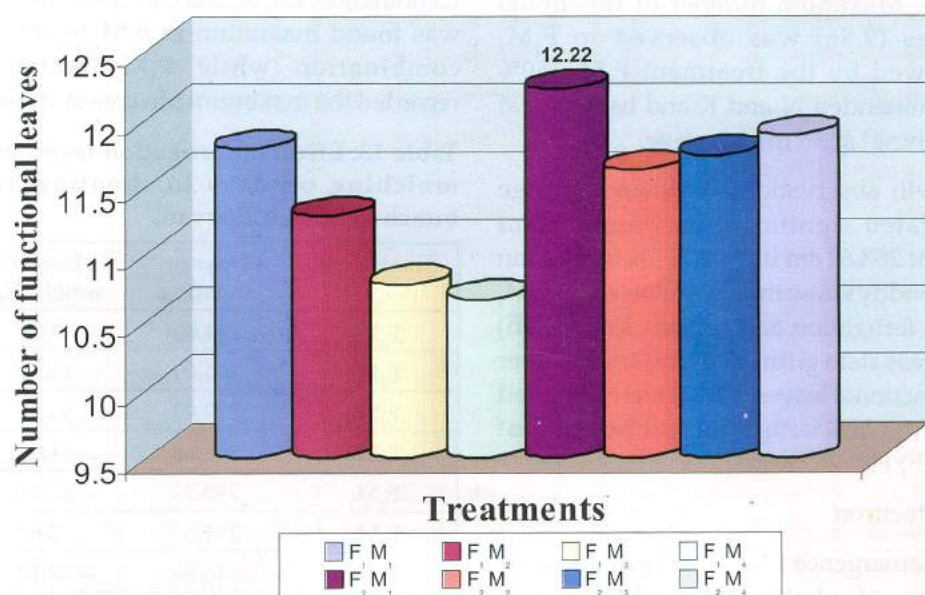




Table 14: Effect of fertigation levels and mulching on leaf micronutrients (ppm)

Treatments	Mn (ppm)	Zn (ppm)	Fe (ppm)
F ₁ M ₁	194.00	107.00	369.67
F ₁ M ₂	155.00	100.33	270.67
F ₁ M ₃	165.33	65.00	299.33
F ₁ M ₄	149.33	66.00	319.67
F ₂ M ₁	169.00	115.00	480.33
F ₂ M ₂	174.33	102.00	387.67
F ₂ M ₃	135.67	117.33	276.67
F ₂ M ₄	170.00	98.33	376.67
CD at 5%	14.88	3.530	93.33

M1 - Banana Leaf
M2 - Paddy straw
M3 - Pseudostem bits
M4 - No mulch

F1- 50% of recommended dose
F2- 75% of recommended dose

Sigatoka leaf spot disease incidence in High density planting

Sigatoka leaf spot incidence was recorded at monthly interval from 6th month after planting. The YLS recorded was high in three plants per hill as compared to paired row system with various levels of fertigation. Disease severity (Infection Index) was recorded as per INIBAP method. The result showed that the DS was highly significant among treatments. The DS was significantly lower in three plants per hill than in paired row system (Table 15). The difference was higher in April as compared to previous months.

2.1.2. Standardization of technology for organic banana production

(M.M. Mustafa, V. Kumar and K.J. Jayabaskaran)

Two experiments were laid out in two varieties viz., Rasthali and Karpuravalli.

Different organic manures like distillery sludge, vermicompost, neem cake and poultry manure were tried in different concentrations and combinations.

Rasthali banana

The combination of distillery sludge 2.5 kg + 1 kg vermicompost + 1 kg neemcake + 2.5 kg poultry manure pl⁻¹ recorded the highest plant height (140.01 cm), plant girth (47.26 cm), total leaf area at flowering (1.71 m²) and chlorophyll content (3.02 mg/g) (Fig. 8 and 9). In addition, it also significantly suppressed root population of root lesion nematode (*Pratylenchus coffeae*), root knot nematode (*Meloidogyne incognita*) and spiral nematode (*Helicotylenchus multicinctus*) to the extent of 52.87 %, 64.89 % and 84.47 % respectively. Vermicompost was least effective in controlling nematodes among individual organic manures. Control

Table 15: Sigatoka leaf spot disease severity in high density planting system with fertigation

S.No	Treatments	Jan	Feb	Mar	Apr
1	T1 (PR, 50% NPK)	16.96	20.37	16.12	7.66
2	T2 (PR 75% NPK)	15.68	20.95	16.05	11.02
3	T3 (PR 100%NPK)	19.20	19.40	19.02	13.81
4	T4 (HD3, 50%NPK)	13.26	13.15	9.92	3.40
5	T5 (HD3, 75%NPK)	12.67	14.66	11.62	2.65
	CD@ 5%	2.3996	2.4074	2.0329	3.576

recorded the lowest values for all the growth characters and also recorded the severe infestation of nematodes (Fig. 8 and 9).

Karpuravalli banana

The treatment distillery sludge 2.5 kg + Neem cake 1 kg / plant applied at three splits recorded the highest plant height (305.4 cm), plant girth (90.6 cm), more number of leaves (14.2), total leaf area

(15.12 m²) and chlorophyll content (3.42mg/g) as compared to other treatments (Fig. 8 and 9). In addition, population of nematodes viz. *Pratylenchus coffeae*, *Meloidogyne incognita* and *Helicotylenchus multicinctus* were also found to be significantly lower in plants which received the above treatment.

Fig. 8. Effect of organic manures on height (cm) and girth (cm) of Karpuravalli and Rasthali banana

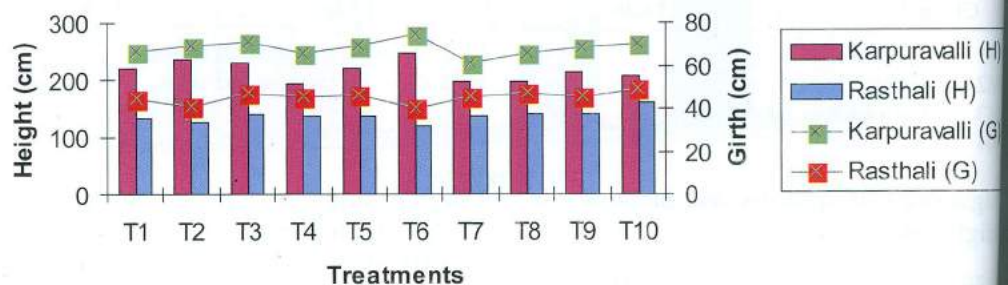
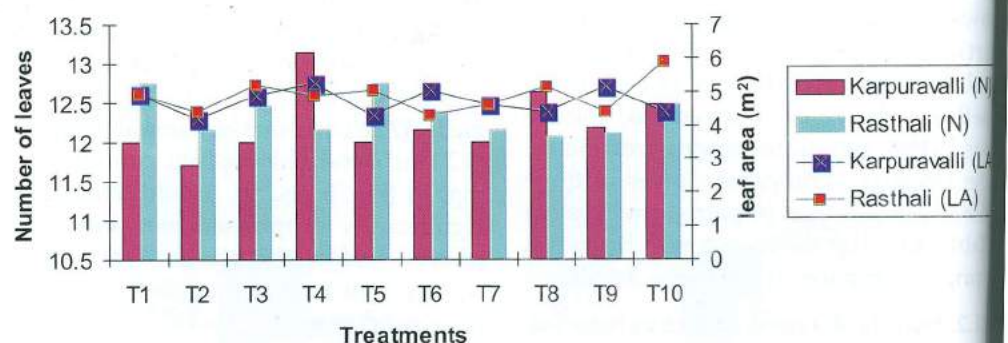


Fig. 9. Effect of organic manures on number of leaves and leaf area (m²) in Karpuravalli and Rasthali banana



2.1.3. Studies on amendment and reclamation of saline sodic soil for banana

Studies on Substitution of Potash-rich Cement Kiln Flue Dust for Potassic Fertiliser in Banana cv. Karpuravalli (K.J. Jeyabaskaran and S.D. Pandey)

Cement Kiln Flue Dust (CKFD), containing 30 % of K) from cement factory was applied at the rate of 0, 0.5 and 1.0 kg / plant as main treatments and K was applied at the rate of 0, 20, 40, 60, 80 and 100 % of recommended K (450 g / plant as sub treatments. Increasing K levels (any source) reduced the plant growth rate in

the early stages while increased during the later stages of growth. Optimum levels of soil and leaf nutrients were found at 0.5 kg CKFD level. TSS was highest at 0.5 kg CKFD / plant and acidity (%) was lower at 1 kg CKFD / plant (Fig. 10). The Potentiometric Buffering Capacities of soil for K (PBC) at 0 kg, 0.5 kg and 1.0 kg CKFD were 35.2, 37.45 and 38.98 cmol / kg. (M / l) respectively. The highest bunch weight (13.1 kg) was obtained at 60% rec. K + 0.5 kg CKFD / plant and was on par with or higher than 100% rec. K (Fig. 11). Application of 0.5 kg CKFD / plant + 60% rec., produced optimum yield, could save 40% of the



Fig. 10. Effect of Cement Kiln Flue Dust (CKFD) with graded levels of K on yield of Karpuravalli

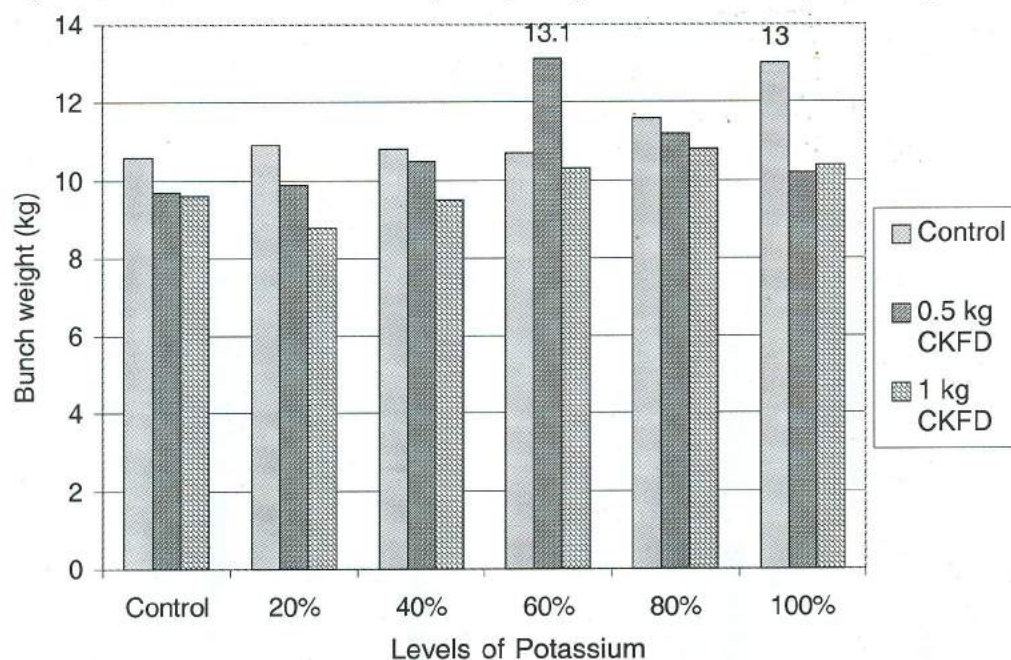
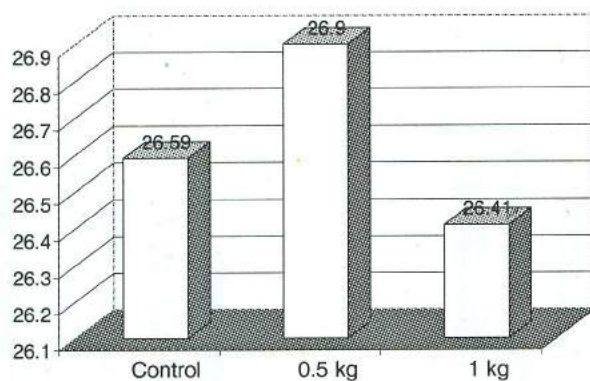
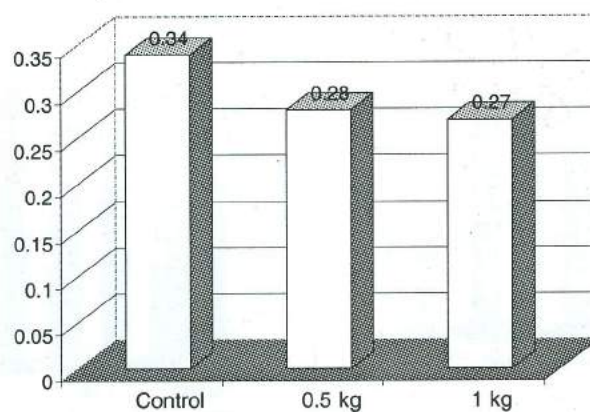


Fig. 11. Effect of CKFD on TSS ($^{\circ}$ Brix) content of fruits



Effect of CKFD on acidity (%) content of fruits





2.1.4. Studies on micronutrients in banana

Soil and foliar applications of micronutrients in banana under high pH soil.

(K.J.Jeyabaskaran and S.D.Pandey)

FeZnB (002) recorded the highest growth parameters like, height, pseudostem girth, number of leaves, leaf area and

phyllochron till 11th month. While FeZn (122) recorded the highest growth parameters after 11th month. Soil application of Fe in high pH soil was better than foliar spray. But, foliar application of Zn and B was found to be better than soil application, in high pH soil, based on the growth parameters (Fig. 12a & b).

Fig. 12a. Effect of soil and foliar applications of micronutrients on the vegetative parameters of Karpuravalli banana

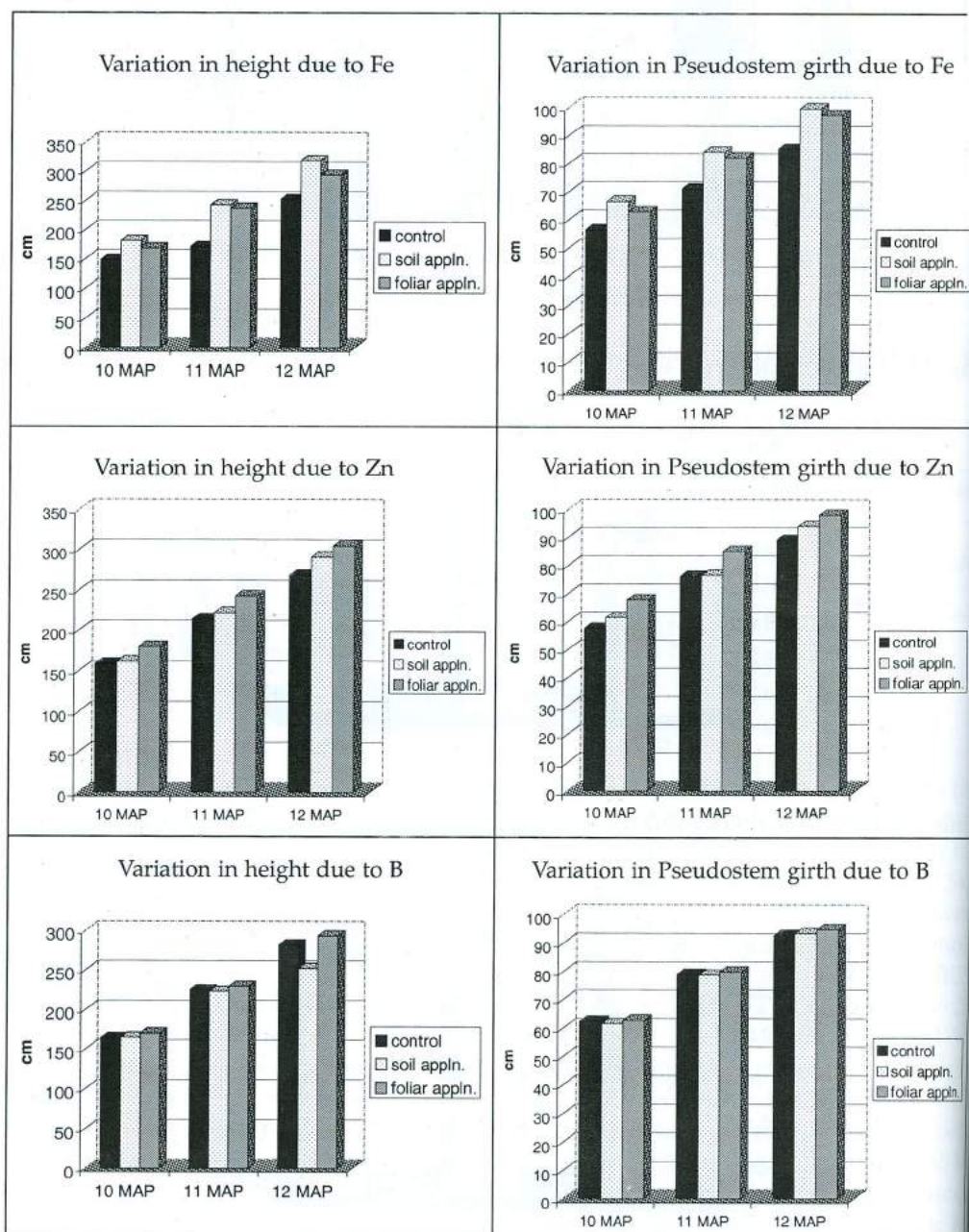
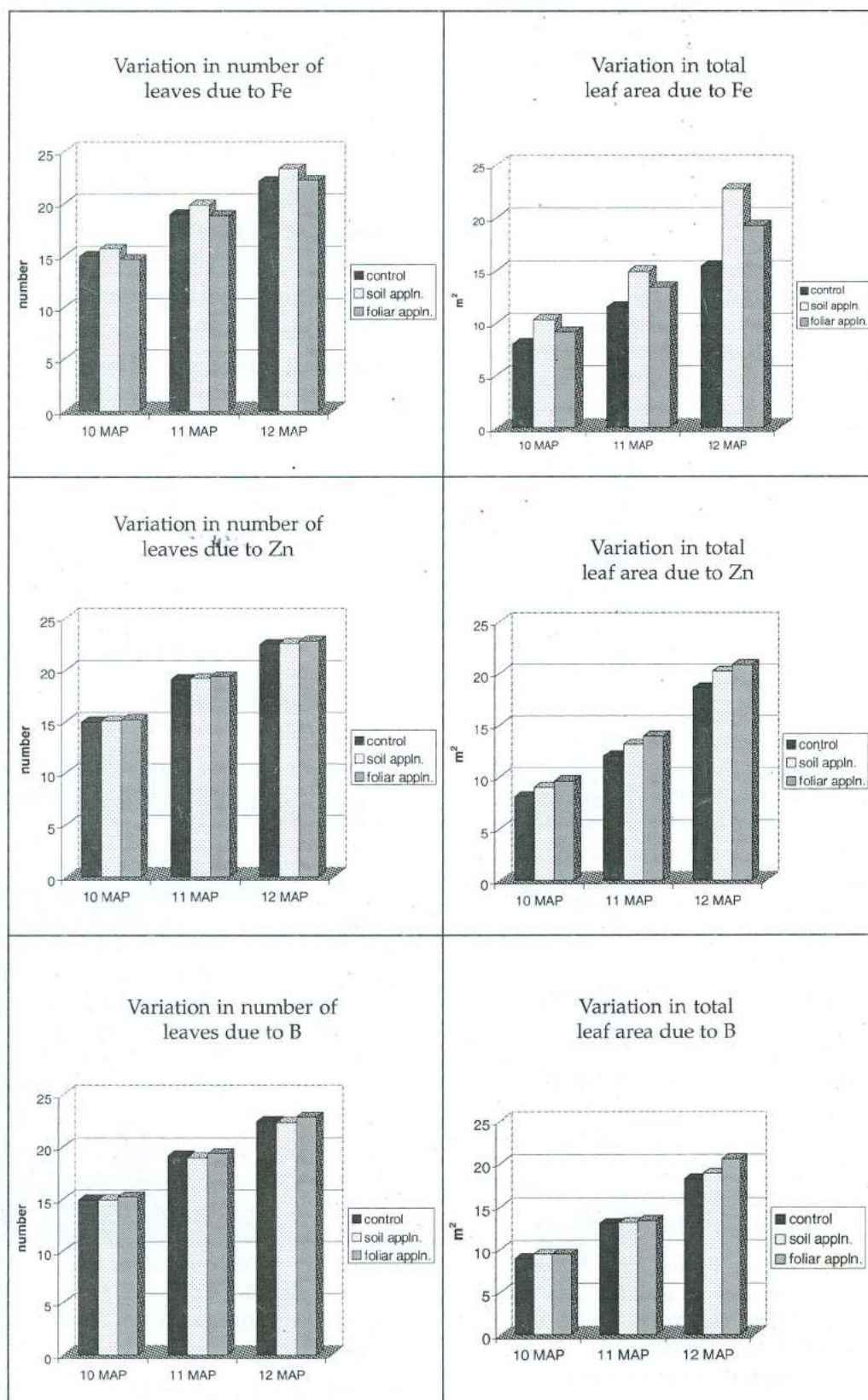




Fig. 12b.





2.2. POSTHARVEST TECHNOLOGY

2.2.1. Studies on handling, storage and processing of banana

(C.K.Narayana and M.M.Mustaffa)

Standardization of recipe for banana flower pickle (North Indian Style)

Karpuravalli banana flower was cut into pieces after removing the pistil and blanched in hot water at 80° C for 15 minutes. Later it was soaked in 1% or 0.1% citric acid solution for 30 minutes and cured in 4% or 8% salt for 25 days. The control had 4% or 8% salt and without citric acid. 8% salt + 0.1% citric acid was unspoiled while others were spoiled within 25 days. Moisture and total chloride increased during storage while acidity decreased. The organoleptic score for colour, flavour, texture, taste and overall organoleptic quality increased during storage upto 120 days.

Standardization of recipe for banana flower thokku

Karpuravalli banana thokku was prepared with four different treatments viz., thokku with oil (T1), thokku with oil + vinegar (T2), thokku with oil + citric acid 0.6% (T3) and thokku with oil + vinegar + citric acid (T4). The thokku was prepared as per the standard recipe. T1 and T3 were spoiled within one month, while the samples with vinegar stored up to 120 days (T2 and T4). The moisture was more (51.8%) in T4 than T2 (45.70%) and it increased during storage. The acidity was more in T4 (1.48%) than T2 (0.91%), which increased during storage upto 60 days and thereafter declined. The total chlorides were also higher (4.33%) in T4 and it increased to 5.23% in T4 upto 30 days and thereafter it decreased (Plate 3).

Standardization of critical temperature for storage of Pachanadan banana

Fully mature Pachanadan banana fruits were stored at 10 and 15°C temperature and 70-75% relative humidity. The fruits stored at 10° C developed chilling injury (CI) symptoms characterized by pitting

and black spots after 15 days of storage while at 15° C no chilling injury symptoms were noticed till 15 days. After 20 days of storage at 15° C about 25% fruits exhibited chilling injury symptoms. The ripening of fruits was affected at room temperature after taking out from 10°C (on 15th day) while those at 15°C ripened normally even after 20 days of storage. Pachanadan banana is susceptible to chilling injury (CI) even at 15° C when stored beyond 20 days.

Effect of maturity, packaging and storage of Pachanadan banana

Pachanadan banana of 75% and 90% maturity were stored at ambient condition, zero energy cool chambers (ZECC) and 13.5°C. Based on weight loss and spoilage, 75% mature fruits stored at room temperature had a storage life of 12 days, while at 13.5°C, it was 15 days and in ZECC it was 24 days. 90% mature Pachanadan fruits had a storage life of 12 days at room temperature and 15 days each at ZECC and 13.5°C. The ripening was faster at room temperature followed by 13.5°C and ZECC in both 75% and 90% mature fruits.

Effect of pre-cooling and packaging on storage life and quality of Pachanadan banana

Seventy five per cent mature Pachanadan fruits were subjected to various pre-cooling treatments like water-cooling, air cooling and stored with and without bagging at 13.5°C. The weight loss was more in fruits without bagging as compared with polyethylene bagging. Pre-cooling either with water or air did not have any beneficial effect on extension of shelf life.

Sweet chutney was prepared with three different levels of sugar and fixed composition of spices using Poovan and Karpuravalli banana. Banana sweet chutney having 300g sugar for every 500g of pulp developed best taste and acceptability with more than 130 days of storage life.

Banana fruit bar preparation was refined



and modified from still air to circulating hot air at 70° C by which the duration of drying was reduced to 20 hours. The moisture level increased while non-enzymatic browning decreased and the acidity increased during 30 days storage.

A new product 'Banana Sauce' was developed using Monthan cooking banana. The process was standardized using different proportions of pulp and water viz., 1:4, 1:5 & 1:6. The treatment with 1:4 dilution was found to be best.

Banana fruit pickle was made using Monthan banana. The fruits were peeled,

cut into 1 cu.cm cubes and fried in oil. The fried cubes were mixed with spices before curing. The pickle was prepared both in Northern style with spices and in Southern style with asafoetida. The score for colour, flavour, texture, taste and overall acceptability showed no significant variation between two types of pickles and stored upto 4 months (Plate 4).

A ready-to-serve banana snack was prepared using Monthan banana fruits. The starch from Rasthali corm was extracted. The starch recovery was 3.57%. A procedure was standardized for production of sweet candy from central core of Rasthali banana.



Plate 3.

Banana thokku made from male flower of Karpuravalli banana



Plate 4.

Banana fruit pickle made from Monthan banana



III. Crop Protection

3.1. Insect pest Management

(B. Padmanaban and P. Sundararaju)

3.1.1. Search for biocontrol agents and new pests

Survey conducted in endemic areas revealed the occurrence of scarabaeid beetle, *Anomala(?) marginipennis* infesting the roots of cv. Robusta. The larval feeding damage resulted in stunted plant growth. Entomopathogenic nematode isolates KNK I, II and TN I were collected from endemic areas. Medium sized corm weevil, incidence was noticed during surveys and identified as *Cosmopolites sordidus* (Plate 5).

3.1.2. Evaluation of trapping methods

A total of 1520 pseudostem traps (376 disc-on-stump and 144 longitudinal traps) were laid out in eleven endemic sites with 15,143 plants. During the observation period, 2393 weevils were trapped and an average 29 traps/plant and 4 insects per trap were recorded, which indicated 90% of Banana corm weevil (BCW), 4% of banana stem weevil (BSW) and 5% medium sized banana corm weevil *C.sordidus*. Sex ratio of the BCW and BSW was 1:1.33 and 1:2.0 respectively.

Banana corm weevil pheromone (cosmolure) was evaluated in cv. Ney Poovan field infested with banana corm weevil. Trap catches were recorded from 52 standard week (26/12/01) to 17th stan-

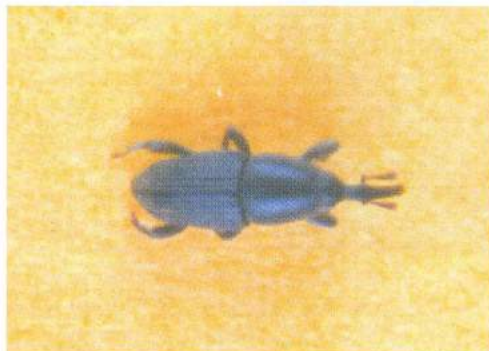
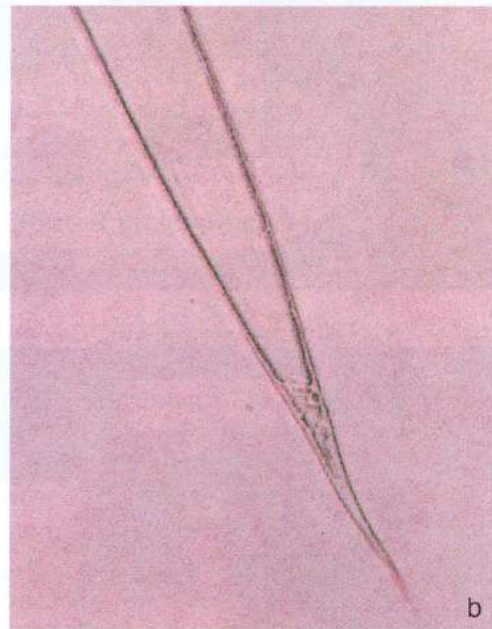


Plate 5. Medium sized banana corm weevil, *Cosmopolites sordidus*



a



b



c

Plate 6. Entomopathogenic nematode, *H.indica* (a), (b) anterior and posterior regions of *H.indica*. c) grub infected with *H.indica*



dard week (2/5/02). Initially there were 108 weevils/week (52 week) which came down to 13 weevils per week during 17th standard week.

3.1.3. Evaluation of Entomopathogenic nematode, *Heterorhabditis indica*

H. indica (PDBC EN 13.3) was evaluated (10-100 IJ's per grub) against BSW and the maximum mortality was observed at 70 IJ's Per grub (Plate 6abc).

3.1.4. Testing of newer insecticides against banana weevils

New insecticide molecule (Nitromethylene/Neonicotinoids) such as Actara 25wG and Cruiser 70 ws were evaluated against banana stem and corm weevil respectively under laboratory conditions using banana leaf sheath. Actara was tested at 50-200ppm. Maximum mortality at 24 hrs was recorded in Monocrotophos and Chlorpyrifos treatments and only 60% was recorded in 200 ppm of Actara. At 48 and 72 hrs, mortality was 70 and 83% respectively at 200 ppm Actara whereas in Chlorpyrifos and Monocrotophos it was 100 per cent. Cruiser 70ws was used as sucker treatment at 50-200ppm and Monocrotophos 0.05% as standard check. Maximum mortality at 24, 48 and 72 hrs with 200ppm Cruiser was 80, 100 & 100 per cent respectively.

3.2. Studies on banana nematodes and their management

(P. Sundararaju, B. Padmanaban and R. Thangavelu)

3.2.1. Survey and extent of damage in different states

The banana growing areas in South India, Bihar, Gujarat, Maharashtra and North

Eastern Hills Regions were surveyed for plant parasitic nematodes and nematode populations were assessed. Seventeen genera of plant parasitic nematodes were recorded from the rhizosphere of banana. Among them, root-lesion nematode, *Pratylenchus coffeae* was found to be the predominant species followed by root-knot nematode, *Meloidogyne incognita* and spiral nematode, *Helicotylenchus multicinctus*. The burrowing nematode, *Radopholus similis* was recorded only in few pockets of Tamil Nadu whereas in Kerala almost 75 per cent of samples collected, yielded *R. similis*. The crop loss due to *P. coffeae* in banana cv. Nendran was estimated to be 25.4 per cent.

Large number of cysts were observed in cv. Robusta (AAA) which revealed the presence of about 86 to 105 matured cysts and 12 to 15 juveniles from 250 g soil and 22 to 29 white females per 10 g of roots. Each matured cyst has 18 to 47 viable eggs. Inoculation of banana roots with second stage larvae resulted in penetration of roots and development of white females with egg sac, filled with viable eggs. The white females and juveniles were identified as *Heterodera oryzae* Rao & Jayaprakash, 1978 (Plate 7 a & b).

Three important nematode species viz., *Pratylenchus coffeae*, *Meloidogyne incognita* and *Helicotylenchus multicinctus* were recorded maximum from banana soil and root samples where three suckers per hill with fertigation level of 50 % N and K were adapted. Conventional system of planting and planting with two suckers per hill recorded more or less same degree of nematode population. Nematode infestation reduced the size of fingers and twisted bunches with few hands.



Plate 7 (a) Egg

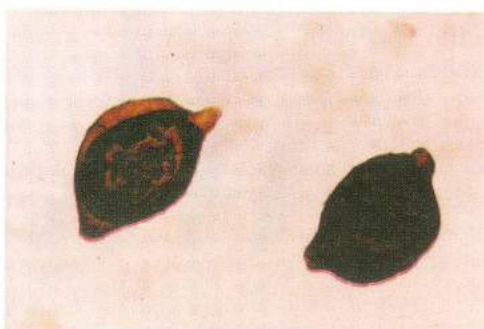


Plate 7 (b) Adult female (cyst)
cyst nematode, *Heterodera oryzae*



3.2.2. Nematode fungal complex disease

The influence of *P. coffeae* and *M. incognita* alone and in combination on the *Fusarium* wilt complex of banana was studied in cv. Rasthali. The plants inoculated with nematodes either singly or in combination followed by fungus resulted in the early onset and increased severity of the *Fusarium* wilt disease. Whereas, *F. oxysporum* f. sp. *cubense* (FOC) inoculated alone in the banana plants showed comparatively moderate effect on plant growth. Maximum reduction of plant growth parameters was observed when all the three pathogens (FOC, *P. coffeae* and *M. incognita*) were present together than when one or two pathogens inoculated, indicating a positive interaction between all the three pathogens (Plate 8).

3.2.3. Management of nematodes using biocontrol agent and botanicals

Mass-production of nematode egg parasitic fungal bioagent, *Paecilomyces lilacinus* was studied on banana wastes (leaf, petiole and pseudostem), castor and pungam leaves and their combinations and a standard check with pre soaked sorghum grains. Fresh substrates were autoclaved and inoculated with the bioagent and maintained for twenty-five days. Highest spore load of 8×10^6 *P. lilacinus* per g of substrate was harvested in ba-

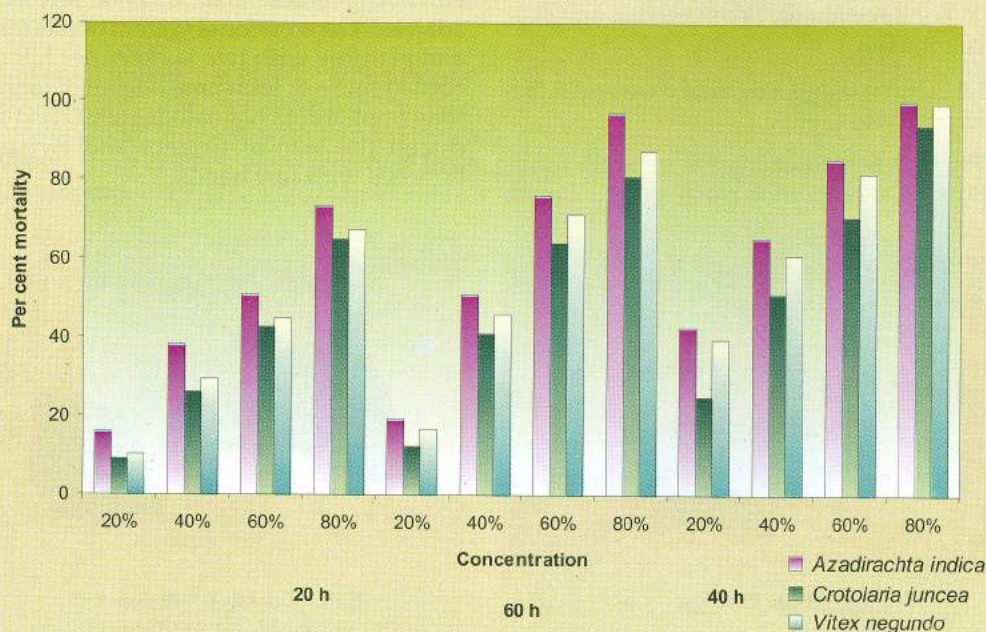
nana petiole and castor leaf mixture. However, sorghum grains registered maximum spore load per g of substrate. Banana pseudostem and pungam leaves were comparable in their substrate nature to the fungus.

Among the ten plant extracts tested, 80% *Azadirachta indica* extract exerted 73.4 per cent mortality of *Pratylenchus coffeae* when exposed to 20 h. and was followed by *Vitex negundo* and *Crotolaria juncea* extracts. (Fig.14)



Plate 8. a. Pc + Mi + FOC b. FOC

Fig. 14 . Effect of plant extracts on the mortality of *Pratylenchus coffeae* in vitro



3.3. Studies on fungal and bacterial diseases of banana and their Management -

(R. Thangavelu)

Isolation of effective bio-control agents for the management of *Fusarium* wilt disease

Fungal, bacterial and actinomycetes were isolated from the banana soil rhizosphere and these were tested under *in vitro* condition against *Fusarium oxysporum* f.sp. *cubense* race-1 and race-2. Two *T.viride* isolates and one *Pseudomonas* sp. were identified and indicated more than 70% inhibition of mycelial growth of both *Foc* race-1 and race-2, besides exhibiting inhibition zone ranging from 40 mm to 60 mm. Further studies are in progress.

Isolation and identification of effective bio- control agents against Anthracnose disease

The pathogen *Colletotrichum musae* was isolated from different varieties of banana and are being maintained to study their variability. Isolation of different antagonists (fungal, bacterial and Actinomycetes) were made using special media from washings of banana fruits of different varieties and were tested against *C. musae* under *in vitro* condition. Two isolates of fungi, one yeast isolate and one bacterial isolate were found to be effective against *C. musae* under *in vitro* condition.

Isolation and identification of effective bio- control agents for Crown rot disease

Pathogens were isolated from the infected portions of the fruits and were identified as *Lasiodiplodia theobromae* and *C. musae*. The pathogenicity of these pathogens was also confirmed. From the washings collected from different varieties of banana fruit, the antagonists of fungal, bacterial and actinomycetes were isolated using special media and pure cultures are being maintained after following single spore/cell culture technique. The isolated cultures were tested against *L. theobromae* under *in vitro* condition by dual culture

plate technique. One fungal, three bacterial and two actinomycetes antagonists against *B. theobromae* were identified.

Evaluation of different fungicides against of banana pathogens

Three fungicides namely Propiconazole, Carbendazim and Benomyl were tested at 0.5 to 0.005% against *C.musae*, *L.theobromae* and *F.oxysporum* f.sp. *cubense* under *in vitro* conditions by poison food technique. Propiconazole was very effective at all the concentrations tested for *C. musae* and up to 0.05% for both *F. oxysporum* f.sp. *cubense* and *L. theobromae*.

Evaluation of botanicals against different pathogens of banana under *in vitro* condition

Leaves from 70 plants were collected, washed in water and ground in 0.1 M phosphate buffer and centrifuged. The supernatant of each plant extract was filter sterilized by 0.22mm Millipore filter. 40µ ml of each extract was tested against different pathogens of banana viz., *Fusarium oxysporum* f.sp. *cubense*, (race - 1) *Colletotrichum musae* and *L. theobromae* for their mycelial inhibition under *in vitro* condition. The extract from *Solanum* sp was found to be more inhibitory to mycelial growth of all the three pathogens tested.

Evaluation of bio-agents, botanicals and fungicides against anthracnose disease under *in vivo* condition.

Different bio-agents, botanicals and fungicides were tested under *in vivo* condition in Rasthali, Robusta and NeyPoovan fruits for two times against anthracnose disease. The fruits were inoculated artificially after the treatments. One plant extract (*Solanum* sp.), two bio-agents viz., *T.viride* and *Pseudomonas* sp. and one fungicide -Propiconazole were found to be very effective not only in reducing the disease incidence but also in increasing both green and yellow life of fruits in all the three varieties. The increase in green life due to the plant extract was 26 days more under cold storage condition (13.5° C) as compared to control and other treatments

including bioagents and chemical and the increase was ranged from 12-26 days.

3.3.7. Evaluation of petroleum oil in combination with some effective fungicides against Sigatoka leaf spot diseases of banana.

Preliminary evaluation on the effect of Petroleum oil with or without fungicides on the Sigatoka incidence in variety Robusta revealed that Petroleum oil 5% + Propiconazole 0.05% spraying at the time of vegetative stage significantly reduced the incidence of the disease followed by Petroleum oil 5% + Carbendazim 0.05% and Petroleum oil 10%. It was also noted that the effect of Petroleum oil was on par with Carbendazim 0.1% concentration.

3.4. Studies in viral diseases and their management (R.Selvarajan)

3.4.1. Survey

Survey for banana bract mosaic virus in Nendran and Robusta was conducted in Trichy district after a gap of two years in order to know the reduction/ increase in spread of the disease. Three plots of each having approximately 100-150 plants were randomly selected and percent-infected plants were recorded. In Robusta and

Nendran, 38.5 and 34.5 percent plants got infected with BBMV (Table 16). Nearly two to three fold increase was observed as compared to previous survey. BBMV was also observed in Kolli hills. Maximum of 80% incidence of BBTV was recorded in Namaran cultivar in Kolli hills. In Cumbam area incidence of BBTV, BSV and BBMV were observed.

3.4.2. Banana Streak badna virus in accessions belong to Mysore group

Banana streak virus symptoms were recorded in all the accessions belonging to Mysore group. Out of 35 accessions, 14 accessions did not show the symptoms, four accessions expressed symptoms either on leaf or pseudostem and 21 accessions had symptoms on both the parts of the plant. An accession named Poovan did not exhibit symptom, but another Poovan accession had typical symptom. Similar observation was recorded in H -2 also. Banana streak virus symptoms have been observed in Hill banana for the first time.

3.4.3. Yield loss assessment

Yield loss assessment was studied in Ney Poovan due to BBMV. There was significant reduction in all the growth and yield parameters in infected plants as compared

Table 16: Incidence of Banana bract mosaic virus in in Trichy district

Orchard No.	Name of the area surveyed	Per cent BBMV infected plants	
		Nendran	Robusta
1	Adavatthur	37	34
2	Kotthatai colony	32	29
3	Palayam	53	18
4	Etterai	46	36
5	Mullai Nagar	39	57
6	Mollikarambur	31	32
7	Kotthatai	33	38
8	Vayalur	27	48
9	Konar Sathiram	42	37
10	Seerathopu	46	31
11	Ettumathadal	26	26
12	Keelavayalur	47	28
	Average	38.25	34.5



to healthy. 19.1 percent reduction in bunch weight was recorded as compared to control. Affected bunches had ill filled fingers and were not marketable. Infected plants took 45 to 60 days more to flower and the number of leaves at flowering was less by 9.98 percent. Nearly 50 percent of infected bunches were broken at the point where the peduncle joins with the stem.

3.4.4. Diagnosis of banana viruses

Direct Antigen Coating ELISA and Dot Immunobinding Assay were compared for detection of banana viruses. DAC-ELISA was found better for BBTv detection where as DIBA was more precise in detecting BBMV. For BSV, both the methods were found better. Detection of BBTv and BBMV by western blot was also standardized. Semidry transblot apparatus was used and the technique was standardized. Midrib tissues from young leaves is ideal for detection of BBTv whereas old highly symptomatic leaves is better for detecting BSV. For BBMV, youngest fully opened leaf midrib should be used for indexing (Plate 9)

3.4.5. Transmission and host range

CMV infected cucumber, cowpea and *Nicotianum benthamiana* but did not infect many naturally occurring weeds. BBMV found to be transmitted by banana aphid *Pentalonia nigronervosa* in a non-persistent manner. The acquisition access and inoculation feeding time were 5 and 30 min re-

spectively and 70 % transmission was observed in cultivar Nendran.

3.4.6. Studies on *Mycosphaerella* Leaf spot diseases and their management

Chemical control of Sigatoka leaf spot disease was repeated in cultivar Robusta. Observations on infection index, YLS, and YLS 33 were recorded after six months of planting. Alternate spray of Tilt: Kavach and Anvil : Kavach was significantly better as compared to control with respect to Infection Index. The YLS was significantly low in control (7.0) as compared to all the fungicide treatments. There was no significant difference among treatments on YLS 33.

3.4.7. Histochemical analysis of germplasm in relation to *Mycosphaerella* leaf pathogens

Sixteen germplasm accessions belonging to different ploidy level and resistant to leaf spot diseases were analysed for different biochemical parameters. The varieties resistant to *Mycosphaerella* leaf spot diseases had high content of wax, tannin, phenol, total sugar, and reducing and non-reducing sugar (Table 17). The activity of defense related enzyme, peroxidase was more in susceptible cultivars than resistant varieties. The stomata count and protein content did not have any correlation with resistance or susceptibility in selected cultivars/hybrids.

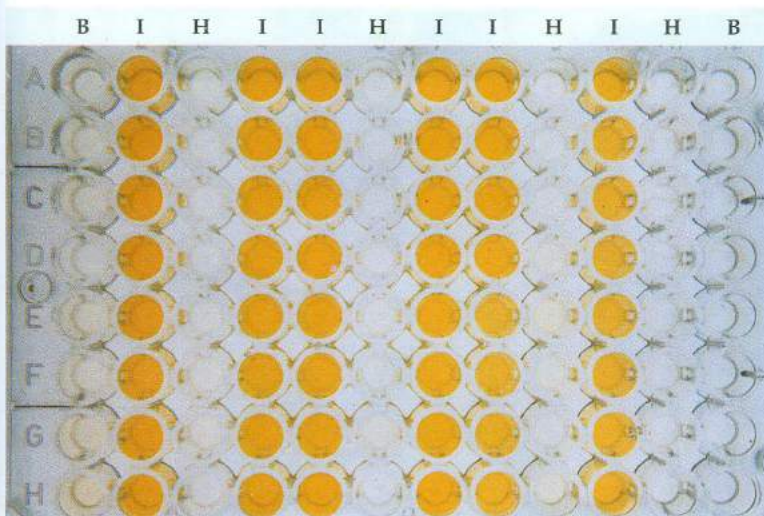


Plate 9.

Detection of BBTv by Direct antigen coating ELISA using indigenous antisera.

B - Buffer
I - Infected leaf
H - Healthy leaf

Table 17: Histochemical analysis in banana accessions resistant / susceptible to *Mycosphaerella* leaf spot diseases

Acc.name	Epicuti- cular Wax content (μg per 10 cm^2 of leaf area)	Phenol content (mg/ 100g)	Tannin content (mg/ 100)	Protein Content (mg/ 100g)	Total Soluble sugar (mg/ 100g)	Reducing sugar	Non- reducing sugar	Peroxi- dase activity
Rasthali	0.07	319.33	3.92	4334.00	1569.50	659.17	910.33	0.7340
Robusta	0.08	169.86	3.14	1019.00	2142.45	635.83	1506.62	0.8590
Nendran	0.02	201.60	2.61	5249.00	3786.18	744.33	3041.85	0.4010
Poovan	0.08	230.00	2.71	2141.00	2226.23	552.67	1673.56	0.2262
Ney Poovan	0.05	328.17	4.35	2610.00	791.83	698.16	93.07	0.3566
FHIA-01	0.05	283.34	4.01	2580.00	2325.78	798.17	1527.61	0.7618
FHIA-03	0.02	265.50	4.46	1497.00	3195.70	529.17	266.54	0.7814
H-2	0.09	279.00	4.23	2360.00	2290.50	695.83	1593.00	0.2632
H-1	0.17	312.67	3.43	2321.00	2631.20	535.83	2095.37	0.1142
Yangambi Km5	0.16	318.74	5.00	3709.00	2730.70	720.50	2010.20	0.3954
Pisang Jari Buya	0.07	327.67	4.82	4568.00	3211.25	909.16	2002.09	0.0838
Pisang Lilin	0.30	261.33	3.33	1824.33	2763.55	745.33	2018.22	0.6344
Pisang Mas	0.11	293.00	4.14	4744.00	3318.00	1388.66	1912.67	0.3020
Manoran- jitham	0.10	210.00	3.07	2078.00	2234.25	809.50	1424.75	0.0640
Thiruvantha- puram	0.10	229.17	5.32	1803.00	3720.60	833.39	2887.21	0.4628
Cultivar Rose	0.11	297.84	5.32	3207.00	3281.75	779.67	2502.09	0.0060

5. TECHNOLOGY ASSESSED AND TRANSFERRED

The technology of preparation of banana flower thokku was assessed and found to be technologically and financially viable. Five entrepreneurs have taken it up for commercial production.

6. EDUCATION AND TRAINING

i) *Musa* Germplasm Information System (MGIS)

A training programme on *Musa* Germplasm Information System (MGIS) was organised by NRC for banana, Trichy in collaboration with International Network for the Improvement of Bananas and Plantains (INIBAP), France and ASPNET, Philippines from 21st to 24th May 2001.

Dr.S.Sathiamoorthy, Director and

Dr.S.Uma, Senior Scientist, NRCB, Trichy; Dr.Elizabeth Arnaud, MGIS Activity Manager, INIBAP, France; and Dr.Suzanne Sharrock, Germplasm Conservation Scientist, INIBAP, France and Dr.Agustin B. Molina, Regional Coordinator, ASPNET, Philippines offered training to 11 banana germplasm curators who participated as trainees from different ICAR centres and SAU's all over the country. The trainees were from Kerala(3), Karnataka(3), Andhra Pradesh(1), West Bengal(1), Andaman(1) and Tamil Nadu(2) (Plate 10 and 11).

ii) A group of 5 potential entrepreneurs were trained for 5 days on production of various value added products.

iii) The following Postgraduate students from Bharathidasan University were trained for their project work for award of M.Sc degree.



Plate 10
MGIS Training



Plate 11
MGIS Training

Sl.No	Project Guide	Name of the Student	College / Institute
01	Dr.S.Sathiamoorthy Director	Ms.V.Renganayaki (M.Sc. Bio-Chem)	Seethalakshmi Ramasamy College, Trichy.
02	Dr.M.M.Mustaffa Principal Scientist	Ms.A.Padmavathi (M.Sc. Micro- Bio.)	Perambalur Dhanalakshmi College.
		Ms.A.L.Nazira Kamil (M.Sc. Micro- Bio.)	Srinivasan UrumuDhanalakshmi, Trichy.
03	Dr.P.Sundararaju Senior Scientist	Mr. T.Senthil kumar (M.Sc. Bio-Chem)	E.G.S. Pillai Arts and Science College, Nagapattinam.
		Mr.R.Ramesh (M.Sc. Micro- Bio.)	UrumuDhanalakshmi College, Trichy.
04	Dr.B.Padmanaban Senior Scientist	Ms. M.Navaneetha (M.Sc. Bio-Chem)	Sethalakshmi Ramasamy College, Trichy.
05	Dr.C.K.Narayana Senior Scientist	Ms. Maragatham (M.Sc. Micro- Bio.)	UrumuDhanalakshmi College, Trichy.
		Ms. D.Geetha (M.Sc. Bio-Chem)	Srimad Andavan Arts and Science College, Trichy.
06	Dr.S.Uma Scientist (SS)	Ms. Vasuki (M.Sc. Bio-Chem)	Avinashilingam Instt. for Home Science, Coimbatore.
		Ms. S.Anitha (M.Sc. Bio-Chem)	Avinashilingam Instt. for Home Science, Coimbatore.
		Ms. Manju (M.Sc. Micro- Bio.)	Dhanalakshmi Srinivasan College, Perambalur.
		Ms.N.Ruha (M.Sc. Micro- Bio.)	Dhanalakshmi Srinivasan College, Perambalur.
07	Mr.Thangavelu Scientist	Mr. J.Mathan (M.Sc. Micro- Bio.)	Jamal Mohamed College, Trichy
		Mr. P.John Justin Rayappan (M.Sc. Micro- Bio.)	Jamal Mohamed College, Trichy
		Mr.R.Satheesh (M.Sc. Micro- Bio.)	Jamal Mohamed College, Trichy
08	Dr.R.Selvarajan Scientist	Ms. R.Suchithra (M.Sc. Micro- Bio.)	Sengamala Thyar Edl. Trust, Mannargudi.
		Ms.K.Saritha (M.Sc. Micro- Bio.)	Sengamala Thyar Edl. Trust, Mannargudi.
		Ms. A. Chitra (M.Sc. Micro- Bio.)	Sengamala Thyar Edl. Trust, Mannargudi.



7. AWARDS /RECOGNITION

Received "Best Poster Award" for the research paper entitled "Effect of population levels of plant parasitic nematodes on high density planting with fertigation levels in banana cv. Robusta" by Dr. P.Sundararaju at the National seminar on 'Emerging trends in pests and diseases and their management' held during 11-13th October 2001, Tamil Nadu Agricultural University, Coimbatore.

8. LINKAGES AND COLLABORATION INDIA AND ABROAD

During this period, NRCB has sent 41 banana accessions to National Bureau of Plant Genetic Resources (NBPGR), New Delhi for *in-vitro* multiplication and for onward transformation to ITC, Belgium (INIBAP) according to MOU between ICAR and INIBAP.

9. PUBLICATIONS

Papers published in Journals

Jeyabaskaran, K.J., Pandey, S.D., Mustaffa, M.M. and Sathiamoorthy, S. 2001. Effect of different organic manures with graded levels of inorganic fertilisers on ratoon of Poovan Banana. *South India Hort.*, 49: 105-108.

Jeyabaskaran, K.J., Pandey, S.D. and Sathiamoorthy, S. 2001. Effect of FYM and gypsum with graded levels of K application on banana grown in saline sodic soils. *Journal of Potassium Research*, 17:101-106.

Mustaffa, M.M. and Sathiamoorthy, S. 2001. Organic Farming in banana - Problems and Prospects. *South Indian Horticulture*, 49: 209-213.

Padmanaban, B., Sundararaju, P., Velaudhan, K.C. and Sathiamoorthy, S. 2001. Evaluation of Musa germplasm against banana weevil borers. *Infomusa* 10:43-44.

Padmanaban, B., Kandasamy, M., Sundararaju, P. and Sathiamoorthy, S. 2001. Banana beetle *Sybra preusta* - New pests

from Tamil Nadu. *Infomusa* 10:43-44.

Padmanaban, B. and Sathiamoorthy, S. 2001. The Banana stem Weevil, *Odoiporus longicollis* Musa Pest Fact sheet No.5 (November 2001) INIBAP, France.

Pandey, S.D., Jeyabaskaran, K.J., Laxman, R.H. and Mustaffa, M.M. 2001. Effect of different moisture regimes and fertigation on growth, yield and quality of Poovan banana. *South Indian Horticulture*, 49: 76-79.

Pandey, S.D., Jeyabaskaran, K.J., Laxman, R.H., Santhi, V.P. and Mustaffa, M.M. 2001. Effect of irrigation, N fertigation and planting geometry on growth and yield of banana cv. Nendran. *South Indian Hort.*, 49: 76-77.

Sathiamoorthy, S. and Mustaffa, M.M. 2001. High density planting in banana and plantains - An overview. *South Indian Horticulture*, 49: 6-12.

Sathiamoorthy, S., Uma, S. and Selvarajan, R. 2001. Banana research and development programme in India and highlights of NRCB-INIBAP collaborative projects. In: Advancing banana and plantain R&D in Asia and the Pacific, Vol 10 (Eds. A.B.Molina and V.Roa), pp 67-76.

Selvarajan, R., Uma, S. and Sathiamoorthy, S. 2001. Etiology and survey for banana leaf spot diseases in India. In: Advancing banana and plantain R&D in Asia and the Pacific, Vol 10 (Eds. A.B.Molina and V.Roa), pp 94-102.

Selvarajan, R., Sathiamoorthy, S., Pandey, S.D. and Dhanasekaran, D. 2001. Incidence of sigatoka leaf spot disease in relation to different plant densities in cultivar Robusta. *South India Horti.* Vol. 49 (special)pp. 43-46.

Sundararaju, P., Cannayane, I. and Sathiamoorthy, S. 2001. Occurrence of *Heterodera oryzicola* on banana in Tamil Nadu, India. *Infomusa*. 10 (2): 43 - 44.

Thangavelu, R., Palaniswami, A., Ramakrishnan, G., Sabitha Duraiswamy, Muthukrishnan, S. and Velazhahan



,R.2001. Involvement of Fusaric acid detoxification by *Pseudomonas fluorescens* strain Pf10 in the biological control of *Fusarium* wilt of banana caused by *Fusarium oxysporum* f.sp. *cubense*. *Journal of Plant Diseases and Protection*.108 (5), 433-445.

Thangavelu R., Sundararaju, P., Sathiamoorthy, S., Raghuchander, T., Velazhahan, R., Nakkeeran, S., and Palanisami, A. 2001. Status of *Fusarium* wilt of banana in India. In: *Banana Fusarium wilt disease management: Towards sustainable cultivation*. (eds: A.B. Molina, N.H. Nik Masdek and K.W. Liew) International Network for the Improvement of Banana and Plantain- Asia Pacific Network, Philippines pp 58-63.

Uma.S., Theriappan, P., Dayarani,M., Shyam, B. and Sathiamoorthy, S. 2001. Characterisation and Intra-group Cluster Analysis of *Musa* sub group Pisang Awak (ABB). *Ind.J.Plant. Gen. Resources* 14(2):190-191.

Uma, S., Shyam, B., Selvarajan,R. and Sathiamoorthy, S. 2001. Collection and characterization of banana and plantains of northeastern India. In: *Advancing banana and plantain R&D in Asia and the Pacific*, Vol 10 (Eds. A.B.Molina and V.Roa), pp 103-109.

Popular articles

Jeyabaskaran, K.J. 2002. Production of vermi-compost from banana orchard wastes - a bio-technology (in Tamil), *Naveena Velanmai*, 1:72-73.

Jeyabaskaran, K.J. 2002. Micronutrient management in banana cultivation (in Tamil), *Naveena Velanmai*, 2:46-49.

Jeyabaskaran, K.J. 2002. A computer software for checking soil textural suitability in banana production (in Tamil), *Naveena Velanmai*, 3:80-81

Padmanaban B. and S.D. Pandey. 2001. Kela thanabodhak : Kela utpadhan ki pramukh samasya *Krishak Dhuniya* 26:(Krishi Saptakiki)

Padmanaban B., Rajeswari R. and Sathiamoorthy, S. 2002. Vazhai thandu thulaippanin badhippai thaduppathy eppadi? *Dhinakaran(Tamil daily)* dated 7.2.2002 p.14.

Sundararaju, P., Padmanaban, B and Sathiamoorthy, S. 2002. Vazhai sagupadiyil vivasayigalin prachanaigal. *Naveena Velanmai (Tamil)* 5: 12-14.

Sundararaju, P. Padmanaban, B and R.Thangavelu. 2001. Naveena muraiyil vazhai noorpuzhukkalai kattup-paduthuthal *Valarum Velanmai* 27:37-40

Sathiamoorthy, S., S.Uma, R.Selvarajan and P. Durai .2002. Ornamental bananas (*Musa spp*) of India with export potential. In *Souvenir of XXIII Flower Vegetable and Fruit Show*, Department of Agriculture, Govt. of Pondicherry pp33-37.

Book chapter

Sathiamoorthy, S. and Mustaffa, M.M. 2001. Technological advances in banana Production in Approaches for sustainable development of Horticulture. Edited by H.P.Singh, J.C.Samuvel. Pp 164 - 169.

Sathiamoorthy,S., Selvarajan,R. and Uma,S. 2001. Status of banana and plantains in Tamilnadu. In: *Changing Scenarios in Indian Agriculture* (eds. S. Kannaiyan and S.Uthamasamy), pp.113-128.

Sundararaju, P. 2001. INM Strategies for nematode problems of banana. In: *Nematode pests and their management*, (Eds. R.K. Upadhyaya and O.P. Dupey), Directorate of Plant Protection, Faridabad.

Technical Bulletins

Sathiamoorthy, S., Uma, S., Selvarajan, R., Auxillia J, and Rameshkumar. A. 2001. Guide on handling and hardening of Tissue -cultured Bananas. Technical Bulletin No.5, NRC for Banana (ICAR), Tiruchirapalli, pp 42.

Singh, H.P., Uma, S. and Sathiamoorthy, S. 2001. "A Tentative Key for Identification and Classification of Indian Bananas" Pp. 61.



Sundararaju, P., M. M. Mustafa., B. Padmanaban., R. Thangavelu., R. Selvarajan and V. Kumar. (2001). Integrated pest management packages for banana. Technical Bulletin, Plant Protection Division, Govt. of India, Faridabad, New Delhi.

Papers presented in the seminars/conference/symposium/workshops etc.

Jeyabaskaran, K.J., Pandey, S.D., Mustafa, M.M. and Sathiamoorthy, S. 2002. Long-term effect of different organic manures with inorganic fertilisers on plant and ratoon crops of banana cv. Poovan. National Seminar on "Emerging Trends in Horticulture" at Department of Horticulture, Annamalai University 14 - 15, Feb., 2002.

Jeyabaskaran, K.J., Pandey, S.D., Mustafa, M.M. and Sathiamoorthy, S. 2002. Effect of cement kiln flue dust with graded levels of potassium on banana cv. Karpuravalli. National Seminar on "Emerging Trends in Horticulture" at Department of Horticulture, Annamalai University, 14 to 15, Feb., 2002.

Jeyabaskaran, K.J., Pandey, S.D., Mustafa, M.M. and Sathiamoorthy, S. 2001. Effect of different organic manures with graded levels of inorganic fertilisers on ratoon of Poovan Banana. National Seminar on "Changing Scenario in the Production Systems of Horticultural Crops", TNAU 28 - 30, Aug., 2001.

Jeyabaskaran, K.J. and Sathiamoorthy, S. 2001. Potassium Management of Banana. International Symposium on Potash, New Delhi 3 - 5, December, 2001.

Jeyabaskaran, K.J., Pandey, S.D., Mustafa, M.M. and Sathiamoorthy, S. 2002. Comparison of silicon rich rice husk ash with other organic manures in banana. National seminar on "Recent trends on sulphur and silicon nutrition of crops" held at AC & RI, Madurai, from 12 to 13, June, 2002.

Mustafa, M.M., Sathiamoorthy, S.,

Kumar, V. and Saravanan, P.C. 2001. Banana - A potential medicinal plant. National Seminar on "Medicinal plants", Trichy, 20-21, October, 2001.

Narayana, C.K., Sathiamoorthy, S., Mustafa, M.M. and Evelin Mary, A. 2002. Processing and Value addition in Banana. National Workshop on Postharvest Management of Horticultural Produce, Chandigarh, 7 - 8th February 2002. pp. 271-277.

Narayana, C.K., Sathiamoorthy, S., Mustafa, M.M. and Ramajayam, D. 2002. Integrated Pre & Postharvest Management technologies for banana. National Workshop on Postharvest Management of Horticultural Produce, Chandigarh, 7 - 8th February 2002. pp. 59-63.

Narayana, C.K., Mustafa, M.M. and Sathiamoorthy, S. 2002. Influence of packaging and storage on shelf life and quality of banana cv. Karpuravalli. National seminar on Emerging Trends in Horticulture, Annamalai University 14 -15th February, 2002.

Narayana, C.K., Sathiamoorthy, S. and Ramajayam, D. 2002. Effect of heat shock treatment on shelf life and quality of Neypoovan banana during storage at low temperature National seminar on Emerging Trends in Horticulture, Annamalai University between 14-15th February, 2002.

Narayana, C.K., Sathiamoorthy, S. and Ramajayam, D. 2002. Effect of ethylene absorbent and hot water treatment on storage life and quality of Rasthali banana. Paper presented in National seminar on Emerging Trends in Horticulture, Annamalai University 14 -15th February, 2002.

Narayana, C.K., Mustafa, M.M. and Sathiamoorthy, S. 2001. Effect of packaging and storage on shelf life and quality of banana cv. Karpuravalli. VIth National seminar on "Resource management for higher sustainable production in coastal areas", Hyderabad, 20-23, November, 2001.

Padmanaban, B., Kandasamy, M. and Sathiamoorthy, S. 2001. Banana stem Weevil: Present Scenario in proceedings of National Seminar on emerging pest and disease problems and their management, October 11-1, 2001 TNAU, Coimbatore pp 78-79.

✓ Padmanaban. B., Kandasamy, M., Sundararaju, P. and Sathiamoorthy, S. 2001. Use of traps (banana pseudostem/corm) for monitoring and management of banana weevil borers, Proc. of II National Symposium on IPM in Horticultural crops, Agricultural Technology Center, Bangalore, October 17-19, 2001 pp 34-39.

Pandey, S.D., Jeyabaskaran., K.J., Kumar, V., Kanagadhileepan, K. 2002. Studies on nutritional requirement of tissue cultured banana cv. Robusta. National Seminar on "Emerging Trends in Horticulture" at Department of Horticulture, Annamalai University 14 - 15, Feb., 2002.

Pandey, S.D., Jeyabaskaran., K.J., Dhanasekar, D. and Kanagadhileepan, K. 2002. New high-density production system for banana cv. Robusta under wet land system of cultivation. . National Seminar on "Emerging Trends in Horticulture" at Department of Horticulture, Annamalai University, 14 - 15, Feb., 2002.

Sathiamoorthy, S. and Mustaffa, M.M. 2001. High density planting including fertigation in banana. Abstract in National Seminar on "Integrated Development of Tropical Horticulture".

Selvarajan, R., Sathiamoorthy, S., Uma, S. and Balasubramanian, V. 2001. New leaf spot diseases in banana and plantains in India- challenges and prospects. Emerging trends in pests and diseases and their management, Coimbatore on October 11-13, 2001.

Selvarajan, R., Uma, S. and Sathiamoorthy, S. 2002. Screening of Indian banana germplasm against *Mycosphaerella* leaf spot diseases. In: "2nd International workshop on *Mycosphaerella* leaf spot diseases of bananas" held at Costa Rica, 20-23 May 2002.

Selvarajan, R., Sathiamoorthy, S., Dayakar., S., Balasubramanian, V., Viswanathan, V. and Ahlawat, Y.S. 2002. Purification and detection of indian isolate of Banana Bunchy Top Virus (BBTV). National symposium on "Crop protection and WTO-An Indian Perspective " held at CPCRI, Kasaragod, on 22nd- 25th Jan 2002, p 30.

Sundararaju, P., Cannayane, I., Padmanaban, B. and Sathiamoorthy, S. 2001. Effect of population levels of plant parasitic nematodes on high density planting with fertigation levels in banana cv. Robusta. National seminar on Emerging trends in pests and diseases and their management, 11-13th October 2001, Tamil Nadu Agricultural University, Coimbatore, Pp, 169-170.

Sundararaju, P., Cannayane, I and Sathiamoorthy, S. 2001. Lesion nematodes problem in banana and their management. National symposium on Integrated pest management (IPM) in Horticultural crops: New molecules, Biopesticides and Environment held during October 17-19th 2001. Association for advancement of pest management in Horticultural ecosystems, IIHR, Bangalore. P. 179-180.

Sundararaju, P., Padmanaban, B., Sathiamoorthy, S. 2001. Management of root-lesion nematode, *Pratylenchus coffeae* in banana through botanicals. Second National Symposium on Integrated Pest Management (IPM) in Horticultural Crops : New molecules, Biopesticides and Environment. Association for advancement of pest management in horticultural ecosystem, IIHR, Bangalore during 17-19 October. pp141

Sundararaju, P. 2001. Population fluctuation of lesion nematodes in banana. *Ibid.* P. 154-155.

Sundararaju, P. 2001. Nematode diseases of banana and their management. National congress on Centenary of Nematology in India: Appraisal and Future Plans, at Indian Agricultural Research Institute, New Delhi, 5 - 7th December, 2001, P. 31.



Sundararaju, P. and Cannayane, I. 2001. Antinematic activity of plant extracts against *Pratylenchus coffeae* infecting banana. *Ibid.* P. 160-161.

Sundararaju, P. and Cannayane, I. 2001. Banana wastes and certain plant leaves used for the mass production of nematode egg parasitic fungus. *Ibid.* P. 145..

Sundararaju, P., I. Cannayane and S.Sathiamoorthy. 2002. Nematode disease of banana. Paper presented in National Seminar on "Centenary of Nematological Research in Kerala" held at CPCRI, Kayangulam, Kerala, 21-22 February.

Sundararaju, P., I. Cannayane and S.Sathiamoorthy. 2001. Lesion nematodes problem in banana and their management. National Seminar on "Emerging trends in pests and diseases and their management" 11-13 October at TNAU, Coimbatore, pp.168-170.

Uma, S., Theriappan, P., Dayarani, M.D., Shyam, B. and Sathiamoorthy, S. 2001. Characterisation and Intra-group Cluster Analysis of *Musa* sub group Pisang Awak (ABB). National Symposium on "Plant Genetic Resources Management : Advances and Challenges" New Delhi, August 1-4, 2001.

Uma, S., Selvarajan, R., Sathiamoorthy, S., Ramesh Kumar, A. and Shyam, B. 2001. Banana diversity in North-Eastern India – Gene wealth, Genetic erosion and solutions. National Symposium on Bio-diversity vis-à-vis Resource Exploitation-An introspection. Port Blair, Andaman and Nicobar islands 23 - 24th April, 2001.

10. LIST OF APPROVED ONGOING PROJECTS

1. Crop Improvement

Management of genetic resources of banana – (S.Uma)

Crop improvement of banana through conventional breeding – (S.Sathiamoorthy)

2. Crop production and Postharvest technology

Standardisation of agrotechniques for banana production and productivity – (S.D.Pandey)

Standardization of technology for organic banana production – (M.M.Mustaffa)

Integrated nutrient management in banana – (K.J.Jeyabaskaran)

Studies on Micronutrients in banana – (K.J.Jeyabaskaran)

Studies on handling, storage and processing of banana – (C.K.Narayana)

3. Crop Protection

Insect pest management in banana – (B.Padmanaban)

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

Investigation on fungal and bacterial diseases of banana and their management – (R.Thangavelu)

Studies on viral diseases of banana and their management – (R.Selvarajan)

11. CONSULTANCY, PATENTS, COMMERCIALISATION OF TECHNOLOGY

Consultancy offered Bioefficacy testing of Mancozeb Flowable against Sigatoka leaf spot disease of banana. The consultancy was funded by Indofil Chemicals Company, Chennai, at a budget of 33,000/-

12. RAC, MANAGEMENT COMMITTEE, SRC, QRT MEETINGS etc., WITH SIGNIFICANT DECISIONS

Institute Management Committee meeting

The Management Committee was held on 12th May 2001, under the chairmanship of Director, NRCB and took various policy decisions for the over all development of the Centre (Plate 12).



Plate 12.
IMC meeting

The IMC meeting was attended by the members at NRCB, Trichy.

- | | | | |
|----|---|---|---------------------|
| 1. | Dr.S.Sathiamoorthy
Director
NRC for Banana, Trichy - 620 017 | - | Chairman |
| 2. | Dr.D.S.Rathore
Asst.Director General(Hort),
Indian Council of Agrl.Research
Krishi Bhawan, New Delhi - 110 001 | - | Member |
| 3. | Dr.R.S.Azhagia Manavalan,
Dean,
Hortl.College & Research Station
Tamil Nadu Agricultural University,
Coimbatore - 641 003 | - | Member |
| 4. | Shri.J. Paul Adrien,
Addl. Director of Agrl.(Hort),
Department of Agriculture,
Pondicherry - 605 001 | - | Member |
| 5. | Shri.A. Krishnan Kutty,
Finance & Accounts Officer,
Sugarcane Breeding Institute, Coimbatore | - | Member |
| 6. | Shri.Subha Somu
C-142, Kambar Street,
Anna Nagar, Thennur, Trichy - 620 017 | - | Non-official member |
| 7. | Dr.P.Sundararaju,
Senior Scientist,
NRC for Banana | - | Member |
| 8. | Dr.S.Shivashankar,
Senior Scientist,
NRC for Banana | - | Member |
| 9. | Dr.B.Padmanaban,
Senior Scientist,
NRC for Banana | - | Member |

- | | | | |
|-----|--|---|------------------|
| 10. | Dr.S.D.Pandey,
Senior Scientist,
NRC for Banana | - | Member |
| 11. | Dr.M.M.Mustaffa
Principal Scientist,
NRC for Banana | - | Special Invitee |
| 12. | Shri.C.J.Stephen,
Asst.Fin. & Accts. Officer,
NRC for Banana | - | Special Invitee |
| 13. | Dr.R.Selvarajan,
Scientist
NRC for Banana | - | Special Invitee |
| 14. | Shri B. Vijayakumar
Asst.Admn.Officer,
NRC for Banana | - | Member Secretary |

The committee reviewed the progress of different activities and the major recommendations were as follows :

- * IMC recommended the purchase of tables, chairs and other furnitures for equipping the new laboratory, committee room, conference room, library etc.
- * A proposal for recognizing hospitals/AMA for the NRCB staff members was approved.

STAFF RESEARCH COUNCIL MEETING

The Sixth Annual Staff Research council of NRCB was held on 27 and 28, November 2001 under the Chairmanship of Director, NRCB and the progress of the on-going projects was discussed. All Scientists

attended the meeting. There were four technical sessions and the progress work of on going 13 research projects was presented by the respective project leaders. The work done under 14 external aided project were also presented by the Principal Investigators and discussed (Plate 13).



Plate 13.
6th annual
SRC meeting

13. PARTICIPATION IN SEMINAR/ SYMPOSIA/CONFERENCE/ WORKSHOP etc.

Scientist	Name of Seminar/ Symposia/ Conference/Workshop	Period
Jeyabaskaran, K.J.	Participated in the National Seminar on "Changing Scenario in the Production Systems of Horticultural Crops", held in TNAU	28 to 30, Aug., 2001.
Jeyabaskaran, K.J.	Participated in the International Symposium on Potash, held at New Delhi	3 to 5, December, 2001.
Jeyabaskaran, K.J.	Participated in the National Seminar on "Emerging Trends in Horticulture" at Department of Horticulture, Annamalai University	14 to 15, Feb., 2002.
Mustaffa, M.M.	Participated in the National Seminar on "Changing Scenario in the Production Systems of Horticultural Crops", held in TNAU	28 to 30, Aug., 2001.
Narayana, C.K.	Participated in the National Workshop on Post Harvest Management of Horticultural Produce, held at Chandigarh,	7-8 th February 2002.
Narayana, C.K.	Participated in the National Seminar on Emerging trends in Horticulture at Annamalai University	14-15 th February 2002.
Narayana, C.K.	Participated in the National Seminar and Exhibition held at Bihar Sharif, Nalanda district, Bihar	2 nd to 3 rd June, 2001.
Narayana, C.K.	Participated in "Food Pro 2001" organized by Confederation of Indian Industries, at Chennai	8-11 th December 2001.
Padmanaban, B.	Participated in the II national symposium on IPM in Horticultural crops held at Bangalore and presented a paper on Use of traps in the monitoring and management of banana weevils.	17-19 October 2001
Padmanaban, B.	Participated in the National seminar on emerging pest and disease problems and their management held at TNAU Coimbatore and presented a paper on present scenario of Banana stem weevil.	October 11-13, 2001
Padmanaban, B.	Attend seminar on banana cultivation technology for export, organized by MYRADA, AIR, Coimbatore and	9 th August 2001



	TNAU, Coimbatore held at Tn Palayam (Periyar District) and presented details on banana pseudostem trapping for pesticide free bananas.	
Pandey, S.D.	Attended National seminar/Exhibition held at Bihar Sharif (Nalanda)	2-3 June 2001.
Selvarajan, R.	Attended the workshop on Mission Mode NATP on "Diagnostics for virus and virus like diseases affecting citrus banana and potato" at CPRI, Shimla.	30 th April 2001
Selvarajan, R.	Participated in the national seminar on Changing scenario in the Production systems of Horticultural crops held at TNAU Coimbatore	August 28 th -30 th , 2001.
Selvarajan, R.	Participated in the third workshop and peer review of NATP-MM project on "Diagnostics for virus and virus like diseases affecting citrus, potato and banana held at ACPV, IARI, New Delhi.	26 th and 27 th March 2002
Selvarajan, R.	Participated in workshop of All India coordinated research projects and ICAR Ad-hoc research schemes on tropical fruits held at TNAU, Coimbatore	18 th -21 st March 2002.
Sundararaju,P.	Participated in the National seminar on Emerging trends in pests and diseases and their; management held. Organised by the Tamil Nadu Agricultural University, Coimbatore.	11-13 th October, 2001
Sundararaju,P.	Participated in the "Second National symposium on Integrated pest management (IPM) in Horticultural Crops: New Molecules, Biopesticides and Environment", Organised by AAPMHE, IIHR, Bangalore	17-19 th October 2001.
Uma,S.	Attended the National Workshop on NHB assisted ventures at NHB, Gurgaon.	14.09.2001
Uma,S.	Attended symposium on "Plant Genetic Resources Management : Advances and Challenges" at NBPGR, New Delhi	2-4, August, 2001
Uma,S.	Attended NATP Zonal workshop and Group meeting 8 th February, 2001 at CTCRI, Trivandrum.	6-7 th February, 2001

Meetings attended

Mustaffa, M.M., participated in the fourth state level committee meeting of National Horticulture board, Chennai on 15.3.2002.

Mustaffa, M.M. and Kumar, V, participated in the workshop on banana organised by Swarna Jayanthi Gram Swarajghar Yojana, DRDO, Trichy on 7.3.2002.

Narayana, C.K. participated in Exhibition and Meeting of Swarna Jayanthi Swayam Rozgar Yojana organized by DRDA on occasion of visit of Hon'ble Union Minister for Rural Development Shri. Venkaiah Naidu. On 18-19 February 2002.

Narayana, C.K. attended the steering committee meeting of CII for conducting the "Agri Conclave 2002" at Hotel Royal Southern, Trichy.

Narayana, C.K. attended the District Rural Industries Project meeting of NABARD at DRDA office, Trichy on 26th February 2002.

Narayana, C.K. attended the launching of District Rural Industries Project by NABARD in Trichy district on 16th March 2002.

Padmanaban, B, attended Farmers Field School meeting organized by the Central IPM center Trichy held at Adavathur on 4th October 2001 and gave a demonstration on ecofriendly management of banana stem weevil.

Padmanaban, B, attend discussion meeting organized by Prof. T.N. Ananthakrishnan at COSTED Chennai during 14th July 2001 on Molecular modalities in manipulation of insect natural enemies: emerging technologies.

Selvarajan, R. participated in the 54th annual meeting and national symposium on "Crop protection and WTO-An Indian Perspective " held at CPCRI, Kasaragod, on 22nd- 25th Jan 2002.

Sundararaju, P. participated in the "National congress on Centenary of Nematology in India: Appraisal and Future Plans,

at Indian Agricultural Research Institute, New Delhi, during 5-7th December, 2001.

Sundararaju, P. participated in the "Milestones of Nematological Research in Kerala, Organised by Central Plantation Crops Research Institute, Kerala, during 21-22nd February, 2002.

Uma, S. attended Meeting on Plant Genetic Resources (PGR) activities in India organized by DDG (Hort) on 28.03.2002.

Trainings attended

Jeyabaskaran, K.J. Scientist (SS), attended ICAR Training course on "Microbial Transformations in Soil" from 13-02-02 to 5-03-02. held in the Department of Agricultural Microbiology, Tamil Nadu Agricultural University, Coimbatore.

Mustaffa, M.M. Principal Scientist and Narayana, C.K. Senior Scientist, participated in Nodal Officers training on "Awareness of IPR and WTO" conducted by I.C.A.R., at DRR, Hyderabad between 10th -12th July 2001.

Padmanaban, Senior Scientist, participated in the individual training programme organized by Project Directorate Biological Control, Bangalore on Mass multiplication of Entomopathogenic nematodes.

Pandey, S.D. Senior Scientist, attended NATP training/ workshop at Sugarcane Breeding Research Institute Coimbatore from 14-15 July 2001

Uma, S. Senior Scientist, attended training on "Recent Techniques in Plant Genetic Engineering and Molecular Breeding" from 12th October 2001 to 1st November 2001 at NRC on Plant Biotechnology, IARI, New Delhi.

Shri R. Neela Mega Shyamala Kannan, Steno - Gr. III and Shri N. Marimuthu, T-2 attended the "Leadership-HRD" to be held at CMFRI Mandapam Camp from 15 - 19 January 2002.



Radio Talks

Mustaffa, M.M. Principal Scientist, participated in "Tissue culture banana cultivation" Question and Answer session with farmers organised by AIR, Trichy.

Jeyabskaran, K.J. Scientist (SS), gave a radio talk on Micro-nutrients in Banana (In Tamil). Broad casted on 4-11-2001 from AIR, Trichy.

14. WORKSHOPS, SEMINARS, SUMMER INSTITUTES, FARMERS DAY ETC. ORGANISED AT THE CENTRE

Workshop conducted

Workshop on Compilation of Names and Synonyms of Bananas and Plantains in India was organised on 25 and 26th May 2001. The workshop was inaugurated on 25th by Dr.S.Sambandamurthi, Retd. Dean, TNAU who delivered the keynote address and released a book entitled " A Tentative key for Identification and Classification of Indian Bananas" authored by H.P. Singh, S. Uma and S. Sathiamoorthy. Dr. Agustin B. Molina, Regional Co-ordinator, ASPNET, Philippines, stressed the need to eliminate synonyms existing in bananas and plantains. There were three sessions of technical presentation by 12 resource persons from various ICAR and SAU's representing different banana growing regions in India. In the plenary session, the participants discussed and compiled the names and synonyms available in different banana growing areas for various bananas and

plantains in India. This workshop resulted in bringing out a book entitled "Names and Synonyms of Banana and Plantains in Indian subcontinent" (Plate 14).

Farmers meeting

M.M.Mustaffa, V.Kumar and R. Thangavelu attended a Scientists - Farmers meet on "Export banana cultivation" held at Cuddalore on 2.9.2001.

B.Padmanaban, R.Selvarajan, V.Kumar and R.Selvarajan, participated in "Scientists - Banana Growers Meet on Banana Cultivation for Export " held at T.N. Palayam (Gobichetti palayam) on 9-8- 2001 organised by AIR Coimbatore TNAU and Banana Growers Association, T.N Palayam.

B.Padmanaban, R.Selvarajan, V.Kumar and R.Thangavelu, participated and delivered lectures in a farmers meeting in Thottium organized by Thottium banana growers association and Syngenta on 11.12.2001.

V.Kumar and R. Thangavelu participated in farmers meet "On banana cultivation in kolli hills" at kolli hills on 12.12.01.

Vayal veli Vazhai payirchi Mugaam (Training school -IPM) on 22.9.2001

EXHIBITION

1. Participated in 'Krishi India Agri 2002' organised by TIDISSA, NRCB and TNAU on 6TH - 11th Feb.2002 (Plate 15).
2. Participated in DRDA programmes at Jenny's residency on 19.2.2002.

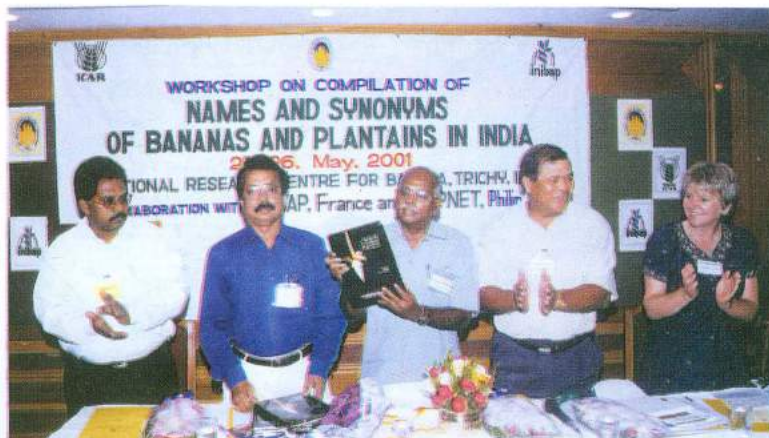


Plate 14.

Dr. S. Sambanda Murthy, Rtd. Dean TNAU releasing the book entitled "A Tentative Key for Identification and classification of Indian bananas" on 25-5-2001



Plate 15.
Krishi India
Agri 2002



Plate 16.
DRDA Stall

Shri Venkaiah Naidu Hon. Minister for State, Rural Industries, Government of India visited our stall during the occasion (Plate 16).

3. 45 Farmers from Theni and 25 women from TANVA Thozhil munaivor sangam visited on 18.3.2002 at NRCB on Post Harvest Technology and

value added products.

4. Participated in the Swarna Jayanthi Gram Swarojkar Yojana, organised by District Rural Development Agency, Trichy, on 27.3.2002 (Plate 17).
5. Participated in Agri Conclave '2002' organised by Confederation of India Industries on 9th and 10th Feb. 2002 (Plate 18).



Plate 17.
Swarna Jayanthi
Gram Swarojkar
Yojana meeting
with Collector Trichy,
on 27.3.2002



Plate 18.

Participated in the
Agri Conclave 2002.
Shri Pranesh, IAS,
Commissioner
Agriculture, Govt. of
Tamil Nadu, visited
the NRCB stall

15. DISTINGUISHED VISITORS

S.No	Name & Designation	Institute	Date of Visit
1.	Dr.D.S.Rathore Asst.Director General (Hort.)	Indian Council of Agrl.Research Krishi Bhawan, New Delhi	12.4.2001
2.	Dr.R.S.Azhagia Manavalan, Dean (Hort.)	Hortl.College & Research Station TamilNadu Agricultural University, Coimbatore	12.4.2001
3.	Shri.J. Paul Adrien, Addl. Director of Agrl.(Hort)	Department of Agriculture, Pondicherry - 605 001	12.4.2001
4.	Shri.A. Krishnan Kutty, Finance & Accounts Officer	Sugarcane Breeding Institute, Coimbatore	12.4.2001
5.	Shri.Subha Somu	Kambar Street, Anna Nagar, Thennur, Trichy	12.4.2001
6.	Dr.R.N. Pal Deputy Director General (Hort.)	Indian Council of Agricultural Research, Krishi Bhawan, New Delhi	7.5.2001
7.	Dr.Elizabeth Arnaud, Germplasm Active Manager	INIBAP, France	22.5.2001
8.	Dr.Suzanne Sharrock, Germplasm Conservation Scientist	INIBAP, France	22.5.2001
9.	Dr.Agustin B.Molina, Regional Co-ordinator	ASPNET, Philippines	22.5.2001
10.	Dr.N.Kumar, Professor and Head,	Dept. of Pomology, TNAU, Coimbatore	22.5.2001
11.	Dr.Hore, Sr.Scientist	In-charge, NBPGR Regional Station, Shillong	22.5.2001
12.	Dr.Hazarika	Assam Agricultural University	22.5.2001
13.	Dr. G.Kaloo, Deputy Director General (Hort.)	Indian Council of Agrl.Research Krishi Bhawan, New Delhi	21.3.2002

**Plate 19.**

Dr.R.N.Pal DDG
(Hort.) ICAR,
New Delhi, visit to
NRCB on 7.5.2001

16. PERSONNEL

Appointment

Shri .R.Natarajan, Scientist, Joined on 29.12.2001. He was transferred from National Research Centre for Medicinal & Aromatic Plants, Boriavi, Anand, Gujarat.

Promotion

Dr. M.M. Mustaffa, Principal Scientist (Hort.) was promoted as Principal Scientist under the Career Advancement Programme of ICAR from 28.7.2001.



Plate 20. Dr. G.Kaloo, Deputy Director General (Hort.) visited on 21.3.2002



RESEARCH MANAGEMENT

Dr.S.Sathiamoorthy M.Sc., (Ag.) Ph.D.

Director

SCIENTIFIC

Dr.M.M.Mustaffa, M.Sc.,(Ag.) Ph.D.

Principal Scientist (Hort)

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

Senior Scientist (Nema.)

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

Senior Scientist (Biochem.) @

left on 31.5.2001

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),

Scientist (Hort) from 29.6.2001 #

Mr.Thangavelu, M.Sc., (Ag.)

Scientist (Pl.Path.) from 25.7.2001 #

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

Scientist (Pl.Path.)

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

Scientist (Pl.Physiol.) left on 24.5.2001 @

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

Scientist (Soils)

Mr.R.Natarajan, M.Sc., M.Phil.

Scientist (Eco. Bot.) from 29.12.2001

joined after study leave @ transferred

TECHNICAL

Mr.RaghuRaman

T5 - Junior Garden Superintendent

ADMINISTRATION

Mr. B.Vijayakumar

Assistant Administrative Officer

AUDIT and ACCOUNTS

Mr.C.J.Stephen

Assistant Finance and Accounts Officer

17. ANY OTHER RELEVANT INFORMATION SUCH AS SPECIAL INFRASTRUCTURAL DEVELOPMENT

METEOROLOGICAL DATA

Month/Year	Temperature (° C)		Relative humidity (%)		Rainfall (mm)
	Minimum	Maximum	Minimum	Maximum	
Apr 2001	23.42	36.11	37.30	93.75	30.80
May 2001	25.93	38.30	31.58	80.06	13.20
Jun 2001	26.05	35.84	32.48	71.64	4.30
Jul 2001	25.70	36.27	34.03	73.72	97.50
Aug 2001	25.50	36.24	34.59	76.83	13.50
Sept 2001	25.97	35.50	39.93	86.99	219.80
Oct 2001	23.21	32.73	52.35	93.01	173.30
Nov 2001	22.4	31.56	56.42	96.61	165.8
Dec 2001	20.19	29.65	55.13	95.8	28.4
Jan 2002	19.96	31.00	48.00	92.73	1.8
Feb 2002	20.1	32.6	44.51	96.7	47.9
Mar 2002	21.79	37.23	29.91	94.12	-0-

Hindi Day



Plate 21.
Hindi day
celebration at NRC

The Hindi week was celebrated at NRCB and the valedictory function was held on 19th September 2001. Shri S. Devidas, Deputy Director, Central Hindi Teaching

Scheme, Trichy, was the chief guest distributed the prizes to the winner various events viz., Hindi dictation, recitation, signing, quiz etc.

High Level Committee



Plate 22.
High Level
Committee meeting
with Director, NRC

A high level committee was constituted by the Government of Tamil Nadu, Chennai to study the Horticultural development in Tamil Nadu and to suggest future areas of research and development to be carried out in Tamil Nadu for the improvement of Horticulture Industry in Tamil Nadu. Dr. Kirti Singh, Ex. Chairman, ASRB, New Delhi was the Chairman, Dr. M.K. Nair, Ex. Director, CPCRI, Kasaragod; Dr. S. Thamburaj, Ex. Dean, Hort. College, TNAU, Coimbatore; Dr. R.S. Azahia

Manavalan, Dean, Hort. College, TN Coimbatore and Dr. E. Vadivel, Prof. Hort. College, TNAU, Coimbatore were the members of the committee, visited NRC for banana. Discussed with Director NRCB and other Scientists of the Centre about the problems in Banana, future thrusts to enhance the productivity and also on going research programs in banana for the upliftment of banana industry in Tamil Nadu.



Plate 23.

NRCB sports team at
CMFRI, Cochin

A NRC for Banana sports (contingent) team participated in the Zone III Inter Institutional Sports Meet held at Central

Marine Fisheries Research Institute, Cochin, Kerala during December 4, 2001.

कार्यकारी सारांश

जननद्रव्य प्रबंध एवं फसलसुधार

उत्तरी पूर्वी क्षेत्रों नागालैंड एवं मनीपुर के सर्वेक्षण के दौरान 45 नये केले के जननद्रव्यों का एकत्रीकरण किया गया। 10 एए एवं 40 ABB जननद्रव्य में उनके अनुवांशिक संबंधों की जानकारी हेतु मैलेट डिहाइड्रोजीनेज, ग्लूटामेट डिहाइड्रोजीनेज, सिकमिक डिहाइड्रोजीनेज एवं फास्फोग्लूको आइसोमरेज का परीक्षण किया गया। सबसे ज्यादा पालीमार फिल्म मैलेट डिहाइड्रोजीनेज एवं सिकमिक डिहाइड्रोजीनेज में पाया गया।

केले के कीट प्रतिरोधी मूल्यांकन में संकलन सं. 047,07,011,167 आइ.सी. 84809 आई सी 84863 और आई सी 84889 को तना विविल एवं संकलन सं. 047,007,021,425 एवं 440 को कर्म विविल के लिए प्रतिरोधी पाया गया। नामराई एवं पिसांग मास को केले के मुख्य सूत्रकृमियों के प्रति प्रतिरोधी पाया गया। माइक्रोसफेरेला पत्ती धब्बा रोग के प्रति प्रतिरोधी किस्मों में वैक्स, टैनिन, फिनाल, एवं सुगर की मात्रा ज्यादा पायी गयी। केले के स्ट्रीक विषाणु के लक्षण मेसूर समूह के सभी संकलनों में पाये गये।

सिथॉटिक डिपलायड विकास हेतु प्रयास किये गये, परिणाम स्वरूप H-201 एवं पिसांग लिली को प्रतिफल संकरण में 5-7 बीज पाये गये। मट्टी का मट्टी के साथ संकरण में 3 बीज प्रति फल पाये गये।

उत्पादन

करपूरावल्ली एवं रस्थाली केले में 2.5 किलो डिस्टलरी स्लज, 1 किलो वर्मीकम्पोस्ट, 1 किलो नीमखली एवं 2.5 किलो मुर्गी की खाद प्रति प्रौधा पौधों की वानस्पतिक वृद्धि के लिए अच्छा पाया गया। इसके अलावा इससे सूत्रकृमियों की संख्या में

भी काफी कमी पायी गयी। अकेले वर्मीकम्पोस्ट का प्रभाव सूत्रकृमि निपत्रण पर कम देखा गया। सिगाटोका पत्ती धब्बा रोग का प्रौधों पर प्रभाव कार्बनिक खादों के प्रयोग से कम पाया गया।

पूवन केले में केले की सूखी पत्ती का विद्वावन 75% नत्रजन एवं पोटेशियम के साथ केले की वानस्पति वृद्धि के लिए अच्छा पाया गया। रोवस्टा केले के लिए द्वि पंक्ति पद्धति 100 प्रतिशत नत्रजन एवं पोटेशियम (प्रतिपौधा) वानस्पतिक वृद्धि के लिए अच्छा पाया गया। 3 पुत्ती प्रति गडढा लगाने पर 75% नत्रजन एवं पोटेशियम की मात्रा अच्छी पायी गयी।

केले के उत्पादन में सीमेंट क्लिन डस्ट का प्रयोग भी उपयोगी पाया गया एवं 0.5 किग्रा मात्रा 60% पोटेशियम की मात्रा के साथ अच्छा उत्पादन दिया। इसके प्रयोग से 40 प्रतिशत तक पोटेशियम की बचत की जा सकती है।

ज्यादा क्षारीय मृदाओं में लोहे की मात्रा का मिट्टी में प्रयोग एवं जस्ता एवं बोरान का पर्णाय छिड़काव उपयोगी पाया गया।

तुड़ाई उपरांत संभला व एवं प्रसंस्करण :-

करपूरावल्ली के पुष्प से पिस्टिल निकालने के बाद छोटे आकार में काटकर 80 डिग्री ताप पर 15 मिनट ब्लांच करके 8% नमक एवं 0.1 प्रतिशत सिट्रिक अम्ल से तैयार अचार बहुत अच्छा पाया गया। करपूरावल्ली केले के फल से तैयार तोककू (तेल + सिरका के साथ) भी अच्छा पसंद किया गया। केले के तने के मध्य भाग से (रस्थाली जाति) मोठी कैडी भी तैयार की गयी।

फसल सुरक्षा :-

केले की विविल कीट से वचाव हेतु केले का



तना का जाल (Trap) काफी प्रभावी पाया गया। केले के तने को विविल के नियंत्रण के लिए मोनो क्रोटोफास का 5 एवं 7 वें महीने में तने में इन्जेक्शन काफी प्रभावी देखा गया। मोनोक्रोटोफास (15 मिली/लीटर पानी 30 मिनट केलिए) के द्वारा पुत्ती का उपचार या कार्बोफ्यूशन 60 ग्राम प्रतिपौधा 4 एवं 7 वें महीने में जमीन में प्रयोग विविल निमंत्रण के लिए बहुत प्रभावी पाया गया।

सूत्रकृमि के 17 जेनरा केले में अभिलेखित किए गये। इनमें रुट लेजन एवं रुटनाट सूत्रकृमि जेनरा मुख्य हैं। केले के उत्पादन में द्वि पक्वं पद्धति में सूत्रकृमियों की संख्या 3 पुत्ती प्रति गड़ढा पद्धति से कम पायी गयी। 80 प्रतिशत नीम के स्ट्रैक्ट (जूस) से 20 घंटा उपचार में 73.4 प्रतिशत सूत्रकृमियों की मृत्युदर देखी गयी।

टी. हाराजिएनम आइसोलेट एवं एक स्यूडोमोनास आइसो लेट रेस 1 और रेस 2 की माइसीलियम वृद्धि को 70 प्रतिशत तक घटाया। सोलेनम जाति का स्ट्रैक्ट (जूस) एफ. आक्सीसपोरम एवं एफ. क्यूबेन्स एवं बी. थियोब्रोमा की माइसीलियम वृद्धि कम करने में काफी प्रभावी रहा। सोलेनमएस्ट्रैक्ट (जूस), दो वांमोएजेन्ट जैसे - टी. हाराजिएनम एवं स्यूडोमोनास एन्थेकनोज बीमारी के निमंत्रण में काफी प्रभावी पाये

गये, साथ ही साथ इनका प्रभाव केले की भण्डारण क्षमता पर भी अनुकूल देखा गया। पेट्रोलियम तेल 5% + टिल्ट (प्रोपीकोनाजोल) 0.05% का पत्तियों पर छिड़काव (वानस्पतिक अवस्थाओं में) रोवस्टा केले में सिगाटोका पत्ती धब्बा रोग के नियंत्रण के लिए अच्छा पाया गया।

केले के बैक्ट मो जैक विषाणु के कारण केले की ने पूवन जाति में केले की घेर में 19.1 प्रतिशत तक कमी देखी गयी। विषाणु से प्रभावी पौधों में फूल 45-60 दिन देरी से आये एवं फूल आने के समय पत्तियों की संख्या भी कम देखी गयी। DAC-ELISA केले के वची टाप विषाणु के संक्रमण पता लगाने के लिए अच्छा पाया गया जबकि DIBA केले के बैक्ट मोजैक विषाणु के संक्रमण पता लगाने के लिए अच्छा पाया गया। केले के स्ट्रीक विषाणु का संक्रमण पता लगाने के लिए दोनों विधियां उत्तम पायी गयी।

तकनीकी स्थानान्तरण

किसानों को प्रक्षेत्र पर सलाह, किसान गोष्ठी एवं भाषणों द्वारा सही पौध सामग्री प्राप्त करने, उच्च तकनीकी उत्पादन, कम खर्च में अधिक उत्पादन, सही फसल सुरक्षा आदि के बारे में जानकारी दी गयी। अन्तर्राष्ट्रीय स्तर पर मूसा अनुवांशिक सूचना पद्धति प्रशिक्षण भी आयोजित किया गया।

