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ANNUAL REPORT

2000 - 2001

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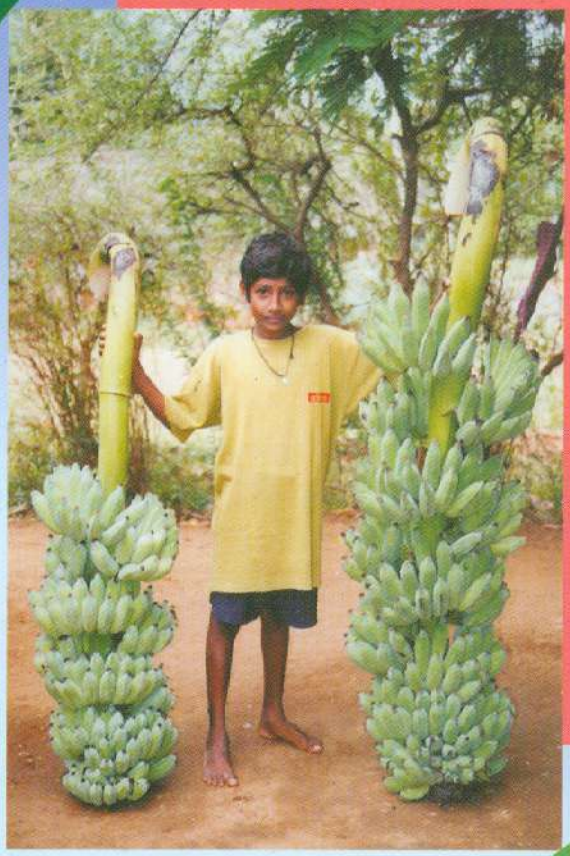

NATIONAL RESEARCH CENTRE FOR BANANA
(Indian Council of Agricultural Research)
TIRUCHIRAPALLI - 620 017, TAMIL NADU

PMEC

वार्षिक प्रतिवेदन
ANNUAL REPORT
2000 - 2001

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

NATIONAL RESEARCH CENTRE FOR BANANA
#17 Ramalinga Nagar South Extension, Vayalur Road,
Tiruchirapalli – 620 017, Tamil Nadu.

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PREFACE

It gives me great pleasure in brining out the Annual Report of the Centre for the year 2000-2001. The report gives significant achievements of research work carried out in the Centre on crop improvement, crop production, crop protection, post harvest technology, physiology and biochemistry. The Research programme is organised into 13 inter- disciplinary and 12 externally funded projects.

Significant achievements were made during 2000 -2001, particularly in respect of collection and characterisation of *Musa* bio-diversity. The collection at NRCB is one of the largest in Asia. Recently *Ensette glaucum* and other *balbisiana* wild species were added on. The germplasm is systematically screened for reaction to biotic and abiotic stress and breeding programme has been initiated.

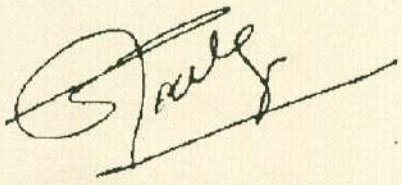
A novel high density planting in banana was found to be profitable which could reduce the fertilizer and water consumption to an extent of 30 and 40 % respectively, there by reducing the cost of cultivation by 40 %. Various soil amendments have improved the soil health and reduced the fertilizer requirement for banana by 20 - 30 percent.

Integrated pest management strategies have been developed for the control of stem weevil and nematodes. Molecular diagnostic kit has been developed for identification of virus diseases in banana and programmes are in progress to develop the antisera indigenously.

The Centre has received accolades from various quarters of the Industry for developing various value added products from banana. The Centre has been awarded with prizes for their products in exhibitions including the second prize for the handicraft using banana stem powder at the International banana competition during the *Promusa* meeting held in Thailand.

I wish to express my sincere appreciation to the section Heads, Scientists and all the staff members of the Centre for their sincere efforts and cooperation in carrying out the research projects and activities of the centre appreciably.

I am also grateful to the Editorial Committee for compilation and editing the annual report document.



S.SATHIAMOORTHY
Director

Trichy

CONTENTS

EXECUTIVE SUMMARY

CROP IMPROVEMENT

Explorations were conducted in less exploited areas of banana origin and diversity viz. in Mizoram, Tripura and lower Assam and collected 11 wild diploid *acuminata* and one diploid *balbisiana*. For the first time *Ensete glaucum* was collected from Mizoram. One accession from North-Eastern region was found to be a natural tetraploid, a first report from India. 200 accessions have been supplied to NRC for DNA Finger Printing for molecular characterization.

Evaluation reports of NRCB selections from three multi location centres were compiled. Data on 290 accessions have been sent to global *Musa* germplasm database at INBAP, France under MGIS. Selected accessions were evaluated for specific traits in groups like Monthan, Bluggoe, Bangrier, Mysore and elite clones.

CROP PRODUCTION AND POST-HARVEST TECHNOLOGY

Different moisture regimes and N fertigation under normal and paired row planting showed significant response for plant height and leaf area of Nendran banana. Higher level of irrigation and fertigation caused early shooting. Normal planting with 100% moisture regime and N fertigation recorded the earliest flowering (217.75 days). Bunch weight was significantly maximum (9.82 kg) under normal planting with 100% irrigation and nitrogen level followed by paired row planting with 80% irrigation and 125% nitrogen level.

The suitability of different organic manures for Poovan banana was found to be in the order of poultry manure = rice husk ash > pressmud >FYM. Application of 15 kg poultry manure or rice husk ash per plant could save 20% of NPK and produced 18.5% more yield in Poovan banana. Application of 0.5 kg Cement Factory Kiln Dust (CKFD) per plant in Karpuravalli recorded higher growth in the later stage of plant growth. Optimum soil chemical parameters were recorded at 0.5kg CKFD level. The potential buffering capacity of soil for K (PBCK) at control, 0.5 kg and 1.0 kg CKFD were 35.23, 37.45 and 38.98 Cmol/kg- $(M/l)^{1/2}$ respectively.

Different levels of post harvest calcium chloride application on Rasthali, Ney Poovan and Robusta banana showed that 4% calcium chloride enhanced the shelf life marginally by 1-2 days while, higher concentrations of calcium chloride did not have any positive results. Antioxidants like citric acid at 200 ppm and propylene glycol at 1000 ppm were effective in checking the rise of acid value and peroxide value in the Nendran banana chips during the storage.

Packaging of bananas in sealed 400 gauge polyethylene bags and storage at 13 ± 1^{0} C extended the storage life up to 29.66 days in Poovan and 19.33 days in Karpuravalli

fruits. Maximum spoilage was observed in fruits packaged in sealed bags and stored at ambient condition and Zero Energy Cool Chamber (ZECC). The physiological loss in weight and other quality changes were lowest in fruits stored at 13±1° C. The postharvest losses in banana 8-9% at farmer's level, 20-25% at whole seller's level and 15% at retailer's level. The major spoilages were due to PLW and finger drop, which were high after ripening of fruits. The quality and shelf life of Karpuravalli banana fig could considerably be improved by osmotic dehydration technique. The product had more than 90 days of storage life with acceptable organoleptic quality. Karpuravalli banana fruit bar prepared with 20% sugar, 0.5% pectin and 4-5 drops of colour was found to be highly acceptable with a shelf life of more than 20 days. Spiced pickle in oil from male flowers of Karpuravalli banana was prepared after blanching in hot water for 5 minutes and the study is in progress.

CROP PROTECTION

Occurrence of *Scopulariopsis brevicaulis* (Sacardo) Banier and *Aspergillus flavus* as entomopathogens of banana stem weevil was identified. Small Curculionid, *Polytus melerborghii* Boheman and Cerambycid, *Sybra praeusta* Pascoe were reported as new pests of banana from India. Among the pseudostem traps, disc-on stump trapped more weevils. Bunch covering was effective in controlling the finger thrips. Screening of *Musa* germplasm against banana stem weevil indicated few resistant accessions.

Sixteen genera of plant parasitic nematodes were recorded during the survey around Thadiyankudisai and Cumbum area. Among the several botanicals studied, *Calotropis procera, Prosopis juliflora, Datura stramonium, Crotolaria juncea* were effective in reducing nematode population. In management of root lesion nematode, press mud application was on par with Carbofuran treatment in Nendran banana. Use of *Trichoderma* significantly reduced the nematode population in Rasthali banana infected with *Pratylenchus coffeae* and *Fusarium* wilt pathogen complex. Among the germplasm screened, 391 accession belonging to different genomic groups were free from nematode infection.

Eye spot disease (*Drechslera* sp) was reported for the first time in India in diploid bananas. BSV and BBMV were reported in cv.Red banana in highlands. BBMV and BSV infection was noticed in germplasm accessions no.25 and 20 respectively. ELISA and DIBA tests were undertaken to study the disease intensity. Screening of 434 *Musa* accessions against Sigatoka leaf spot (*Mycosphaerella* spp.) indicated that 63 were partially resistant and 10 were highly resistant. Propiconazole and Hexaconazole alone and in combination with Kavach decreased the disease severity and increased the YLS. The CLV from cv. Robusta was successfully sap transmitted in to cowpea.

CROP PHYSIOLOGY AND BIOCHEMISTRY

The physiology of flowering and fruit development in six cultivars of banana was

studied. Significant differences were observed for the growth parameters at 7th month stage. The photosynthetically active leaf area of the plant is more important in deciding the duration and extent of female phase in banana. Non-significant differences were recorded for the growth parameters between healthy and Neervazhai affected plants. The Neervazhai affected plants produced bunches of 2-3 Kgs weight with 2-3 fingers which developed in to full maturity as compared to the normal bunch weight observed in healthy plants. Application of STS, Ethrel and BA @25ppm had no influence in controlling the malady. A significant difference in chlorophyll content was recorded in leaves of healthy and affected plants.

TRANSFER OF TECHNOLOGY

Technology of processing of banana products was transferred to the potential entrepreneur's sponsored by Districts Industries Centre, Trichy for a period of five months from February to July 2000.

A banana seminar was organized in association with Trichy All India Radio farmers Association and Thottiyam Banana Growers Association under the chairmanship of the Director on January 28, 2001. Scientists of the Centre spoke on different aspects of banana cultivation, plant protection, postharvest technology and tissue culture plantation. The doubts of the farmer's were clarified. An exhibition was arranged depicting various activities of the centre, symptoms and control measures for various pests and diseases of banana and also on the various values added products.

HUMAN RESOURCE DEVELOPMENT

Dr.K.J. Jeyabaskaran, attended "Tenth Winter School on Remote Sensing in Agriculture with Special Emphasis on Crop Weather Relations", sponsored by ISRO, Department of Space, Government of India and organised by Division of Agricultural Physics, IARI, New Delhi from Nov.13 to Dec.8, 2000.

Dr. B. Padmanaban, participated in the summer school on environmental impact of pesticides in the agro ecosystems - assessment and abatement, organized by ICAR held at the Dept. of Agricultural Entomology, TNAU, Coimbatore from May 3 - 23, 2000.

Dr.P.Sundararaju, Dr.C.K.Narayana and Dr. B.Padmanaban awarded Certificate in Computing (CIC) by Indira Gandhi National Open University (IGNOU), New Delhi.

Mr. P.Ravichamy was deputed for computer training on DeskTop Publishing (DTP) at ECIL - BDPS, Computer Education Centre, Trichy.

3. 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

Crop Improvement

National Research Centre for Banana (NRCB) has so far collected 1061 accessions of bananas and plantains including wild *Musa* species of different botanical sections, through survey of various banana growing regions in India and through introductions from abroad. Survey of North-Eastern region has led to identification of *Musa acuminata* subspecies and several members of the section *Rhodochlamys* and *Australimusa* types.

The collected *Eumusa* accessions were assessed of their ploidy level and these accessions are being maintained in field genebank. Selected accessions are being conserved *in-vitro* for medium duration storage. Protocol for large scale multiplication and long term storage of *in-vitro* plants has been developed, particularly for clones of AAB and ABB genome.

The accessions have been systematically screened for their fertility pattern and reaction to major diseases and pests to identify new sources of resistance. Embryo culture of banana has been standardized. This has helped to derive more hybrid seedlings from seeds, which generally have very poor germinability of less than 1%. Clonal selections have led to identification of high yielding commercial cultivar Karpuravalli (ABB) and a short duration Robusta banana.

Molecular characterization of banana using isozymes and evolutionary divergence analysis through numerical taxonomy have also been worked out for Silk (AAB), Pisang Awak (ABB) and culinary groups (ABB).

Crop Production and Post-harvest Technology

In a study on the effect of season of planting on growth and yield of Robusta, Rasthali, Nendran and Poovan, maximum bunch weight was recorded when planted during February-April, where as Pachanadan (AAB) and Karpuravalli (ABB) recorded maximum bunch weight when planted in June and December respectively. 25% N as FYM + 50% N as neem cake +25% N as urea recorded vigorous plant growth, shorter crop cycle, increased yield and TSS in Robusta, Rasthali and Poovan cultivars. In moderate sodic soils the plant growth was the best in the treatment of gypsum + 15 kg FYM and addition of increasing rates of K had further improved growth. Application of 15 Kg poultry manure per plant + 80% of recommended NPK recorded the highest bunch weight in Poovan.

Highest bunch weight was recorded in conventional planting over paired row planting under 100%E^0 and 125% N fertigation. The fruit quality viz., TSS and acidity were significantly influenced by the moisture regimes and N fertilization.

Weeds affecting banana during first six months has drastically reduced the growth, bunch weight and extended the crop duration.

Coconut oil was the best frying medium for Nendran (Plantain) banana chips, which had a shelf life of 30 days. Good quality fruit powder could be made out of plantains. Banana biscuits prepared from banana powder had good consumer acceptance and had high commercial potential. Poovan (AAB) and Ney Poovan (AB) puree could be stored upto 3 months at ambient and 5 months under refrigerated conditions with 2000 ppm potassium metabisulphite (KMS). Banana figs prepared using 1% KMS dip or blanching for 5 minutes at 80°C or 0.1% KMS infiltration or 1000 ppm ascorbic acid infiltration stored upto 35 days without spoilage.

Crop Protection

Occurrence of a new banana pest, banana stem weevil, *Odoiporus longicollis* has been identified. This caused serious crop losses up to 80 per cent, if unchecked. Originally, a pest of North-Eastern hill regions of India, it has now become a serious pest of Southern India. Most preferred host is plantain cultivars (AAB) followed by Red banana (AAA) and hill banana Virupakshi (AAB). Scanning electron microscopic studies on *O.longicollis* adult weevil indicated substantial layer of variously shaped sensilla in the antennal tip, anternnal segment, proboscis and elytra, which were used as sensory receptors. Stem injection of Monocrotophos (diluted at 1:2.5) @ 4 ml / plant four times at monthly interval from 4th month was found effective for controlling stem weevil. Banana leaf eating caterpillar, *Spodoptera litura* mortality was the highest in Azarec and Nimbicidine. Chlorpyrifos spray

and insecticide impregnated bagging reduced the finger thrips infestation. Giant African snail (*Achatina fulica*) damage was observed in coastal districts of Tamil Nadu.

Wide spread occurrence of root-lesion nematode (*Pratylenchus coffeae*), burrowing nematode (*Radopholus similis*), root-knot nematodes (*Meloidogyne incognita*) and spiral nematode (*Helicotylenchus multicinctus*) on banana were recorded in Southern India, Gujarat, Maharashtra and North Eastern Hill regions. Significant reduction in nematode population was recorded in a 50% 'N' as neem cake. In Nendran, maximum damage was done by *P.coffeae* in red soil and the least in alluvial soil, Diploids of AA and AB genomes with resistance / tolerance to nematodes have been identified.

Wide spread occurrences of Banana Bract Mosaic Virus (BBMV) and Banana Streak Virus (BSV) were found in all the 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 as BBMV. The yield loss due to BBMV and BSV has been ranging from 48 to 70%. DIBA, DAC-ELISA tests have been standardized 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. Rasthali, 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 in certain areas. Occurrence of new race is suspected.

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

Crop Physiology and Biochemistry

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 offered quality like flavour and taste.

MANDATE

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

BUDGET

NRCB Budget and Expenditure Details For 1999-2000 (Rupees in lakhs)

Head of Account	Budget for 2000-2001		Expenditure 2000- 2001	
	Plan	**Non-Plan**	**Plan**	**Non-Plan**
Estt. Charges	20.00	42.69	18.07	41.17
Travelling expense	1.50	0.75	1.25	0.75
Other charges	68.50	11.56	58.02	10.02
Works	110.00	——	119.78	——
Total	200.00	55.00	197.12	51.94

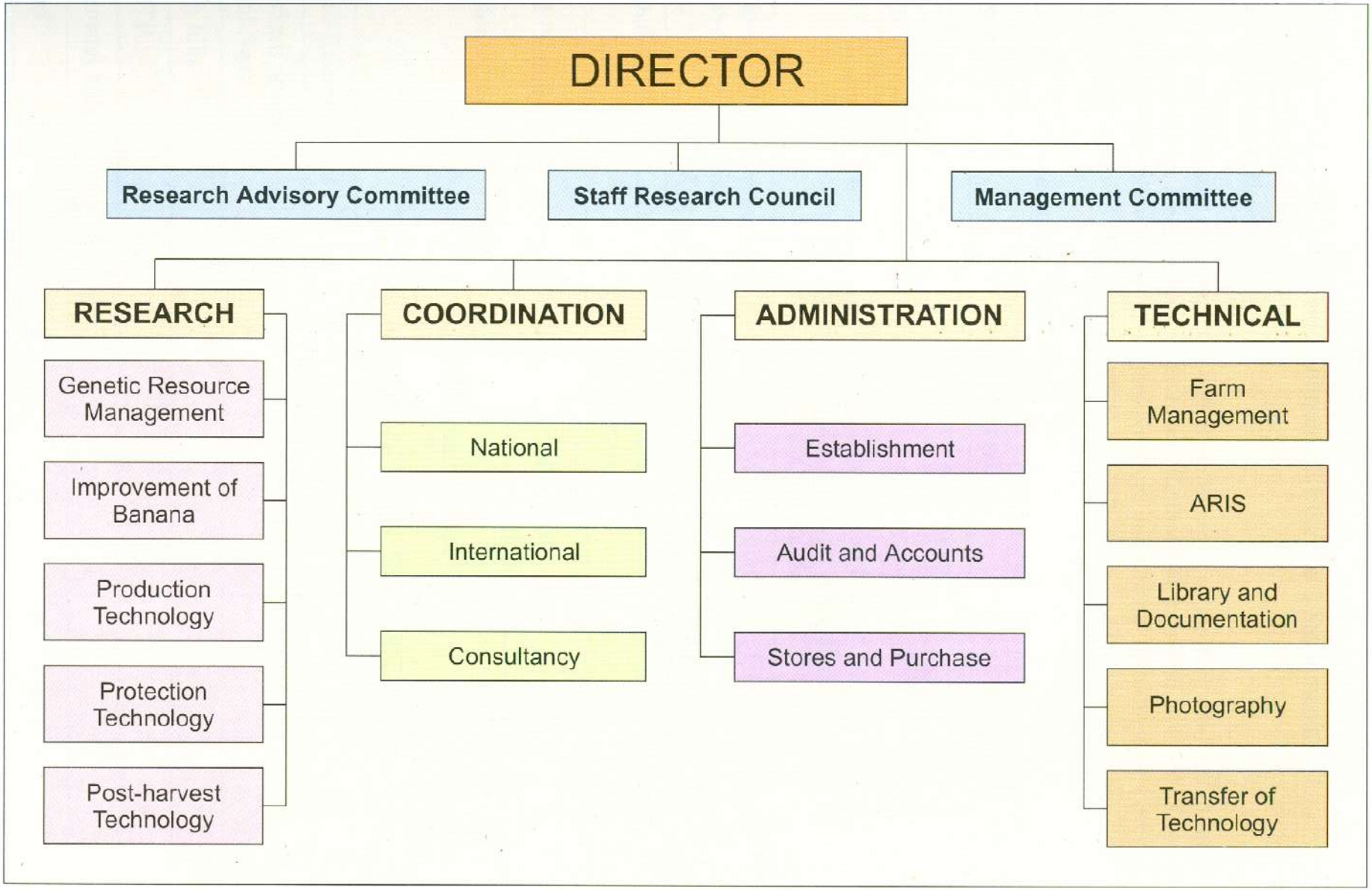
METEOROLOGICAL DATA

Month/Year	Temperature (°C)		Relative humidity (%)		Rainfall (mm)
	Minimum	Maximum	Minimum	Maximum	
Apr 2000	23.7	36.3	63.9	92.1	109.4
May 2000	25.35	38.16	64.14	90.6	183.4
Jun 2000	25.5	36.3	61.2	83.8	1.0
Jul 2000	25.16	36.40	32.56	77.98	166.7
Aug 2000	24.52	34.01	44.14	84.38	65.3
Sept 2000	24.47	34.35	46.43	93.6	237.6
Oct 2000	23.14	33.71	45.39	98.5	151.3
Nov 2000	21.38	31.53	52.4	96.57	157.4
Dec 2000	19.36	29.91	51.72	96.63	131.5
Jan 2001	19.75	30.47	49.32	96.35	8.4
Feb 2001	19.98	34.36	31.91	96.64	0.1
Mar 2001	21.6	36.3	27.9	93.6	—

MANPOWER

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

ORGANOGRAM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RESEARCH ACHIEVEMENTS

1. CROP IMPROVEMENT

I. Management of genetic resources of banana (S.Uma and S.Sathiamoorthy)

1. Exploration and collections

During the present year emphasis was given to explorations in North-Eastern states which are the potential areas of banana diversity. Central, Western and Northern Tripura were covered extensively while in Mizoram, Northern and Central districts were covered. Southern tip of Assam was also covered which was left unexplored during last year.

Table 1 : Areas explored during 2000-2001.

Exploration	Areas covered
North-Easteran States	Assam,Tripura, Mizoram
Southern tip of Tamil Nadu	Tirunelveli and Kanyakumari districts
Kolli hills, Tamil Nadu	Semmedu, Thempalam Market, Sinna Kovilur, Peria Kovilur, Vilaram, Arappaleeswarar temple, Vasalurpatti, Cholakkadu
Kalakkad - Mundanthurai Tiger Reserve forest(KMTR), Tamil Nadu	Forests of KMTR, Courtallum, Puliyarai, Sengottai
Anamalai hills and Kerala.	Anamalai hills and forest ranges of Thrissur and Palakkad districts

Table 2 : Details of accessions collected during 2000-2001

Exploration	Genomic groups							No. of accessions collected
	AA	AAA	AAB	AB	ABB	BB	Unidentified	
North-Easteran states	11	3	4		4	1	5	28
Southern tips of Tamil Nadu	1	2	1	-	-	-	-	4
Kolli hills	-	3	1	-	1	-	-	5
KMTR	2	-		2	-	-	-	4
Anamalai hills	5	-	-	-	-	-	-	5
Total								46

2. Details of the unique accessions collected during explorations

Karu Vaazhai (Manoranjitham-AAA): Karu Vaazhai is the local and specific cultivar of Kolli hills, grows to a height of 4-5m, dark red pseudostem, glossy and shiny leaves, has religious importance, sweet taste, pleasant flavour with, TSS of 26° Brix. Now this banana has attained the stage of extinction due to *Fusarium* wilt and Bunchy Top disease. This accession is unique due to its immunity to leaf spot disease and highly female fertile.

Sai Su (*Ensete glaucum*): Very unusual collection, Sai Su was found growing in the deep forests of Mizoram. It is an unique accession referred as *Musa glaucum*. It belongs to the genus Ensete and bears geotropic, lotus like inflorescence with green bracts. Sai Su is propagated only by seeds.

M. acuminata Wild: Grows to a height of 4 m, pseudostem is black blotched, 60-70 cm in circumference, wide opened leaf petiole, pedicel is short (0.7 1.0 cm), prominent bract scar on the peduncle, hairy peduncle, were compact bunch, 7-9 hands, 16 fingers per hand finger apex is 1.0-1.5 and filled with black seeds. The sub species status has to be ascertained.

Accessions collected during north-eastern exploration had a mortality rate of 60.5 per cent. The surviving commercial and wild accessions were planted and characterized for 117 traits.

Table 3 : Exotic introductions from INIBAP through NBPGR

Name of the accessions
Lidi, Kluai Namwai Khom, Ama (South Johnstone), Tien (Than Hua), *Musa peekelii* ssp. Peekel, Singapuri, Schizocarpa no. 1, Robusta (Poyo), Dwarf French Plantain, Improved Lady Finger, Sabra, *M.acuminata* ssp. Banksii, Pisang Kra, Mapua, Giant Parfitt, T6, Buccanner, Datil, Mjenga "Gros Michel" Dipl, Paka, Taybut, Nkono Wa Tembo, GCTCV – 215, Yangambi no.2, GVTCV – 119, Pisang Berangan, Paracido del Rey, NAM, Pisang Serun 404, Pisang Serun 400, Chuoi Ngu Thoc, PC 12-05, PA 03-22, Ambiri, Cardaba, Pisang Masak Hijau, Pisang Buntal, Gros Michel, Kluai Namwa Khom, Kluai Lep Mu Nang, Gros Michel, Morong Princesa, *M.ac.ssp.microcarpa* type, Cocos, Kluai Tiparot, AA cv Rose, Vietnam No.5, Skai, Utafun, *Musa peekelii* ssp. *Peekel*, *Musa maclayi* ssp.*ailuluai*, *Musa lolodensis*, Long Tavoy, Honduras, Banksii, Pa (Songkla)x, Banksii, *M.schizocarpa*, Hawain 3, Japaraka no. 1, Hawain 2, Banksii, Msinyore, Taybut, Nkono Wa Tembo, Pisang Berangan, Pisang Serun 404, Calcutta-4, Pisang Jari Buaya, FHIA 02, Williams, Pisang Berlin, Cachaco, Cultivar Rose, Gros Michel, Yangambi KM5, FHIA 23, TMP2x1297-3, BITA 2, BITA 3, SH 3640, PV 42-320, FHIA 18, FHIA 21, CRBP 39, Pisang Lilin, TMP2x2829-62, PITA 16, FHIA 25, TMB2x9128-3, Pisang Ceylon.

3. Characterization of germplasm

Characterization and Intra-group Cluster Analysis of *Musa* sub group Pisang Awak. Multivariate analysis of morphological variations among the 48 Pisang Awak (ABB) accessions was studied.(fig. 1) for 18 qualitative trails.

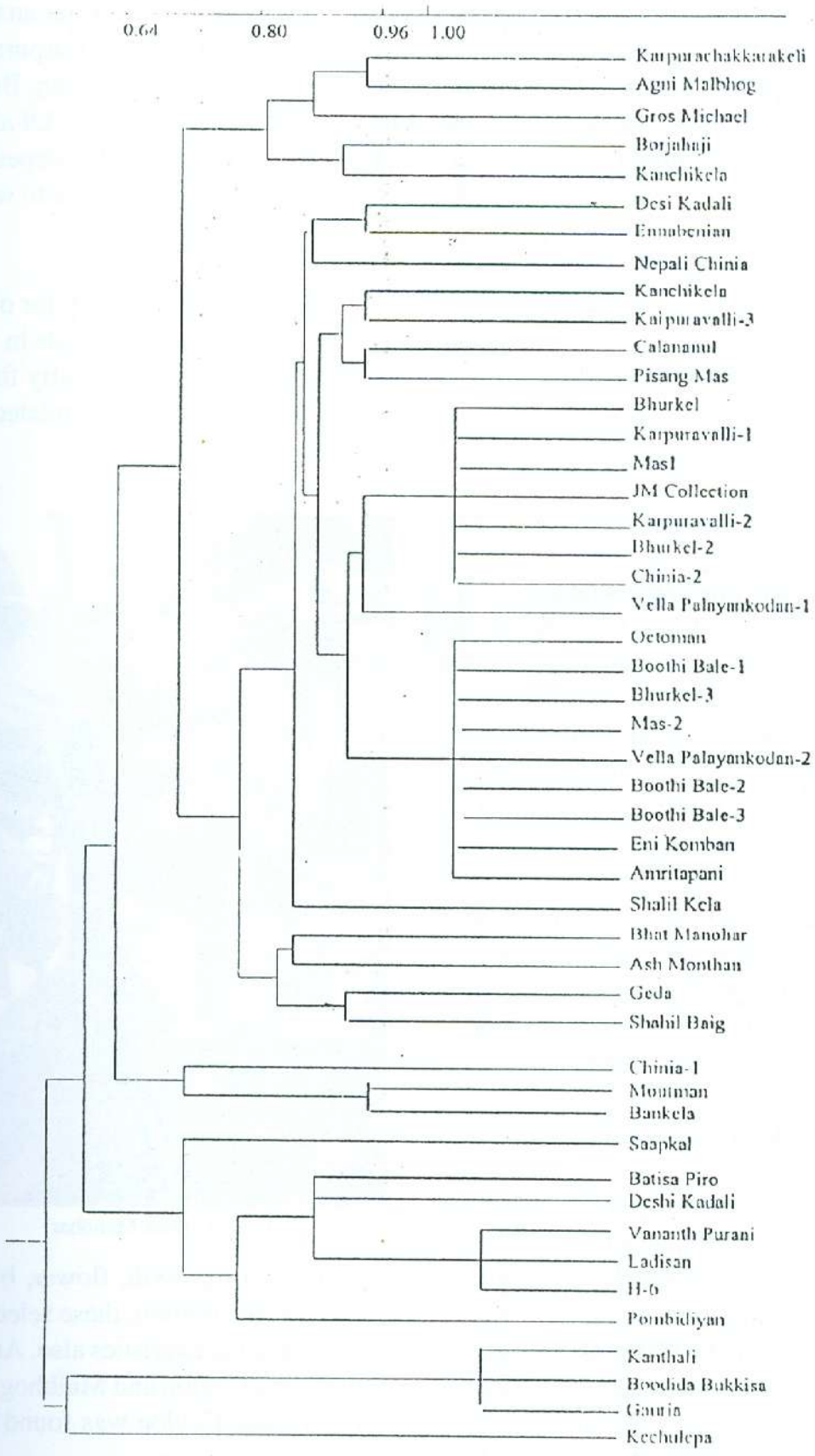


Fig. 1 : Phenogram showing intra-group cluster analysis of matrix of distance coefficients among Pisang Awak (ABB) Accessions

The phenogram was developed for 48 accessions. According to the cluster analysis of matrix distance co-efficients, two distinct groups were identified Bhurkel 1, 2., Karpuravalli 1, 2., Mas, Jammulapalm collection, Chinia and the others comprising of: Octoman, Boothi Bale 1, 2, 3., Bhurkel 3, Mas, Vellapalayankodan, Eni Komban and Amritapani. Of all the collections Shalil Kela, Chinia 1, Poombidian and Kechulepa had distinct independent clustering. In many cases, the names and the actual accession did not coincide due to wrong labelling at the secondary centres of collection.

Small clusters of three to four members were noticed varying especially for one or more traits. Pisang Awak group being highly female fertile, produces ample seeds in open pollinated conditions. The seed progenies thus developed have contributed greatly for the present variation. Molecular characterisation will further elucidate the genetic relatedness among the genotypes.

4. First report of tetraploid banana from India

Bhat Manohar, one of the wild accessions collected from the Namsai forest range bordering upper Assam and Arunachal Pradesh was studied for its ploidy status through flow cytometry (with the assistance of IAE, Vienna, Austria) with reference to Pisang Lilin (2x), Rasthali (Silk) (3x) and FHIA-01 (4x). The result suggested that its ploidy status as 4x. The histogram in comparison with the known accessions is presented (fig 2). Considering its tetraploidy status, chromosomal count and scoring method, the genomic status of Bhat Manohar could be 'ABBB'. Hence Bhat Manohar could be the first known natural tetraploid with ABBB genome. (plate 1)

Plate 1. Bhat Manohar

5. Evaluation of NRCB selection

Seventeen selections comprising of five selections in Monthan (ABB), 4 in Bluggoe group (ABB), 4 in Bangrier (ABB unique) and 5 elite clones were evaluated for growth, flower, bunch, finger, bunch and quality parameters in plant and ratoon crops. In addition, these selections were evaluated for Sigatoka leaf spot diseases and gas exchange characteristics also. Among these selections, Pacha Bontha Batheesa, Saba, Bangrier, Pisang Ceylon and Malbhog were found promising with high yield with good quality fruits. Pisang Ceylon was found to be free from Banana streak virus (BSV) as compared to Poovan.

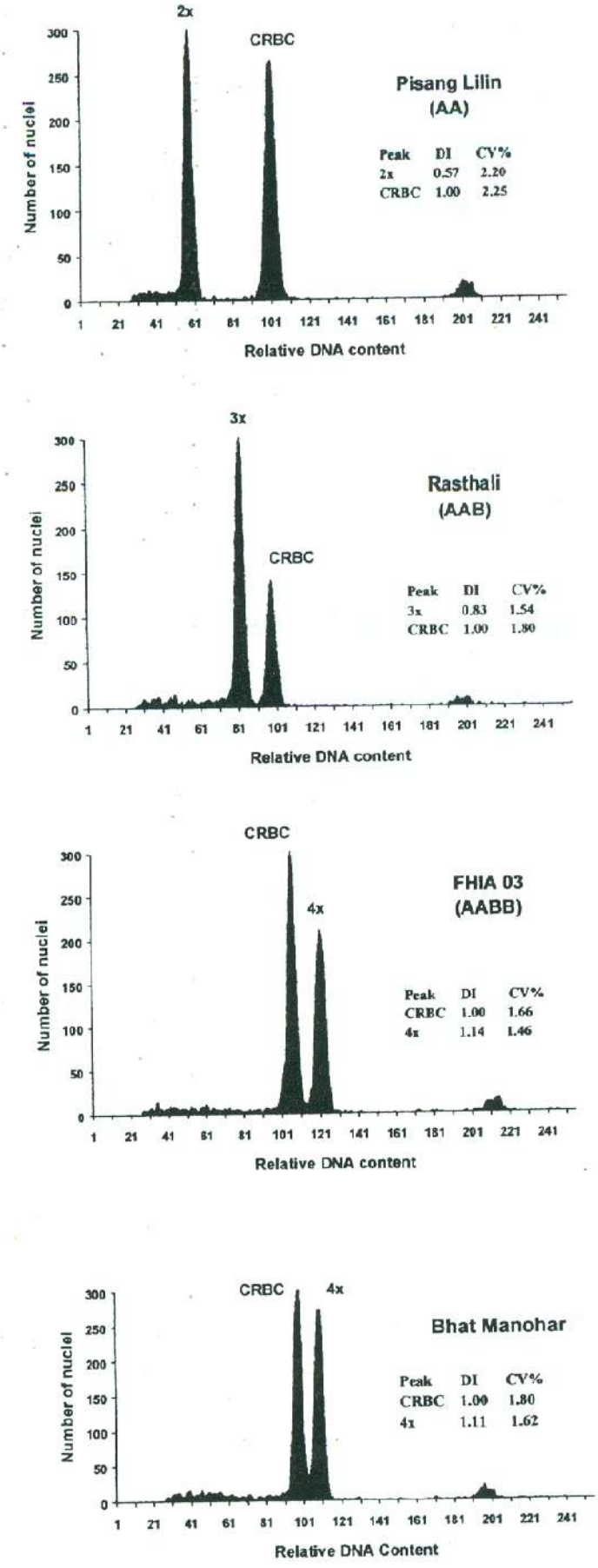


Fig. 2 : Histogram of Bhat Manohar in comparison with Pisang Lilin, Rasthali and FHIA 03

6. Evaluation of selected accessions of Banana for leaf industry

Preliminary evaluation during 1998-99 led to the identification of 8 accessions suitable for leaf industry. These selections were evaluated separately for their superiority and suitability for leaf purpose. The traits considered were total number of leaves produced, leaf area, number of side suckers, physiological traits like stomatal density midrib thickness and shelf life of leaves. The other traits like bunch and yield parameters were also recorded.

Elavazhai recorded excellent leaf parameters suitable for leaf industry. Due to its seedy fruits its adaptability as an exclusive leaf yielding banana cultivar is less. But other cultivars like Kunnan, Saba and Borkal Baista were found to be better substitutes for existing varieties like Poovan, Peyan and Karpuravalli. These varieties produced more number of leaves with better shelf life. They also produced marketable bunches of which Kunnan and Saba have assured market throughout the year. Except for leaf area, all other parameters showed significant differences.

7. Evaluation of Exotic accessions under multilocation trials.

High yielding five ITC introductions from INBAP France, namely FHIA - 01, FHIA - 03, Saba, Bluggoe and Burro Cemsa were multiplied and tested under multilocation trials. The results suggested that FHIA- 01 was more suited to higher elevations with less acidity and apple flavour. Saba and Burro Cemsa were highly potential cultivars for marginal lands and backyards.

As a part of IMTP-Phase III, a new set of 24 accessions have been received from INIBAP through ITC as proliferating shoot cultures. Of these 9 accessions were contaminated during transit and 4 more during further proliferation. NBPGR, New Delhi has been requested to replenish the lost accessions.

2. Studies on Nutritional requirement of tissue cultured banana cv. Robusta

(S.D. Pandey; M.M. Mustaffa and K.J. Jeyabaskaran)

The experiment was conducted to study the performance of tissue culture banana cv. Robusta under different combination of Nitrogen and Potassium. Observations recorded on different growth parameters revealed the effect of N and K combination and time of application on pseudostem height and leaf area only. The application of 300g N and 400g K in 7 splits at 45 days interval registered maximum plant height (247.50cm) and maximum leaf area (1.446 m^2) followed by 5 splits application of Nitrogen and Potassium (300g N and 400g K). Girth of pseudostem, number of functional leaves and different combination of nitrogen, potassium and time of application did not affect leaf emergence rate. Photosynthetic rate at different stage of observation also showed non-significant response (Table 5).

Observations recorded on yield parameters showed significant response to different treatment combination and application of 300g N and 400g K in 5 splits recorded maximum bunch weight (23.33 Kg) followed by 400g N and 400g K when applied in 7 splits. Maximum fruit weight, finger length and girth were recorded with higher levels of potassium application (Table 6). Quality parameters in respect of T.S.S, acidity and T.S.S/acid ratio revealed non-significant response to different combination of nitrogen and potassium.

Table 5 : Effect of N and K application on growth parameters of tissue culture banana cv. Robusta at flowering stage

Treatment	Height (cm)	Girth (cm)	Functional leaves	Leaf area (m^2)
T_1	196.38	61.00	12.23	1.182
T_2	213.83	74.05	12.30	1.275
T_3	240.34	73.94	11.57	1.484
T_4	218.58	68.67	12.32	1.201
T_5	191.85	64.18	10.73	1.099
T_6	223.45	69.07	12.30	1.381
T_7	218.63	66.07	11.30	1.154
T_8	235.15	64.10	12.23	1.201
T_9	242.06	72.30	12.00	1.370
T_{10}	247.50	75.63	12.80	1.446
T_{11}	201.44	67.15	10.28	1.076
T_{12}	211.44	63.05	10.73	1.157
T_{13}	198.96	59.70	9.90	1.106
T_{14}	190.83	72.00	11.20	1.320
T_{15}	196.78	68.73	10.83	1.202
T_{16}	216.51	67.79	10.80	1.204
T_{17}	227.34	64.67	11.23	1.278
T_{18}	221.34	66.27	10.33	1.173
CD @ 5%	31.566	NS	NS	0.2293

2. CROP PRODUCTION AND POSTHARVEST TECHNOLOGY

PRODUCTION TECHNOLOGY

I. Standardization of Agrotechniques for banana production and productivity

1. Effect of different moisture regimes and N fertigation on growth and yield of banana. (S.D. Pandey; K.J. Jeyabaskaran and M.M. Mustaffa)

The experiment was studied under two crop geometry with three levels of irrigation (80,100 and 120% of E_0) and fertigation (75,100 and 125% of recommended N dose) in first ratoon of Poovan banana.

The plant height and girth were not influenced by different moisture regimes and fertigation levels under both crop geometry at all stages of observations. However, number of functional leaves and leaf area recorded significant differences (Table 4). Maximum number of functional leaves (13.89) and leaf area (0.78 m^2) were recorded in $P_1I_3F_3$ (Conventional planting, 120% E_0 and 125% N level) treatment combination. Earliest shooting (231 days) and maximum bunch weight (11.83 kg) were also recorded in conventional planting at 120% E_0 and 125% N fertigation.

Table 4 : Effect of irrigation and N fertigation on growth (at 9th month) and bunch weight of ratoon Poovan (AAB)

Treatments	Height (cm)	Girth (cm)	Number of functional leaves	Mean leaf area (m^2)	Days taken for shooting	Bunch weight (kg)
$P_1I_1F_1$	215.89	62.81	9.33	0.50	307.67	8.78
$P_1I_1F_2$	214.57	60.03	10.49	0.68	308.67	8.72
$P_1I_1F_3$	205.26	64.17	12.92	0.75	288.00	8.50
$P_1I_2F_1$	204.44	65.61	12.21	0.70	315.33	11.33
$P_1I_2F_2$	208.79	59.16	12.53	0.69	323.00	9.92
$P_1I_2F_3$	216.44	59.57	12.69	0.70	291.33	11.35
$P_1I_3F_1$	206.22	62.05	10.00	0.56	312.00	9.97
$P_1I_3F_2$	217.52	60.95	13.21	0.76	275.33	10.39
$P_1I_3F_3$	206.39	64.22	13.89	0.78	231.00	11.83
$P_2I_1F_1$	218.94	64.22	10.00	0.70	318.33	6.83
$P_2I_1F_2$	213.83	66.44	9.71	0.77	316.33	7.08
$P_2I_1F_3$	216.11	66.83	12.91	0.78	293.00	6.73
$P_2I_2F_1$	212.83	62.20	10.25	0.57	323.33	8.04
$P_2I_2F_2$	217.28	63.96	10.55	0.64	322.67	7.88
$P_2I_2F_3$	210.13	58.05	12.37	0.63	293.33	8.61
$P_2I_3F_1$	226.61	64.39	12.79	0.69	301.33	8.09
$P_2I_3F_2$	212.00	63.83	13.75	0.66	289.33	7.99
$P_2I_3F_3$	217.89	65.42	14.23	0.76	273.33	8.69
CD at 5%	**NS**	**NS**	**1.710**	**0.148**	**33.462**	**1.280**

Table 6 : Effect of N and K application on yield parameters of tissue culture banana cv. Robusta

Treatment	Bunch wt (kg)	No. of fingers /bunch	Av. Fruit wt. (g)	Length of finger (cm)	Girth of finger (cm)
T_1	16.33	138.75	135.00	21.33	11.67
T_2	19.17	149.88	126.00	21.00	12.33
T_3	17.44	162.16	108.00	21.00	11.33
T_4	17.27	150.67	121.33	20.00	11.66
T_5	19.67	142.33	136.00	20.33	14.00
T_6	20.17	148.78	135.00	18.33	11.67
T_7	19.00	152.66	128.17	20.67	11.67
T_8	17.33	134.33	135.33	21.33	12.67
T_9	23.33	159.98	139.93	18.67	12.00
T_{10}	20.67	148.67	129.00	21.33	11.66
T_{11}	19.25	149.22	126.67	21.00	11.33
T_{12}	22.00	161.22	138.33	21.67	12.33
T_{13}	18.50	144.77	123.00	19.01	11.00
T_{14}	19.00	151.67	128.12	21.66	11.00
T_{15}	17.33	146.33	141.67	22.33	11.66
T_{16}	16.33	141.67	120.23	20.33	11.00
T_{17}	19.17	158.00	117.33	19.33	11.31
T_{18}	20.17	148.83	128.81	18.33	4.33
CD @ 5%	3.087	NS	17.892	2.722	1.772

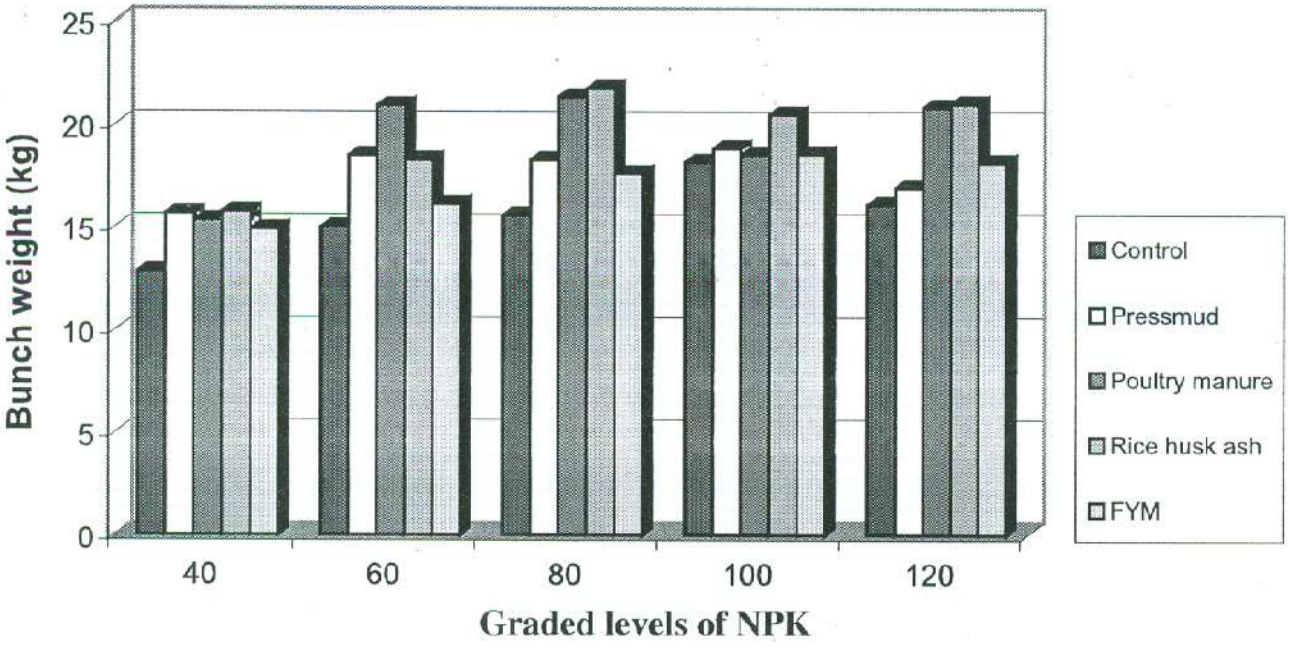
Non significant differences in photosynthesis rate among different treatment combinations at 5th and 7th month stages were recorded and also between the two stages. Whereas, transpiration rate showed significant differences at 5th and 7th month and for stomatal conductance only at 7th month. From the results, it could be concluded that the tissue culture Robusta plants maintained high photosynthesis rate during the vegetative phase which was crucial for producing high vegetative growth and subsequently higher yields.

3. Effect of different organic manures with graded levels of inorganic fertilizers on ratoon of Poovan banana (K.J.Jeyabaskaran; S.D.Pandey and M.M.Mustaffa)

The performance of different organic manures in first ratoon yield of Poovan banana was Poultry manure = rice husk ash > Pressmud > FYM > control. The minimum bunch weight (12.79 kg) was recorded at 40 % of recommended NPK without any organic manure

(control) and the maximum bunch weight (21.73 kg) at 80 % of recommended NPK + 15 kg rice husk ash/plant. It was found that nearly 20 % of NPK could be saved by adding either 15 kg poultry manure or 15 kg rice husk ash per plant. An additional profit of either Rs. 2375/ha or Rs. 3225/ha, respectively was obtained over control. (Fig. 3).

Fig. 3. Effect of different organic manners with graded levels of NPK on yield of Poovan ratoon



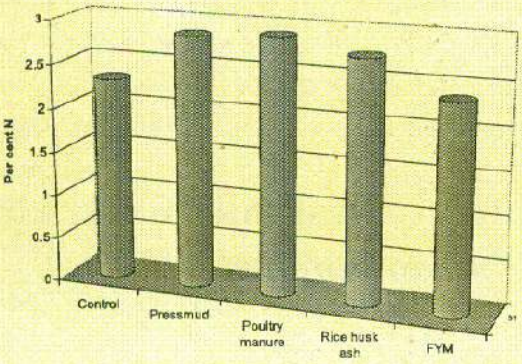
Application of poultry manure 15 kg/plant recorded maximum growth parameters like pseudostem height, girth, total number of leaves and total leaf area in the ratoon crop (Table 7). The poultry manure application recorded maximum leaf, N, P K, Ca, Mg, Fe, Cu, Mn, and Zn contents than control (fig. 4 & 4(a))

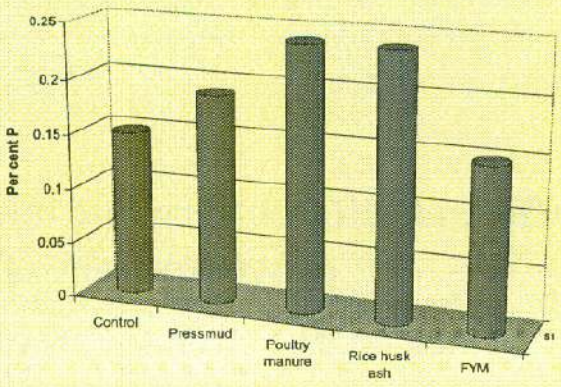
Table 7 : Effect of different organic manures on growth parameters of ratoon of Poovan banana.

Organic manures	Plant height (cm)	Pseudostem girth (cm)	Total leaf area (m^2)	Total number of leaves
Control	234.6	58.1	7.9	25.5
Press mud	236.5	59.0	8.8	28.1
Poultry manure	237.9	60.8	10.1	31.6
Rice husk ash	236.8	59.3	9.3	30.7
FYM	229.9	58.9	8.1	29.8
CD (P=0.05)	NS	1.36	1.64	1.08

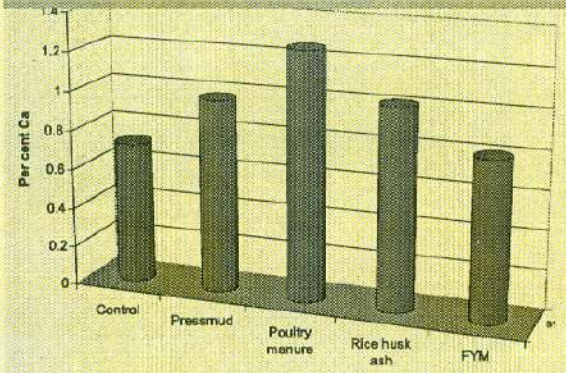
Fig. 4

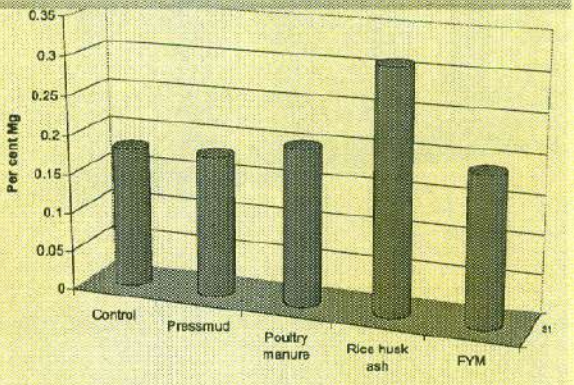
Effect of different organic manures on leaf N and P concentrations in Poovan banana



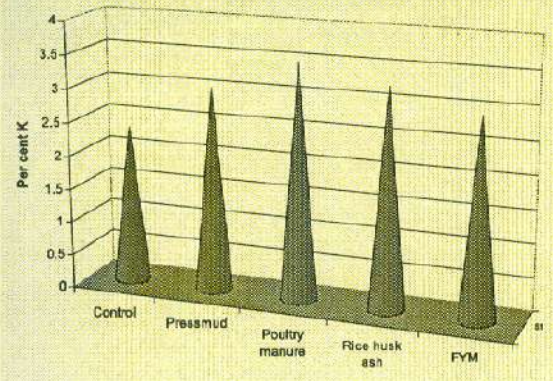


Effect of different organic manures on leaf Ca and Mg concentrations of Poovan banana





Effect of different organic manures on leaf K and Na concentrations of Poovan banana



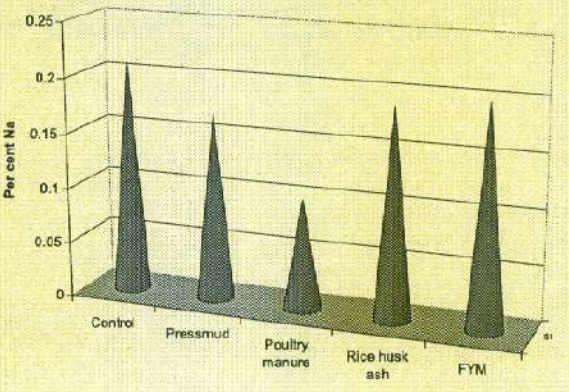
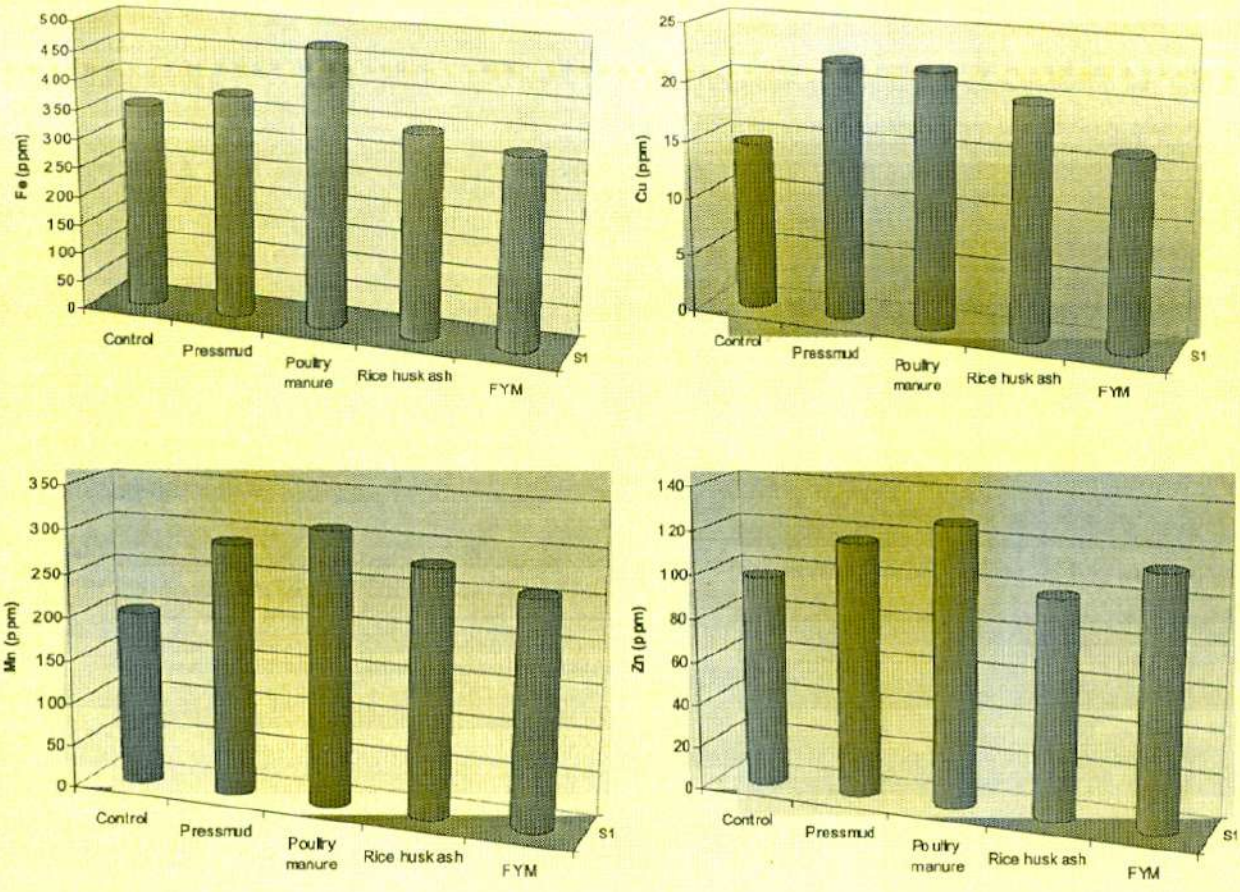


Fig. 4a

Effect of different organic manures on leaf micro-nutrient concentrations of Poovan banana



4. Studies on utilising cement factory kiln flue dust (CKFD) as soil amendment and K source (K.J.Jeyabaskaran; S.D.Pandey and M.M.Mustaffa)

The plant height, girth, phyllochron were recorded during initial growth phase upto 6 months. Among the main treatments, 0 level of CKFD recorded the maximum during initial growth and later 0.5 kg CKFD recorded the maximum values. Among the potassium levels, 20 % of recommended K recorded highest values for the above parameters till 6th month and after that 40 % of K recorded maximum (fig. 5). The increasing K levels (from any source) reduced the plant growth rate during the early stage and increased plant growth rate in the later stage.

Optimums of soil nutrients were recorded at 0.5 kg CKFD level. A soil pH of 7.22 and EC of 0.3 dS/m were observed at 1 kg CKFD level. Maximum soil and leaf Ca, Mg, Na, K, P and N contents were recorded at 1 kg CKFD application. (Table 8 and 9).

The Quantity/Intensity parameters for soil K at different levels of CKFD are given in the fig.4. The Potential Buffering Capacities of soil for K (PBCK) at control, 0.5 kg and 1.0 kg CKFD are 35.23, 37.45 and 38.98 $cm_0 l/kg.(M/l)^{-0.5}$, respectively.

Table 8 : Effect of CKFD and potassium on soil K, Na and K/Na ratio.

Treatments	Potassium (ppm)				Sodium (ppm)				Potassium/Sodium			
	M_0	M_1	M_2	Mean	M_0	M_1	M_2	Mean	M_0	M_1	M_2	Mean
S_0	341	591	881	604a	168	165	188	174b	2.0	3.6	4.7	3.4a
S_1	544	888	966	799c	155	173	185	171ab	3.5	5.1	5.2	4.6bc
S_2	556	503	891	650a	145	153	173	157a	3.8	3.3	5.2	4.1b
S_3	775	556	988	773c	148	178	175	167ab	5.2	3.1	5.6	4.6bc
S_4	644	609	903	719b	150	173	193	172b	4.3	3.5	4.7	4.2bc
S_5	753	859	747	786c	150	165	172	162ab	5.0	5.2	4.3	4.8c
Mean	606a	668b	896c		153a	168b	181ab		4.0a	4.0a	5.0b	

Mean values followed by same letter in row or column in each category are not significantly different. Interaction CD (0.05) = Potassium - 64.3, Sodium – 31.6 and Potassium/Sodium – 0.55

Table 9 : Effect of CKFD and Potassium on leaf K, Na and K/Na ratio.

Treatments	Potassium (%)				Sodium (%)				Potassium/Sodium			
	M_0	M_1	M_2	Mean	M_0	M_1	M_2	Mean	M_0	M_1	M_2	Mean
S_0	2.21	2.20	2.61	2.34a	0.28	0.31	0.22	0.27d	7.9	7.1	11.9	9.0a
S_1	2.32	2.25	2.74	2.44ab	0.28	0.28	0.20	0.25cd	8.3	8.0	12.0	9.4a
S_2	2.30	2.78	3.14	2.74bc	0.23	0.27	0.18	0.23bc	10.0	10.3	17.4	12.6b
S_3	2.63	2.72	2.92	2.76c	0.19	0.20	0.19	0.19a	13.8	13.6	15.4	14.3b
S_4	2.81	2.80	2.83	2.81c	0.19	0.21	0.19	0.20ab	14.8	13.3	14.9	14.3b
S_5	3.12	2.53	2.71	2.79c	0.19	0.22	0.18	0.20ab	16.4	11.5	15.1	14.3b
Mean	2.57a	2.55a	2.83b		0.23b	0.25b	0.19a		11.9a	10.6a	14.5b	

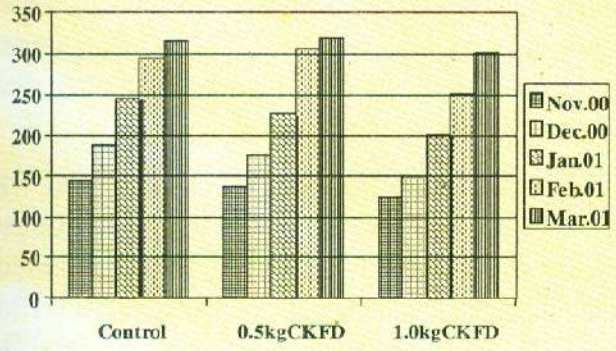
Mean values followed by same letter in row or column in each category are not significantly different. Interaction CD (P=0.05) Potassium – 0.168, Sodium – 0.031 and Potassium/Sodium – 2.15

Table 10 : Effect of CKFD on soil and leaf N, P, Ca and Mg concentrations

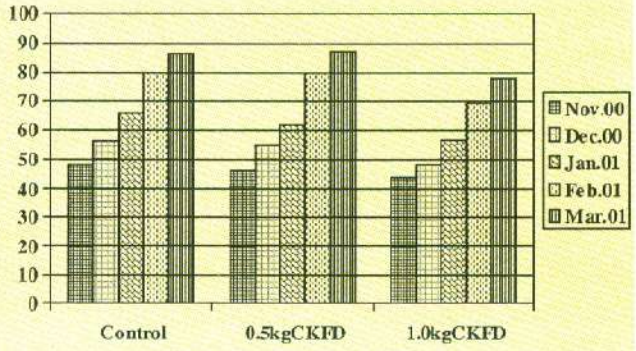
Nutrient	Soil (ppm)			Leaf (%)		
	M_0	M_1	M_2	M_0	M_1	M_2
N	120	130	127	2.67	2.51	2.04
P	10	14	18	0.19	0.17	0.20
Ca	2816	2793	3012	0.52	0.64	0.71
Mg	1314	1353	2063	0.21	0.20	0.28

Fig. 5

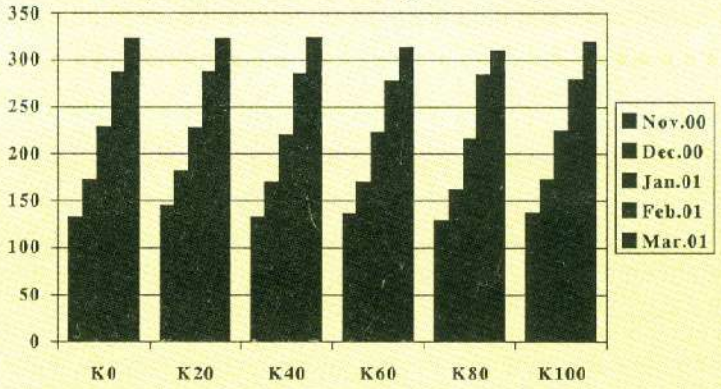
Effect of CKFD on height (cm) of Karpuravalli at different growth stages



Effect of CKFD on girth (cm) of Karpuravalli at different growth stages



Effect of K levels on height (cm) of Karpuravalli at different growth stages



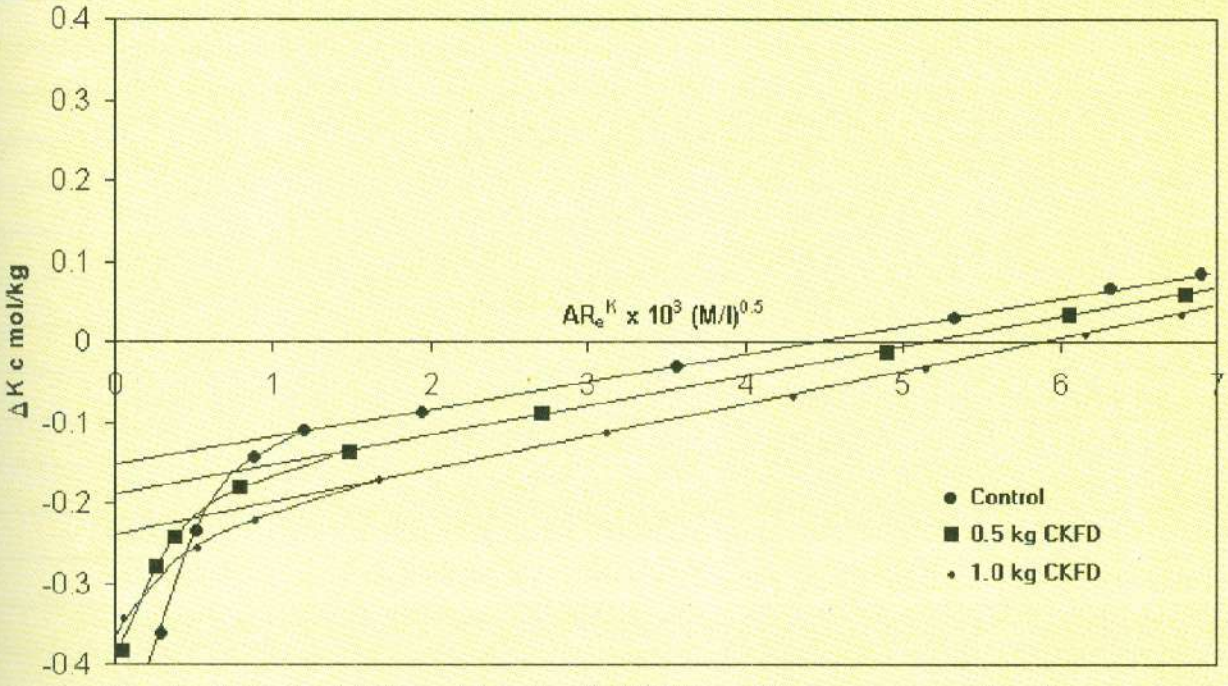


Fig. 6 : Effect of different levels of CKFD on Q/I parameters of soil

5. New production system of banana for export and domestic needs. (S.D.Pandey and S.Sathiamoorthy)

The observations on gas exchange characteristics were recorded at 7th month stage. The data revealed that there were significant differences among the treatments for photosynthesis rate and stomatal conductance and non significant differences for transpiration rate. The highest photosynthesis rate was observed in P_1 (conventional) followed by 2 plants/ hill. Lowest was recorded in P_2 (paired row) followed by P_4 (3 Plants/hill), indicating that the photosynthetic rate is lower under high density planting.

The data on diurnal variations in gas exchange characteristics was recorded at 7th month stage (Table 11). Among the planting densities, P_1 (conventional) had highest photosynthesis rate (conventional) followed by P_3 (2 plants/hill) and least was in P_2 (paired row) followed by P_4 (3 plants/hill) at 8 and 10 AM and 4 PM. But at 12 noon, 2 and 6 PM lowest was in P_4 followed by P_2, indicating that at higher density i.e., paired row and 3-plants/ hill the photosynthesis rate was lower as compared to conventional and 2 plants/hill. The transpiration rate and stomatal conductance rate also varied along with photosynthetic rate during the day (Table 12).

Table 11 : Influence of different splits on gas Exchange of Tissue culture Robusta banana

Treatments	Photosynthetic Rate (μ mol m^{-2} sec^{-1})	Transpiration Rate (m mol m^{-2} sec^{-1})	Stomatal Conductance (m mol m^{-2} sec^{-1})
1	20.27	6.18	340
2	20.82	5.22	320
3	20.80	5.52	310
4	19.31	5.11	300
5	20.54	5.56	350
6	20.07	4.80	270
7	21.52	5.42	280
8	19.52	5.83	340
9	19.93	5.47	320
10	20.86	5.26	280
11	20.28	5.45	300
12	20.02	5.36	300
13	20.51	5.68	300
14	20.21	5.10	250
15	20.78	5.75	330
16	20.19	5.15	300
17	19.94	6.04	320
18	19.31	5.41	320
CD at 5%	NS	0.60	52

Table 12 : The diurnal variations in the Photosynthetic rate (mol CO_2 m^{-2} sec^{-1}) in cv. Robusta (AAA) at 7th month stage under different planting densities and Fertigation levels

Treatment	8AM	10AM	12Noon	2PM	4PM	6PM
P_1F_1	16.61	17.94	14.31	10.38	7.46	3.49
P_1F_2	17.33	18.76	14.53	10.47	7.54	3.72
P_1F_3	17.16	18.42	14.50	10.27	6.66	3.46
P_2F_1	14.75	16.38	13.30	10.51	3.54	2.83
P_2F_2	14.85	16.42	13.62	10.15	3.38	2.90
P_2F_3	14.85	16.68	13.24	9.22	3.54	2.95
P_3F_1	16.57	18.05	14.56	10.61	7.00	2.64
P_3F_2	17.09	17.71	14.87	10.21	7.10	2.92
P_3F_3	16.63	17.9	14.49	10.33	7.02	2.77
P_4F_1	16.6	16.03	12.62	8.42	3.82	2.54
P_4F_2	16.51	16.58	12.74	8.54	3.93	2.77
P_4F_3	16.69	16.84	13.3	8.55	3.90	2.76
CD at 5%	1.19	1.30	1.46	1.48	1.19	0.59

3. CROP PROTECTION

I. Insect Pest Management in Banana (B.Padmanaban and P.Sundararaju)

1. Search for new insect pests, biological control agents of banana weevils from endemic areas

Survey was undertaken in banana weevil endemic areas of Coimbatore, Thadiyankudisai, Pechiparai, Cumbum, Trichy and Karur. Soil samples and corm were collected from endemic areas and kept for trapping of entomopathogenic nematodes/fungi and emergence of parasitoids. Natural enemies were not recorded from the samples collected. Occurrence of two fungi, viz., *Scopulariopsis brevicaulis* (Sacardo) Bainer and *Aspergillus flavus* as entomopathogens of banana stem weevil were recorded from the fungal infected weevils. Two new insects namely a small Curculionid weevil, *Polytus mellerborgii* Boheman also known as small banana weevil and a *Cerambycid, Sybra praeusta* Pascoe were also recorded in Tiruchirapalli and Perambalur districts of Tamil Nadu, feeding on leaf sheaths of French plantain, Nendran (AAB), Giant Plantain, Myndoli (AAB). Pisang Awak (ABB) and Monthan (ABB). The small banana weevil is reported as a new pest from India. (plate 2)

Plate 2

(i) Small Curculionid weevil *(Polytus mellerborgii)* (ii) Cerambycid, *(Sybra praeusta)*

2. Evaluation of trapping methods

Plate 3. Disc - on - stump trap longitudinal Pseudostems split trap

Spent pseudostems (plate 3) of longitudinal splits and disc on stump were kept as traps and were checked weekly for the incidence of adult weevils. Monitoring was done from February 2000 under wet land and garden land conditions. Among the traps, the disc-on-stump trapped more weevils. The BCW out numbered the BSW in collection. Trap material was changed weekly.

3. Banana finger thrips management

Plate 4. Rust thrips on Cv. Karpuravalli

Banana finger thrips (plate 4), rust thrips, *Chaetanaphothrips signipennsis* (Bagnall), silvery thrips, *Hercinothrips bicinctus* Bagnall and flower thrips, *Thrips hawaiiensis* Morgan caused considerable damage on the banana fingers, which reduced the finger appeal hence fetched low price. Bunch covering was best in controlling the thrips and the fingers were free from thrips infestation.

4. Screening *Musa* germplasm and commercial cultivars against Banana Stem Weevil (BSW) under laboratory conditions

A simple laboratory screening procedure against BSW was standardized for the first time using banana leaf sheaths as a test material. The *Musa* germplasm involving 23 diploid accession, 42 triploids, 2 tetraploids, 22 exotic accession and 11 commercial cultivars were screened which resulted into seven distinct groups based on Pseudostem Sheath Area Damage (PSAD) values. Dudhsagar (AAA), H-2 (AAB), Pisang Lilin (AA) and Pisang Jari Buaya (AA) were found to be resistant according to PSAD values. Most of the commercial cultivars exhibited high degree of susceptibility to BSW.

5. Screening of *Musa* germplasm against banana corm weevil (BCW)

Relative susceptibility of *Musa* germplasm under field conditions of NBPGR Regional station, Thrissur revealed that out of the 309 accessions, two ABB, one AA, one BB and two AB genomic groups were free from corm weevil infestation.

II. Studies on banana nematodes and their management (P.Sundararaju and B.Padmanaban)

1. Survey

Sixteen genera of plant parasitic nematodes were recorded from the samples collected during the survey. The root-lesion nematode, *Pratylenchus coffeae* was the predominant species in most of the places surveyed followed by root-knot nematode, *Meloidogyne incognita* and spiral nematode, *Helicotylenchus multicinctus*. The burrowing nematode, *Radopholus similis* was recorded in Virupakshi (Hill banana) from Thadiyan Kudisai and in Robusta from Cumbum areas in Tamil Nadu.

2. Control of root-lesion nematode, *Pratylenchus coffeae* using botanicals on Nendran and Rasthali

Field experiment was carried out in a heavily infested root-lesion nematode field with two commercial cultivars namely Nendran and Rasthali. The leaves of the ten botanicals viz. *Azadirachta indica, Calotropis procera, Prosopis juliflora, Datura stramonium, Crotolaria juncea, Abutilon indicum, Cassia auriculata, Tridax procumbens, Vitex negundo* and *Xanthium indicum* tested against root-lesion nematode on Nendran and Rasthali revealed that all the botanicals were found to be effective in reducing the nematode population and subsequently increased the plant growth characters and yield as compared to untreated control. Among the different treatments, application of *Crotolaria juncea, Calotropis procera, Datura stramonium, Vitex negundo* and *Prosopis juliflora* were found to be superior and effective in reducing the nematode population and significantly increased the yield.

3. Management of root-lesion nematode, *Pratylenchus coffeae* in Plantain (Nendran AAB) fields.

Field experiment was carried out for the management of *P.coffeae* using press mud (a by-product from sugar factory) recorded significant reduction in nematode population and increased plant growth as compared to control. However, pressmud application was on par with Carbofuran treatment. The use of pressmud is economical and environmentally safe as compared to chemical nematicide.

4. Management of nematode-Fusarium wilt complex in banana through bio-agent, *Trichoderma viride* (Bio-T)

Plate 5. *Trichoderma viride* (Bio-T) solution

Field and green house experiments were conducted by using different doses of bio-agent, *Trichoderma viride* on susceptible cultivars viz. Virupakshi and Rasthali. Significant yield increase and reduction in nematode population was noticed from the treated plants. The effect of *T.viride* on growth of Rasthali banana infected with root-lesion nematode, (*Pratylenchus coffeae*) and fungus (*Fusarium oxysporum f.sp.cubense*) in pots under the green house condition showed a significant reduction in nematode population and without wilt symptoms whereas, 40% wilt incidence was recorded in the control plants. (plate 5)

6. Field evaluation of *Musa* germplasm against major nematode pathogens.

Six hundred and four banana germplasm consisting of 566 indigenous and 38 exotic collections were screened under field conditions for tolerance/resistance to major nematode pathogens viz., *Radopholus similis, Pratylenchus coffeae, Meloidogyne incognita* and *Helicotylenchus multicinctus*. Among the germplasm screened, 391 accessions belonging to different genomic groups were found to be free from nematode infestation. The triploids AAB and ABB showed maximum nematode infestation for all the four nematodes as compared to diploids or tetraploids. The cyst nematode, *Heterodera oryzicola* reported for the first time from Robusta in Tamil Nadu.

III. Studies on fungal and bacterial diseases and their management (R. Selvarajan)

1. Management of Sigatoka leaf spot disease using fungicides

A field trial was conducted for the control of Sigatoka leaf spot using fungicides in cultivar Robusta. A total of four sprays were given. The severity index and the YLS were recorded at 15-20 days after each spray and the bunch parameters like number of fingers, hands and the bunch weight were recorded. The YLS recorded in the month of December and January was significantly superior as compared to control. Similarly the bunch weight increased significantly in all the fungicides sprayed plants. Propiconazole (Tilt) and Hexaconazole (Anvil) alone and in combination with Kavach decreased the disease severity and increased the YLS, and bunch weight as compared to *Bavistin* and *Kavach* (Chlorothalonil) combination.

Table 13 : Chemical control of Sigatoka leaf spot disease in Cv. Robusta

Treatments	18/12/2000		10/1/2001		8/2/2001		10/3/2001		Bunch
	DS	YLS	DS	YLS	DS	YLS	DS	YLS	Weight (kg)
T-I	38.08	8.37	25.74	7.96	31.91	6.00	30.97	7.12	20.58
T-II	36.23	7.66	30.17	6.83	36.78	5.02	38.35	6.31	21.39
T-III	40.98	7.94	32.49	6.71	44.83	5.43	40.80	6.26	19.78
T-IV	38.90	7.79	30.34	7.75	45.14	4.83	34.71	6.46	18.97
T-V	33.33	7.83	25.39	7.67	41.12	5.46	34.69	6.71	21.39
T-VI	34.92	8.08	32.87	6.71	35.68	4.79	35.86	6.37	20.25
T-VII	40.00	8.12	31.47	6.98	43.71	5.25	39.20	6.43	18.40
T-VIII	44.95	6.78	55.01	5.45	57.94	4.25	50.90	5.0	13.11
CD@ 5%	4.25	0.64	7.6	1.37	13.93	NS	7.4	NS	3.80

DS: Disease Severity; YLS: Youngest Leaf Spotted

To assess the Sigatoka disease incidence, disease severity and youngest leaf spotted (YLS), observations were recorded at monthly interval starting from 5th month after planting. Significant differences in disease severity among the treatments during February and May was observed. The lowest disease severity was recorded in treatment P_4 (three plants per hill) compared to all other treatments

Table 14 : Comparison of Sigatoka leaf spot incidence under different plant densities in cv. Robusta

Plant	Disease severity (%)						Youngest Leaf Spotted (YLS)					
density	Jan	Feb	March	April	May	June	Jan	Feb	March	April	May	June
P1	31.49	39.85	26.08	40.19	40.20	48.63	8.30	9.10	8.30	8.30	7.60	5.60
P2	31.03	36.76	29.19	36.48	45.26	48.22	9.00	9.40	8.20	8.70	6.80	6.70
P3	31.66	38.51	26.55	38.74	44.18	48.82	8.25	8.65	8.10	8.35	7.25	6.65
P4	24.58	32.06	22.18	36.64	22.18	43.25	8.37	9.66	7.36	7.69	7.36	6.29

P1-Conventional planting; P2-Paired row planting; P3- Two suckers per hill; P4- Three suckers per hill

2. Screening of *Musa* germplasm against Sigatoka leaf spot disease

The available germplasm in the field genebank were screened against Sigatoka leaf spot incidence. The disease severity and the YLS were recorded as per INIBAP-IMTP Sigatoka guidelines (Technical manual of IITA, Nigeria) at 6th month, at shooting and at harvest.

Based on the above scoring out of the 434 accessions 134 accessions were found susceptible, 172 were less susceptible, 63 were partially resistant and 10 accessions were found to be highly resistant for the remaining 45 accessions the data is completed for vegetative stage only. Among diploids screened against leaf spot diseases (Sigatoka/Septoria) seven were found resistance and Matti, Anaikomban, Erachi Vazhai and Kanai Bansi were found susceptable.

3. Screening of IMTP wilt accessions against Sigatoka leaf spot

IMTP on wilt was taken up in an infected farmer's field at Thottiam. The selected field was already a sick soil for wilt hence no artificial inoculation was done. Only Gross Michel (AAA) was infected with wilt. The Sigatoka leaf spot incidence was recorded at 7th month and 9th month after planting. Based on the 9th month observation on 20 IMTP Wilt accessions, FHIA-3, PA 03-22, PV 03-44, Cultivar Rose, Yangambi km5, and Pisang Lilin did not show Sigatoka leaf spot symptoms and were grouped as highly resistant.

4. Screening of exotic germplasm accessions against Sigatoka leaf spot

The exotic accessions were screened against Sigatoka leaf spot disease. The disease severity and the YLS were recorded at 6th month, at flowering and at harvest. Eight accessions viz., FHIA-3, PA 03-22, PV 03-44, Cultivar Rose, Yangambi km5, Pisang Jari Buaya, Calcutta IR 24 and Pisang Lilin did not show any symptoms. Pisang Ceylon and Pisang Nangka were less susceptible. The remaining accessions were rated as susceptible.

5. Disease development time (DDT)

The DDT was recorded in 17 promising accessions of NRCB along with some commercial cultivars. The accession Kachkel recorded the minimum (44.85 days) and Burro Cemsa the maximum (76.75 days). The DDT ranged from 52.25 to 69.44 days in the rest of the accessions.

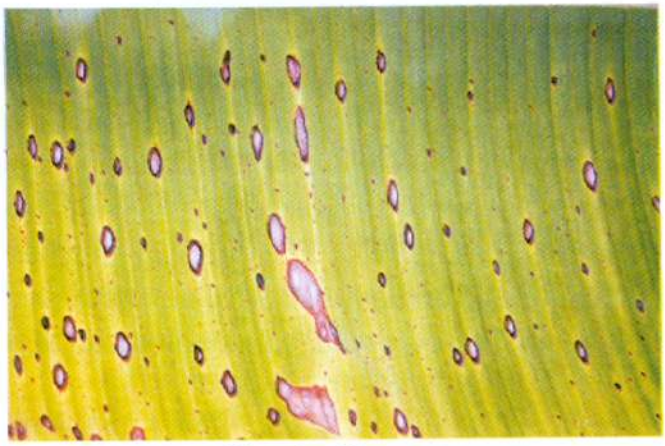


Plate 6a. Eye spot

Plate 6b. Eye spot on youngest leaf

6. Eye spot disease

Eye spot disease was noticed on cigar and youngest leaves (Plate 6a, b) during the month of February-March, 2001 in germplasm block and also in the diploid gene bank. The causal organism was isolated and identified as *Drechslera* Sp. Koch's postulate was established for the pathogens. This is to be the first report from India. The symptoms were more pronounced in diploids. Out of fifty-eight accessions, 49 had severe symptoms and only nine accessions were free from this disease. Among the twelve weed hosts, the spot was more on *Cynadon dactylon* and *Cyprus rotandus*.

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

1. Serodiagnosis of BBMV

Out of 300 accessions maintained in field gene bank, 25 accessions showed symptoms of BBMV. Serodiagnosis was done using antisera produced against BBMV by ELISA and DIBA (Enzyme linked immunosorbent Assay and Dot Immuno Binding Assay). All symptomatic samples showed positive reaction to ELISA but to DIBA only eight samples recorded positive reaction, indicating that ELISA is more sensitive than DIBA. In ELISA out of 18 samples tested, 6 were highly positive 7-showed

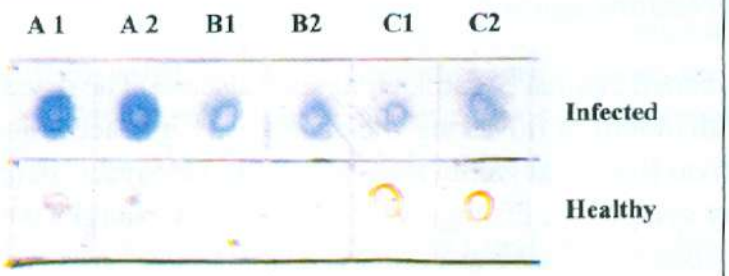


Plate 7. Detection of BBMV in Dot Immuno Binding Assay(DIBA)

A1,A2 : Midrib of first opened leaf
B1,B2 : Midrib of third leaf
C1,C2 : Midrib of seventh leaf

moderate and 5 were slight where as in DIBA, 6 samples showed slight reaction and two were doubtfully positive. Different parts of the plants were tested for BBMV in DIBA. Only midrib samples were positive and among the midrib of different ages, young leaves showed higher intense reaction than older leaf midribs. (plate 7)

Eighteen banana germplasm samples were tested against sugarcane mosaic virus antisera in DIBA and found that 9 samples reacted strongly, 9 showed moderate reaction while healthy and buffer controls were negative. Since the SCMV and BBMV belongs to POTY virus group, BBMV infected samples reacted to SCMV antisera.

2. Purification of BBMV

BBMV was partially purified as per Thomas *et al.* (1997), The partially purified preparation had the O.D 260 / 280 ratio 1.9, which indicated contamination of host proteins. Further purification and run in SDS gel electrophoresis showed a clear band with molecular weight of 37 KD.

3. Detection of Banana Streak Virus (BSV) using ELISA and DIBA

Twenty accessions in germplasm indicated BSV infection. Out of the 20 accessions, four showed severe symptoms, 12 were moderate and 4 showed slight symptoms. All the symptomatic accessions were tested serologically using the antisera of BSV (Supplied by B.E.L.Lochart). Direct Antigen Coating ELISA and DIBA techniques were employed. Irrespective of the symptom severity, all the samples were positive in DAC-ELISA and same results were obtained in DIBA also. In DIBA, the diluted samples reacted better than crude samples and in ELISA crude samples gave intense reaction than the diluted. The partially purified virus using PEG gave intense reaction in DIBA. SCMV antisera were also used for detection of BSV in DIBA. Similar results were obtained with BSV antisera also Pisang Ceylon; the cultivar received from INIBAP also gave positive reaction with both the viral antisera. Probably the virus may exist as an integrated form with the host genome. When western blot test was done for BSV, the result showed many bands indicating that the antiserum contains antibodies for host proteins too. It is understood that cross absorption with healthy samples is a pre requisite for detection.

Plate 8. BBMV - symptom on Red Banana

4. Survey for banana viruses

Survey was taken up in lower Pulney hills for the occurrence of BBMV and BSV. Five orchards at different elevations indicated 80 % of Red banana plants with severe symptoms of BBMV. The infected plants were unusually slender, the leaf sheath separated from the pseudostem, leaves had typical spindle shaped mosaic symptoms at higher elevations. The Red banana plants affected with BBMV had normal robust pseudostem, the leaves were intact and only the male bud and the fingers showed the mosaic symptoms at lower elevation. Leaf mosaic and pinkish streaks on pseudostem were also observed. Banana streak virus was recorded in cultivar Red Banana in hill regions. Infected plants had chlorotic and necrotic streaks on leaf lamina. Virupakshi banana was not affected with both the viruses. In Pulney hills, Banana Bract Mosaic virus was observed in cultivar Red banana. (plate 8)

5. Transmission and Host Range Studies

The banana aphid, *Pentolonia nigronervosa* and cotton aphid *Aphis gossipii* were tried for transmission of BBMV to *Nicotiana tobaccum* and to tissue cultured healthy banana plant. Inoculation access period of 5 and 10 minute feeding period was given. An hour of starvation was given before access period for quicker probes in the infected plant leaves. Even after two months, there was no symptom expression. The cucumber mosaic virus from Robusta banana was successfully sap transmitted into cowpea and out of 20 plants 5 showed typical symptoms of mosaic.

4. CROP PHYSIOLOGY AND BIOCHEMISTRY

I. Studies on physiology of flowering and fruit development in banana.

(R.H..Laxman and S.Sivashankar)

1. Studies on flowering behavior and its regulation in banana germplasm accessions

A study was taken up on six cultivars having different degrees of female and male phase viz., Pacha Bontha Batheesa, Zangiber, Pisang Seribu, Ayirankai Rasthali, Karthobium and Rasthali. There were highly significant differences among the cultivars for plant height, number of leaves and leaf area (Table 15). The highest plant height and girth were recorded in cultivar Ayirankai Rasthali followed by Pacha Bontha Bathesa and lowest was recorded in Rasthali. The leaf area was highest in Ayyarankai Rasthali followed by Pisang Seribu and the lowest was in Rasthali, while the number of leaves was highest in Rasthali followed by Pacha Bontha Bathesa and lowest was in Pisang Seribu. It was concluded that the photosynthetically active leaf area of the plant had an important role in deciding the duration and extent of female phase.

Table 15 : Growth parameters of six cultivars of banana

Cultivars	Plant height(cm)	Number of leaves	Leaf area (m^2)
Pacha Bontha Bathesa	180.43	23.53	5.79
Zangiber	168.10	20.70	4.84
Pisang Seribu	150.33	15.40	6.54
Ayirankai Rasthali	193.87	18.47	6.98
Karthobium	162.20	17.33	6.03
Rasthali	107.00	24.07	2.07
CD at 5%	30.59	4.17	2.13
CD at 1%	43.51	5.93	3.03

2. Studies on the role of temperature and leaf area on fruit development in banana.

The experiment was studied on eight commercial cultivars viz., Pachanadan, Poovan, Nendran, Robusta, Rasthali, Ney Poovan, Karpuravalli and Monthan to find the role of temperature and leaf area on fruit development. The highest plant height and girth were recorded in Pachanadan followed by Monthan and lowest was recorded in Rasthali. The number of leaves was highest in Ney Poovan followed by Pachanadan and lowest was in Robusta. The leaf area was highest in Pachanadan followed by Karpuravalli and the lowest was in Rasthali.

The diurnal variations in relation to gas exchange characteristics were also studied and found significant differences in photosynthesis rate, transpiration and stomatal conductance among the cultivars (Table 16).

Table 16 : Growth parameters of eight commercial cultivars at 7th month Stage

Cultivars	Plant height(cm)	Girth (cm)	Number of leaves	Leaf area (m^2)
Pachanadan	166.20	46.93	25.07	3.92
Poovan	155.00	42.50	22.33	3.33
Nendran	155.20	39.67	22.33	3.48
Robusta	114.00	36.13	21.20	2.11
Rasthali	107.00	35.93	24.07	2.07
Ney Poovan	148.33	40.93	25.87	2.36
Karpuravalli	160.33	46.87	24.97	3.53
Monthan	164. 33	45.93	24.40	2.89
CD at 5%	22.52	4.96	2.63	1.05
CD at 1%	31.25	6.89	NS	NS

Table 17 : The gas exchange characteristics at 5th and 7th month stages of banana

Cultivars	Transpiration Rate (m mol m^{-2} sec^{-1})	Stomatal Conductance (m mol m^{-2} sec^{-1})	Photosynthesis Rate (mol m^{-2} sec^{-1})	Transpiration Rate m mol m^{-2} sec^{-1})	Stomatal Conductance (m mol m^{-2} sec^{-1})
Pachanadan	5.87	510	20.37	3.29	180
Poovan	6.26	590	18.64	3.34	150
Nendran	6.18	450	14.83	3.67	150
Robusta	6.19	590	20.78	3.94	210
Rasthali	6.60	640	20.01	4.14	200
Ney Poovan	6.38	590	19.51	4.08	190
Karpuravalli	6.49	620	17.64	4.92	240
Monthan	6.52	650	20.57	5.29	240
CD at 5%	1.28	NS	100	1.81	0.57 35
CD at 1%	1.78	NS	NS	2.51	0.79 49

II. Biochemical and Physiological studies on maladies of unknown etiology (S.Sivashankar and R.H.Laxman)

Neer Vazhai affected suckers were planted along with healthy suckers of Nendran. Poovan and Rasthali suckers were also planted. The growth parameter leaves on development and leaf retention were monitored at monthly intervals from 5th month to the shooting stage. The days taken from the emergence of inflorescence upto harvesting of the bunch were recorded. Non-significant differences were recorded between healthy and Neer vazhai plants for the plant growth attributes (Table 18). In Neer vazhai plants, the fruit growth was severely affected (2-3 Kg/bunch) with hardly 2-3 fingers in the second hand at to full maturity while in the healthy plants, the bunch weight was 11.5 Kg/bunch. Application of STS (25 ppm), Ethrel (500ppm) and BA (25 ppm) to Neer vazhai plants at 5th and 7th month of growth corresponding with the initiation and differentiation of flower primordium did not produce any improvement in finger development. The chlorophyll content in leaves of healthy and neer vazhai affected plants showed significant differences wherein the healthy plants recorded lower values in comparison with the Neer vazhai affected plants (Table 19).

The flower bud tissue samples were collected at flower initiation stage (5th month) and differentiation stage (7th month) and stored at -20^0 C for analysis of endogenous cytokinin and auxin levels by immunoassay at the Dept. of Crop Physiology, UAS, Bangalore. The data on gas exchange characteristics showed that there were no significant differences between healthy and Neervazhai affected plants for photosynthesis rate, traspiration rate and stomatal conductance (Table 20).

Table 18 : Growth Parameters of Neer Vazhai affected and healthy plants of Nendran

Growth parameters	Plant height (cm)		Girth (cm)		No. of leaves		Leaf area	
	H	NV	H	NV	H	NV	H	NV
6th Month	81.68	81.36	26.32	27.39	13.39	13.50	2313.18	2280.07
7th Month	123.07	125.68	37.71	39.00	4.857	4.82	54987.22	55177.15
8th Month	191.786	192.321	53.71	54.43	4.86	4.75	117347.60	82210.36
9th Month	230.00	229.11	60.00	59.00	4.00	4.00	100028.30	132219.10
10th Month	264.64	266.25	66.11	66.50			126722.90	124419.50
11th Month	287.21	302.50	68.46	68.46	11.29	11.286	102212.60	103403.00

H- healthy; NV - Neer Vazhai affected

Table 19 : Leaf Chlorophyll concentration in Healthy and Neer vazhai affected plants

Nendran	Chlorophyll 'a'	Chlorophyll 'b'	Chlorophyll 'a+b'
Healthy			
H 11	25.0218	18.5691	43.5655
H 12	37.0135	38.194	75.4982
H 21	30.6562	23.8420	54.4982
H 22	29.1315	21.6236	50.7551
H 31	32.8924	24.0966	56.9342
H 32	55.9173	68.2398	124.0222
Neer vazhai			
N 11	56.9418	63.1018	119.8527
N 12	38.2187	25.0231	63.2418
N 22	34.9033	26.6242	61.5275
N 21	43.4064	38.6807	82.0879
N 31	38.9276	25.9280	64.8556
N 32	39.5780	28.1769	67.7549

Table 20 : The gas exchange characteristics in healthy and Neer Vazhai affected plants in Nendran at flowering stage

Treatment	Photosynthesis Rate (μ mol m^{-2} sec^{-1})	Transpiration Rate (m mol m^{-2} sec^{-1})	Stomatal Conductance (m mol m^{-2} sec^{-1})
Healthy	15.17	4.36	180
Neervazhai affecte	15.30	4.38	180

5. TECHNOLOGY ASSESSED AND TRANSFERRED

1. Technology of processing of banana products was transferred to the potential entrepreneur's sponsored by Districts industries Centre, Trichy during February to July 2000.

2. The banana seminar was organized in association with Trichy All India Radio farmers Association and Thottiyam banana growers association under the chairmanship of the Director on 28th January 2001. Scientists of the Centre spoke on different aspects of banana cultivation, plant protection, postharvest technology and tissue culture plantation. The doubts of the farmer's were clarified. An exhibition was arranged depicting various activities of the centre, symptoms and control measures for various pests and diseases of banana and also on the various value added products.

6. EDUCATION AND TRAINING

NRCB is actively involved in educating the local farming community at institute and also at farmer's fields.

The Centre also conducted one day education programme on banana cultivation was organised for two batches of the post Graduate/ Graduate students of Tamil Nadu Agricultural University.

Dr.Ahmed Mostafa Abd EL. Kadder, Horticultural Research Institute (ARC), Egypt, attended the Training Programme on "Studies on Banana Improvement" from 22.8.2000 - 26.8.2000 at NRCB, Trichy.

7. AWARDS / RECOGNITION

'Banana Research cum Extension Award' in the field of Research and Development for the year 2001 was awarded to Dr..M.M.Mustaffa, Dr.P.Sundararaju, Dr. B.Padmanaban Dr. C.K.Narayana, Dr. S.Uma and Dr. R.Selvarajan by the Trichy All India Radio farmers' Association and Thottiyam Banana Growers Association.

Dr.P.Sundararaju conferred the Fellow of Indian Society for Plantation Crops (FISPC) at the annual general body meeting of the society held in December 2000.

NRCB participated in All India Banana Show Organized by Ministry of Agriculture and Cooperation, Government of India, during 22-24th September, 2000 at Jalgaon, Maharashtra and won four first prizes and three-second prizes for value added products from banana developed at the Centre. The award contain seven cups and certificates of Merit for the Centre.

i)	Banana Juice (RTS)	-	First Prize
ii)	Banana dehydrated	-	First Prize
iii)	Banana chips	-	First Prize
iv)	Banana health drink	-	First Prize
v)	Banana Powder	-	Second Prize
vi)	Banana Biscuit	-	Second Prize
vii)	Banana Baby Food	-	Second Prize

International

NRCB won an International Award for the exhibit from India ' Pictures drawn with Banana pseudostem powder' under the Non-Edible Banana Products at the International Banana Competition held at Bangkok, Thailand on 6th November 2000.

Recognition of Dr. S.Sathiamoorthy, Director as Co - Convenor for the Crop Improvement group (Conventional breeding) in the Promusa meeting held at Bangkok, Thailand from 6th - 8th November 2000.

Dr.S.Uma and Dr.R.Selvarajan, have been recognized as the members of Crop improvement - working group and Sigatoka working group respectively under International PROMUSA Meeting.

8. LINKAGES AND COLLABORATION IN INDIA AND ABROAD

As part of the collaboration developed between NRCB and NRC for DNA Finger Printing, NBPGR campus, New Delhi, 259 accessions both wild and indigenous were supplied for molecular characterization.

NRCB has developed collaboration with IAEA, Vienna, Austria for studying ploidy status of selected *Musa* germplasm at NRCB using flow cytometry.

NRCB has collaboration with Prof. Udaya Kumar, Department of Crop Physiology, UAS, Bangalore, for the assay of growth regulators in banana flower buds.

9. LIST OF PUBLICATIONS

Papers Published in Journals

Jeyabaskaran, K.J. and Sundararaju, P.2000. Identification and evaluation of salt tolerance mechanism in some commercial varieties of banana. *Indian Journal of Plant Physiology*, 5(3): 290 - 292

Jeyabaskaran, K.J. 2000.Studies on fixing critical limits of K, Na and K/Na ratio for banana and soil in saline sodic conditions. *InfoMusa*, p.34

Laxman, R.H. and Srivastava,G.C. 2000. Photosynthetic and respiratory activity in sunflower (*Helianthus annus* L.) bracts. *Indian Journal of plant physiology,* 5(1) : 101 - 104

Laxman, R.H. and Srivastava,G.C. 2000. Photosynthetic characteristics of sunflower (*Helianthus annus* L.) leaves and bracts. *Indian Journal of plant physiology,* 5(2) : 150 - 153

Neelima Garg., Singh B.P. and Narayana, C.K. 2000. Effect of modified atmosphere on aerobic mesophilic and psychrophilic microflora of mango fruits. *Indian Food Packer*, September-October, 2000. 75-77.

Padmanaban, B., Thangavelu,R. and Sundararaju,P. 2000. Occurrence of Giant African snail, *Achatina fulica Boa.* on Banana. *Indian J.Entomology,* 62(1): 95-97.

Padmanaban, B., Sundararaju, P. and Sathiamoorthy,S. 2001. Incidence of banana pseudostem borer, *O.longicollis* in banana peduncle. *Indian J.Entomology,* 63(2) :

Rajagopal,V., Naraeshkumar,S., Kasturi Bai, K.V. and Laxman, R.H. 2000. Daytime fluctuations in photosynthetic parameters and water relations in juvenile coconut palms grown under rained and irrigated conditions. *Journal of plant Biology,* 27 (1) : 27 - 32.

Shivashankar.S 2000. Effect of ascorbic acid and calcium chloride on the chilling injury of banana. *Journal of Tropical Agriculture,* 38: 56-60.

Sripriya.C., Padmanaban, B. and Uma.S. 2000. Evaluation of banana (*Musa spp*) germplasm against insect pests. *Indian J. Entomology,* 62(4) : 382-390.

Uma, S., Singh. H.P., Dayarani M. and Shyam, B. 2000. Variety evaluation for response to edaphic factors on yield and physico-chemical characterisation of commercial banana cultivars. *Indian Journal of Horticulture*, 56(1-4): 104-08.

Uma, S., Dayarani, M., Singh, H.P., Shyam, B. and Sathiamoorthy, S. 2000. Studies on Genetic Variability in Banana - Silk subgroup (AAB). *Indian Journal of Horticulture*, 57(2):106-109.

Uma..S., Selvarajan, R., Sathiamoorthy, S., Rameshkumar, A. and Shyam, B. 2001 Banana diversity in North Eastern India, Genetic erosions and solutions. *In the proceedings of the National Symposium on Biodiversity vis –a –vis Resource Exploitation - an Introspection.*Held at CARI, Port Blair on 23-24th, April, 2001.

Uma,S., Sathiamoorthy,S., Shyam,B. and Selvarajan,R. 2000. Role of Mizotribal Women in Eco-conservation of fibre yielding wild banana (*Musa* sp.) in Mizoram. *In the proceedings of 88th Indian National Science Congress part -IV* held at New Delhi from January 3- 7, 2001. Pp 408-409

Books/Chapter In Books

Padmanaban,B., Sundararaju,P. and Sathiamoorthy,S. 2001. Review on natural enemies of banana rhizome weevil, *Cosmopodites sordidus* (Germar) (Curculionidae: Coleoptera) and study their potential in the management of the pest. In Innovative pest and disease management in horticultural and plantation crops. (Eds.) S.Narasimhan, G,Suresh and S.D.Wesly. pp 166 - 175, Allied Publishers Ltd., Chennai.

Padmanaban,B., Sundararaju,P. and Narasimhan,S. 2001. Pheromone studies of banana rhizome weevil, *C.sordidus* G. (Curculionidae: Coleoptera) for the management pest - a review, pp41 - 45 ibid.

Sundararaju,P. 2001. Biocontrol of plant parasitic nematodes in Banana. In Innovative pest and disease management in horticultural and plantation crops, Allied Publishers Ltd., Chennai. pp 58-60.

Sundararaju,P. 2001. Biocontrol agents of plant parasitic nematodes in banana. In: Innovative and disease management in Horticultural and plantation crops. (Eds S. Narasimhan *et.al.* 2000. Allied publishers Ltd. Chennai. pp. 93-95.

Popular Articles

Jeyabaskaran,K.J. and Sundararaju,P. 2000. Importance of boran and copper in banana. (in Tamil) *Valarum Velanmai*, 2: 20

Padmanaban,B. 2001. Banana stem weevil- a new threat to bananas and plantains. In: Banana new technologies, published by Trichy Radio farmers association and Thottiyam banana growers association , Trichy pp. 6 -9. (In Tamil)

Sathiamoorthy,S., Uma..S, Selvarajan,R. and Ramesh Kumar, A. 2001 Thissu vazharppu vazhai- Oor kannottam (Tissue culture Banana: An overview)In: Vazhayil puthia thozhilnutpangal souvenir released on the occasion of seminar held at Trichy on 28th January 2001organised by All India Radio Farmer's Association and Thottiam Banana Growers Association. pp3-5.

Selvarajan,R, and Sathiamoorthy,S. 2001 Vazhaiyai thakkum puthia noigal (New diseases in Banana) In: Vazhayil puthia thozhilnutpangal souvenir released on the occasion of seminar held at Trichy on 28th January 2001organised by All India Radio Farmer's Association and Thottiam Banana Growers Association. pp10-15.

Selvarajan,R and Sathiamoorthy,S. 2001. 'Vazhayil ilai pulli noi kattupadum Uyar vilaichalum'. In Novartis Vazhai sirappu Seithi Madal pp2-8

Reports / Review Articles

Narayana, C.K. 'Scope for banana based Agro industries in Tiruchirapalli' – a report submitted to Shri. P.R. Kumaramangalam, Hon'ble Minister for Power. Govt. of India.

Narayana, C.K. Self employment for self-help group of Trichy district- Banana based value added products', report submitted to Collector of Trichy.

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), pp113-128.

Technical Bulletin

S.Sathiamoorthy, S.Uma, R.Selvarajan, B.Shyam and H.P.Singh, 2000. Multiplication of Virus free plants through shoot tip culture. Technical Bulletin No.3, NRC for Banana (ICAR), Tiruchirapalli, pp 42

Papers presented in Seminar/Workshop/Symposium

Mustaffa, M..M. 2000. Influence of different plant populations on fruit and quality parameters of Ney Poovan banana. Paper presented in the National seminar on "Hitech Horticulture" at Bangalore during 26 - 28th June 2000.

Mustaffa, M.M. and Sathiamoorthy,S. 2000. Banana Production in Tamil Nadu - Problems and Perspective. All India Banana Show and Seminar, Jalgaon, 22-24 Sept., 2000.

Mustaffa, M.M and Sathiamoorthy,S. 2001. Organic Farming in Banana (In Tamil). Banana Seminar organised by All India Radio Farmers' Association - Thottiayam Banana Growers Association at Trichy during 28.1.2001

Mustaffa, M.M. and Sathiamoorthy,S. 2001. Organic farming in banana. Souvenir - 22nd Flower, Vegetable and Fruit Show, Pondicherry, 9-11 Feb., 2001

Nahif, A.A., Padmanaban, B. and Sundararaju, P. 2000. Ultrastructure of the banana pseudostem borer, *Odoiporus longicollis*. Poster presented at the Entomocongress 2000

(International Conference) held during 5-8 November, 2000, organised by the Univesity of Kerala, Thiruvananthapuram, (Abstract P.125).

Narayana, C.K. 2000. Use of Ethrel and smoking for ripening of banana: a comparative study. Paper presented in 'National Seminar on Recent Advances in Plant Biology', held at CPCRI, Kasargod during 3 - 5 February 2000.

Narayana, C.K. 2000. Effect of maturity on shelf life, ripening and quality of banana. Paper presented in 'National Seminar on Recent Advances in Plant Biology', held at CPCRI, Kasargod during 3 - 5 February, 2000.

Narayana, C.K., Pandey, S.D., Mustaffa M.M. and Sathiamoorthy,S. 2000. Post-harvest handling, storage and value addition of banana. Paper presented in The National Seminar – "Fruit Development in U.P" Prospect – 2010, organised by Department of Horticulture and Processing, Lucknow during 3 - 4 July, 2000

Narayana, C.K., Mustaffa, M.M. and Sathiamoorthy,S. 2000. Postharvest losses and value addition in banana: Present status and Future Prospects. A paper presented in "All India Banana Show and Seminar", held at Jain hills, Jalgaon, Maharashtra, during 23-24 September, 2000.

Narayana, C.K. and Singh, B.P. 2000. Effect of ameliorative treatments on reduction of chilling injury in guava. Paper presented in National seminar on "Hitec Horticulture", held at Hotel Atria, Bangalore during 26 -28 June 2000.

Narayana, C.K., Sathiamoorthy,S., Mustaffa, M..M. and Evelin Mary, A. 2001. Value added Products from banana. Paper presented in a "Seminar on Banana Production Technology", jointly organized by Thiruchirapalli Radio Farmers Association and Thottiyam Banana Growers Association on 28th January 2001 at St.Joseph College,Thiruchirapalli.

Padmanaban, B. 2000. Survey for natural enemies of banana rhizome borer, *Cosmopolites sordidus* G. and study their potential in the management of the pest, organised by SPIC Science Foundation, Chennai in March 2000.

Padmanaban, B. 2001. Banana stem weevil on banana production technology jointly organised by Trichy Radio farmers association and Thottiyam banana growers association at Trichy on 28.01.2001

Pandey,S.D., Mustaffa,M.M., Jeyabaskaran,K.J. and Narayana,C.K. 2000. Banana production in India – An overview. Paper presented in The National Seminar – "Fruit Development in U.P" Prospect – 2010, Organised by Department of Horticulture and Processing, Lucknow during 3 - 4 July, 2000.

Pandey,S.D., Laxman, R.H., Jeyabaskaran,K.J. and Sathiamoorthy, S. 2000. Water requirement of banana. Paper presented in The National Seminar – "Fruit Development in U.P" Prospect – 2010, Organised by Department of Horticulture and Processing, Lucknow during 3 - 4 July, 2000.

Pandey, S.D., Laxman, R.H., Jeyabaskaran, K.J. and Santhi,V.P. 2000. Effect of different moisture regimes and N fertigation on growth and yield of banana cv. Poovan. Paper presented in The National Seminar on Hi-tech Horticulture held at Bangalore during 26-28 June, 2000.

Sathiamoorthy,S., Uma, S. and Selvarajan, R. 2000. Banana Research and Development Programme in India. Paper presented in Regional Advisory Committee Meeting ASPNET/ INIBAP held at Bangkok during 9-11, November, 2000.

Sathiamoorthy,S., Uma,S., ValsalaKumari, P.K., Soorianatha Sundaram,K., Kumar,N., Selvarajan, R. and Rema Menon, 2000. Banana Improvement Programme in India. Paper presented in PROMUSA meeting held at Bangkok during 6-8 November, 2000.

Sathiamoorthy, S., Selvarajan, R. and Uma, S. 2000. Status of Bananas and Plantains in Tamil Nadu. Paper presented in International Seminar on AGRIINDEX held at Coimbatore during 29th August to 3rd September, 2000.

Sathiamoorthy,S., Uma, S. and Ramesh Kumar, A. 2001. Tissue Culture Banana - A Glance (In Tamil). Banana Seminar organised by All India Radio Farmers' Association - Thottiayam Banana Growers Association at Trichy on 28.1.2001

Sathiamoorthy,S., Mustaffa, M.M. and Ramesh Kumar, A. 2001. Banana Export (In Tamil). Banana Seminar organised by All India Radio Farmers' Association - Thottiayam Banana Growers Association at Trichy on 28.1.2001

Sathiamoorthy, S. and Mustaffa, M.M. 2001. Improved high density planting system for Bananas. Souvenir - 22nd Flower, Vegetable and Fruit Show, Pondicherry, 9-11 February 2001.

Sathiamoorthy,S., C.K.Narayana and Evelin Mary, A. 2001. Post harvest management and value addition in banana. Souvenir - 22nd Flower, Vegetable and Fruit Show, Pondicherry, 9-11 February, 2001.

Selvarajan, R., Uma, S., Sathiamoorthy, S. and Molina, A.B. 2000. Etiology and Survey of Banana leaf spot diseases in India. Paper presented in PROMUSA meeting held at Bangkok from 6-8, November, 2000

Selvarajan, R. and Sathiamoorthy.S. 2000 Influence of temperature and rainfall on symptom expression of banana streak virus in cultivar Poovan. In symposium on "Emerging trends in plant disease management" Organised by IPS, Southern zone on 7-8th Dec.2000 (Abstract)

Selvarajan, R., Jeyabhaskaran, K.J. and Sathiamoorthy, S. 2000. Yield loss assessment and management strategies for banana bract mosaic virus infecting cultivars Nendran, Ibid.

Selvarajan, R. and Sathiamoorthy, S. 2000. Chemical control of Sigatoka and Septoria leaf spot diseases using Tilt (Propiconazole) and Anvil (Hexaconazole). Ibid

Selvarajan, R., Sathiamoorthy, S. and Uma, S. 2000. Occurrence of new leaf spot diseases in bananas and plantains in India. Ibid.

Shyam,B., Uma, S., Dayarani, M., Sathiamoorthy ,S. and Singh, H.P. 2000. Molecular Characterisation of Banana using Isozymes. **In** the proceedings of National Seminar on Hi-Tech Horticulture held at Bangalore, June 26-28, 2000.

Shyam,B., Uma,S., Dayarani,M., Singh,H.P. and Sathiamoorthy,S.2000. Evolutionary Divergence analysis in Banana. Approaches through numerical taxonomy. Ibid

Shyam, B., Uma,S., Dayarani,M., Singh,H.P. and Sathiamoorthy,S. 2000. Embryo germination and regeneration in-vitro in *Musa* genomes. Ibid

Sundararaju,P. and Padmanaban,B. 2000. Effect of soil types on multiplication of *Pratylenchus coffeae* and growth of banana seedling var. Nendran. Abs. 'National symposium on integrated nematode management for sustainable agriculture' at OUAT, Bhubaneshwar on 23 - 24 November, 2000.

Sundararaju, P. and Kumar, V. 2000. Effect of organics and inorganics on population build up of root-lesion nematode, *Pratylenchus coffeae* on six banana cultivars. Ibid p-14.

Sundararaju,P, 2001, Banana nematodes and their management by using non-chemical methods, seminar on Production technology jointly organised by All India Radio, Trichy Farmers Association and Thottiyam Banana Growers Association at Trichy on 28.01.2001

Uma, S., Dayarani, M., Shyam,B., Singh, H.P. and Sathiamoorthy, S. 2000. Proliferation and Regeneration in Silk cv. Rasthali (AAB). **In** the proceedings of National Seminar on Hi-Tech Horticulture held at Bangalore, June 26-28, 2000.

Uma, S., Dayarani, M., Shyam,B., Sathiamoorthy, S. and Singh,H.P. 2000. Microbicidal studies for banana explant decontamination. **In** the proceedings of National Seminar on Hi-Tech Horticulture held at Bangalore, June 26-28, 2000.

Uma, S., Dayarani, M., Shyam,B., Selvarajan,R.Sathiamoorthy, S. and Singh,H.P 2000. Ecodistribution and Co-existance studies in the genera - *Musa*. **In** the proceedings of National Seminar on Hi-Tech Horticulture held at Bangalore, June 26-28, 2000.

10. LIST OF APPROVED ON-GOING PROJECTS

I. CROP IMPROVEMENT

Management of genetic resources in banana
S.Uma and S.Sathiamoorthy

Crop improvement through conventional breeding of banana germplasm
S.Sathiamoorthy and S.Uma

II. CROP PRODUCTION AND POST HARVEST TECHNOLOGY

Standardisation of Agrotechniques for banana production and productivity
S.D.Pandey and M.M.Mustaffa

Studies on amendment and reclamation of saline sodic soil for banana
K.J.Jeyabaskaran and S.D.Pandey

Studies on organic farming in banana
K.J.Jeyabaskaran and S.D.Pandey

Studies on handling, storage and processing of banana
C.K.Narayana and M.M.Mustaffa

III. CROP PROTECTION

Insect pest management in banana
B.Padmanaban and P. Sundararaju

Studies on banana nematodes and their management
P.Sundararaju and B.Padmanaban

Studies on fungal and bacterial diseases and their management
R. Selvarajan

Bio-control of fusarium wilt of banana and nematodes
R. Selvarajan and P.Sundararaju

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

1V. CROP PHYSIOLOGY AND BIOCHEMISTRY

Studies on flowering behaviour and its regulation in Banana
R.H.Laxman and S.Shivashankar

Biochemical and physiological studies on maladies of unknown etiology
S.Shivashankar and R.H.Laxman

11.CONSULTANCY, PATENTS, COMMERCIALISATION OF TECHNOLOGY

Consultancy:

Evaluation of Propiconazole and Hexaconazole against Sigatoka leaf spot disease of Banana and Plantains

Based on the results of the experiments conducted in two seasons (1999-2001),spraying of Propiconazole(Tilt) 0.15 % was found to reduce the Sigatoka leaf spot incidence and increase the yield significantly. The cost benefit ratio was found higher compared to control in two consecutive seasons for all the three varieties tested.

Experiments conducted during 1999-2001 evaluation of Anvil against Sigatoka leaf spot disease of Banana and Plantains, indicated that the spraying of Anvil (Hexaconazole) 0.15 % found to reduce the Sigatoka leaf spot incidence and increased the yield significantly. The cost benefit ratio was high for all the varieties tested.

Three to four sprays of Anvil/ Tilt 0.15% at 15 to 21 days intervals starting from the appearance of initial symptom (light yellow specks or reddish brown streaks in lower leaves) using power sprayer for first spray and rocker sprayer for the remaining sprays. The sticking agent such as teepol or soap solution or Sandovit must be used with spraying solution. While spraying the lower side of leaves and the cigar leaf should be covered. If favorable weather conditions such as intermittent rains, high relative humidity and dew formation on leaf were prevailing the disease spread would be faster. In such conditions, sprays should be taken up once in 15 days otherwise the duration can be increased between sprays.

12. RAC, MANAGEMENT COMMITTEE, SRC, ORT MEETINGS

Fourth Research Advisory Committee Meeting

The Fourth Research Advisory Committee (RAC) meeting was held at the NRCB Conference Hall on 21.9.2000. Professor R. Yamdagni, Chairman, RAC, chaired the session and conducted the proceedings. Dr. S. Sathiamoorthy, Director, NRCB, welcomed the Chairman and other RAC members, and briefed about the research achievements of NRCB. RAC members clarified points with the concerned Scientists. Dr. P. Sundararaju, Member

Secretary, RAC presented the Action Taken Report on last RAC proceedings and Dr. M.M. Mustaffa, Member Secretary, SRC presented the Action Taken Report of fourth Staff Research Council meeting . After detailed discussion, the action taken report of RAC was approved. The RAC members suggested further programmes to be taken up in various areas of research in banana. The RAC Chairman in his concluding remarks appreciated the Director and his team of Scientists of NRCB for effectively conducting the research programs on banana.

Dr. D.S. Rathore A.D.G. (Hort), ICAR, releasing the NRCB - News letter

Prof. R.Yamudagni Vice-chancellor NADAT-Fiazabad, U.P.	-	Chairman
Dr.D.S.Rathore Asst.Director General(Hort), Indian Council of Agrl.Research Krishi Bhawan, New Delhi	-	Member
Dr.S.K.Gupta Prof. of Soil Science&Agril. Chemistry Calcutta University, Calcutta.	-	Member
Dr.S.K.Roy Emeritus Professor (Hort) Indian Agricultural Research Institute New Delhi.	-	Member
Dr. N.K.Mohan Chief Scientist Assam Agricultural University, Guwahati.	-	Member
Dr.S.Sathiamoorthy Director NRC for Banana, Trichy.	-	Member

Dr.P.Sundararaju, Senior Scientist, NRC for Banana, Trichy.	-	Member Secretary
Dr. M.M.Mustaffa Principal Scientist NRC for Banana, Trichy.	-	Special Invitee
Dr. R.Selvarajan Scientist, NRC for Banana, Trichy.	-	Special Invitee

STAFF RESEARCH COUNCIL MEETING

The Fifth SRC meeting of the Research Centre was held on 24th February 2001 under the Chairmanship of Director, NRCB and the progress of the ongoing projects was discussed. All Scientists attended the meeting. The Scientists presented the progress achieved during the year in respect of the research projects and also the salient achievement of the externally funded projects.

13. PARTICIPATION IN SEMINAR/ SYMPOSIA/ CONFERENCE/WORKSHOP

Mustaffa, M.M., Jeyabaskaran, K.J., Narayana, C.K. and Uma,S. Participated in the National Seminar on Hi-tech Horticulture held at Bangalore 26 – 28th June 2000

Narayana,C.K. attended the "All India Banana Show and Seminar", held at Jain hills, Jalgaon, Maharashtra, between 23-24th September 2000 organized by Ministry of Agriculture and Cooperation, Government of India

Narayana,C.K. Participated in "XXII Flower, Vegetable and Fruit Show and Seminar", organized by Govt. of Pondichery at Botanical Gardens, Pondichery from 9-11 February 2001

Sathiamoorthy,S., Mustaffa,M.M., Sundararaju,P., Padmanaban,B., Narayana,C.K., Uma,S. and Selvarajan, R., Participated in "Seminar on Banana Production Technology", jointly organized by Thiruchirapalli Radio Farmers Association and Thottiyam Banana Growers Association on 28th January 2001 at St.Joseph College, Trichy.

Padmanaban.B. 2000. Ultrastructure of the banana pseudostem borer at the Entomo congress 2000 (International meet) held during 5-8 November, 2000, organised by the Univ. of Kerala, Thiruvananthapuram

Meetings attended

Dr.M.M.Mustaffa, Principal Scientist and Dr.P. Sundararaju, Senior Scientist attended the Banana farmers meeting at Solar village near Erode organised by E.I.D.Parry Ltd., on 9.6.2000. Gave a talk on " Integrated nutrient management on Banana" and Integrated pest management.

Dr.S.Uma, Scientist (SS), attended the zonal technical co-ordination committee meeting of NATP (PB) held at NBPGR Regional station, Thrissur, 9.06.2000.

Dr.S.Uma, Scientist (SS) Attended the training for NATP co-operators and group meeting of CCPI's along with technical co-ordination committee meeting from7-9th June 2000

Dr.S.D.Pandey, Senior Scientist, attended group meeting of Drip Net work at IIHR, Bangalore from 24-26 August 2000.

Dr.M.M.Mustaffa, Principal Scientist, attended a meeting, organized by Jalgoan Department of Agricultural Extension, Department of Directorate of Horticulture, Maharashtra at Jalgoan, Maharashtra on 25.08.2000.

Dr.M.M.Mustaffa, Principal Scientist, attended the "Awareness programme of Banana " held at Agricultural and Processed Food Products Export Development Authority (APFEDA), Rajahmundry, Andhra Pradesh, from 27.08.00 - 29.08.00.

Dr.M.M.Mustaffa, Dr.P.Sundararaju,, Dr.B.Padmanaban and Dr.R.Selvarajan attended the seminar on banana production technology at Poolambady on 3.3.2001 organised by Ayyan Thiruvalluvar Uzhavar Mandram, Poolambady, and IOB, Poolambady and delivered a talks on various improved production and protection technology of banana cultivation.

International

Dr S.Sathiamoorthy, Dr.S.Uma, and Dr.R.Selvarajan, participated in the PROMUSA - A global meet of banana researchers held on 6-9 November 2000, at Bangkok, Thailand.

Human Resources Development :

Training attended

Dr.K.J. Jeyabaskaran, Attended "Tenth Winter School on Remote Sensing in Agriculture with Special Emphasis on Crop Weather Relations", sponsored by ISRO, Dept. of Space, Govt. of India and organised by Division of Agrl. Physics, IARI, New Delhi from Nov.13 to Dec.8, 2000.

Dr. B. Padmanaban, Participated in the summer school on environmental impact of pesticides in the agro ecosystems - assessment and abatement, organised by ICAR held at the Dept. of Agril. Entomology, TNAU, Coimbatore from May 3 - 23, 2000.

Dr. P.Sundararaju, Dr.C.K.Narayana and Dr. B.Padmanaban awarded Certificate in Computing (CIC) by Indira Gandhi National Open University (IGNOU), New Delhi

Mr. P.Ravichamy was deputed for computer training on Desk Top Publishing (DTP) at ECIL - BDPS, Computer Education Centre, Trichy.

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

Radio Talks

Dr. M. M. Mustaffa, Principal Scientist, gave a radio talk on "Integrated nutrient management on banana" at 27.6.2000, AIR, Trichy.

Dr.S.Uma, Scientist (SS), gave a radio talk on 'Banana tissue culture' on 27.6.2000 in Tamil.

Dr.R.Selvarajan, Scientist, "Vazhayil ilai pulli noikalum kattupaduthum muraikalum" broadcasted in the month of September 2000 from AIR Trichy.

15. DISTINGUISHED VISITORS

Sl.No	Name &Designation	Institute	Date of Visit
1.	Dr. Jean Carliear	INIBAP, France	23.8.2000
2.	Dr.Nick Maselek	MARDI, Malaysia	24.8.2000
3.	Dr.J.S.Yadav Deputy Director & Head	Organic Chemistry Division-II Indian Indian Institute of Chemical Technology, Hyderabad..	31.8.2000
4.	Prof. R.Yamudagni, Vice-Chancellor	NADAT-Fiazabad, U.P	21.9.2000
5.	Dr.D.S.Rathore, Asst.Director General(Hort)	Indian Council of Agricultural Research, Krishi Bhawan, New Delhi	21.9.2000
6.	Dr.S.K.Gupta, Prof. of Soil Science &Agril. Chemistry	Calcutta University, Calcutta	21.9.2000

7.	Dr.S.K.Roy Emeritus Prof. (Hort)	IARI, New Delhi	21..9.2000
8.	Dr. N.K.Mohan, Chief Scientist	HRS, AAU, Guwahati	21..9..2000
9.	Dr. Jean Vincent Escalant, Genetic Resource Scientist	INIBAP, France	11.10.2000
10.	Dr. Michael Pillay	Institute of Tropical Agriculture, Nigeria	15.11.2000
11.	Shri. Surjit.K.Chowdhry, Commissioner (Hort.)	Government of Tamil Nadu, Chennai	3.2.2001
12.	Dr.K.V.Raghavan, Director.	Indian Institute of Chemical Technology (CSIR), Hyderabad	22.3.2001

16. PERSONNEL

Appointments

Shri P. Ravichamy was appointed as T-3 Technical Assistant (Journalism) w.e.f. 01.05.2000.

Smt. Anitha Shree was appointed as T-3 Technical Assistant (Lab) w.e.f. 12.05.2000.

Resignation

Mr.B.Shyam, Scientist, resigned on 2.08.2000 to join Indian Foreign Science.

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 (Nematology)
Dr.S.Shivashankar, M.Sc., Ph.D.	Senior Scientist (Biochem.)
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)
Dr.R.H.Laxman, M.Sc., (Ag.), Ph.D.	Scientist (Pl.Physiol.)
Dr.R.Selvarajan, M.Sc., (Ag.), Ph.D.	Scientist (Pl.Path.)

Dr.K.J.Jeyabaskaran, M.Sc., (Ag.), Ph.D.	Scientist (Soil Science)
Mr.V.Kumar, M.Sc., (Hort),	Scientist (Hort) On study leave.
Mr.R.Thangavelu, M.Sc., (Ag.)	Scientist (Pl.Path) on study leave.
Mr.B.Shyam, M.Sc., (Ag.)	Scientist (BioTechnology) (till 02.08.2000)

TECHNICAL

Mr.RaghuRaman	T5 - Junior Garden Superintendent

ADMINISTRATION

Mr. B.Vijayakumar	Assistant Administrative Officer

AUDIT & ACCOUNTS

Mr.C.S.Stephen	Assistant Finance and Accounts Officer

17. ANY OTHER RELEVANT INFORMATION SUCH AS SPECIAL INFRASTRUCTURAL DEVELOPMENT

NRCB Foundation Day

Annual day of the Recreation club of NRCB was celebrated at NRCB Farm, Podhavur on 21.8.2000. Dr. Jayanth Murali, Superintendent of Police, Trichy was the Chief guest and Dr. D.S. Rathore, A.D.G (Horticulture), ICAR, presided over the function. The staff and members of their family participated in different cultural programmes. The Chief guest distributed prizes to the winners of various sports events and Dr. D.S. Rathore gave away the prizes to the winners of the cultural events.

18. SUMMARY IN HINDI

सारांश

फसल सुधार

मिजोराम, त्रिपुरा एवं आसाम के निचले क्षेत्रों में किये गए सर्वेक्षण में 11 जंगली अक्युमिनेटा डिपलाईड और एक बलबिसियान डिपलाईड पाया गया। मिज़ोराम से पहली बार एनसिटे गुलुवकम का संग्रह किया गया। पूर्वोत्तर प्रदेशों से प्रथम बार एक सहज टेट्राफ्लाईड का भी संग्रह किया गया। किए गए संग्रह से 200 किस्मों को NRC for DNA finger Printing, New Delhi को कणत्व गुण दोष निर्धारण हेतु प्रतिपूर्ती किया गया।

तीन विभिन्न केन्द्रों से मिले NRCB Selections की मूल्यान्कन रिपोर्ट का भी संकलन किया गया। MGIS के अन्तर्गत INIBAP France को 290 किसमों के बारे में विवरण भेजा गया। मोनदन, बुलगो बांगरियर, मैसूर एवं अन्य वर्ग की कई किसमों को निश्चित गुणों के लिए मूल्यांकन किया गया।

फसल उत्पादन एवं तुड़ाई उपरांत संभलाप एवं प्रसंरकरज

नेन्द्रन किस्म केले में विभिन्न आर्द्रता स्तर एवं नत्रजन फरटिगेशन का विशिष्ट प्रभाव देखा गया इस में साधारण एवं पेयरड रो की शैली में पौधा लगाने का प्रभाव मुख्य रूप से पौधे की ऊँचाई एवं पत्तों के क्षेत्रफल पर दिखाई दिया। अधिक मात्रा की आर्द्रता और फरटिगेशन के कारण फूल के निकलने के समय में कमी पाई गई। 100% आर्द्रता स्तर एवं फरटिगेशन से 217.75 दिन में ही फूल निकल आया। साधारण रूप से पौधे लगाकर 100% आर्द्रता एवं नत्रजन स्तर कायम करने पर अधिकतम गुच्छे का वजन (9.82 कि.ग्रा.) पाया गया।

विभिन्नि तरह की जैविक खादों में मुर्गी की खाद सबसे उत्तम पायी गयी। 15 कि.ग्रा. मुर्गी की खाद या धान भूसा भस्म प्रति पैधे के हिसाब से डालने से 20% एन.पी.के. की बचत हुई एवं 18.5% अधिक पैदावार पूवन केले में पायी गयी। 0.5 कि.ग्रा. सिमेंट कारखाने की धूल प्रति पौधे में लगाने से करपूरवल्ली केले में अधिक वानस्पतिक वृद्धि पायी गयी। 0.5 कि.ग्रा. सिमंट कारखाने की धूल के प्रयोग से मिट्टी में सही रासायनिक संतुलन पाया गया। मिट्टी में पोटाशियम की शक्य बफरिंग क्षमता, कन्ट्रोल में 35.23, 0.5 कि,ग्रा. सिमेंट कारखानें की थूल में 37.45 एवं 1.0 कि.ग्रा. सिमेंट कारखानों की धूल में 38.98 (molkg-1(M/l)^{½} पायी गयी।

रस्थाली, नेपूवन एवं रोबस्टा किस्मों के केले में 4% कैलसियम क्लोराइड के तुडाई उपरांत उपचार से उसकी भंडारण क्षमता 1-2 दिन बढ़ी, कैलसियम क्लोराइड की मात्रा बढ़ाने पर कोई विशेष प्रभाव नहीं देखा गया। सिट्रिक अम्ल (200 पी पी एम) एवं प्रोपाइलिन ग्लाइकोल (1000 पी पी एम) जैसे एन्टीआकसिडेंट के प्रयोग से केले की चिप्स में एसिड वाल्यू और पेराकसाइड वाल्यू की वृद्धि पर नियन्त्रण पाया गया।

400 गेज़ पालीथीन थैली में सील करकें 13.50 सेलसियस तापमान में भंडारण करने से पूवन केले को 29.66 दिन तक एवं करपूरवल्ली को 19.33 दिन तक अच्छी स्थिती में भंडारण किया गया। बिना छेद के पालीथीन थैली में सील करकें साधारण तापमान एवं ज़ीरो एनरजी कूल चेंबर में भंडारण करने पर दोनों किस्मों के केले में अत्याधिक क्षति पायी गयी। 13.50 सेलसियस तापमान में भंडारण किये गये सभी फलों में न्यूनतम दैहिकीय क्षति भार एवं गुणवत्ता बदलाव पाया गया। तिरुच्ची केले के बाज़ार में एवं किसानों के स्तर पर होने वाली तुडाई उपरान्त क्षति का सर्वेक्षण किया गया था। जाँच से यह पताचला की केले में किसान के स्तर पर 8-9%, थोक बाज़ार में 20-25% एवं फुटकर बाज़ार में 15% तक तुडाई उपरांत क्षति होती है। इस क्षति का मुख्य कारण फल का टूटकर गिरना एवं दैहिकीय क्षति भार है।

आस्मोटिक डीहैड्रेशन तकनीक से शुष्क केले की गुणवत्ता एवं भंडारणक्षमता में वृद्धि पायी गई। इस पदार्थकों 90 दिन से अधिक समय तक अच्छी स्थिती में भंडारण किया गया। 20% चीनी, 0.5% पेक्टीन एवं 4-5 बूंद चेरी रंग मिला कर करपूरवल्ली केले से फल पट्टी बनायी गयी। अच्छी गुणवत्ता के साथ इसको 20 दिन से भी अचिक समय तक रखा गया। करपूरवल्ली केले के फूल से एक मसालेदार अचार बनाने में भी सफलता मिली। इस पर और अधिक शोध कार्य प्रगती है।

पौध संरक्षण

केले के तना छेदक कीट (Banana stem weevil) पर पलने वाली परान्न फफूंदी के रूप में स्कोपुलाँरिस ब्रविकालिस एवं आँसपरज़िल्लस फ्लाँवस को पहचाना गया। पालिटस मेलेरबोरगी एवं सैब्रा प्रकुष्टा नामक दो नये कीटों को केले का नुकसानदायक कीट के रूप में पहचाना गया। केले का तना पिजड़ों में "डिस्क आन स्टम्प" सब से अधिक तना छेदक कीटों कों फँसाया। केले के गुच्छे को ढाँकने सें थ्रिप्स का प्रकोप फलों पर कम पाया गया। केले जननद्रव्य मूल्यांकन से कुछ ऐसी किस्में पायी गयी जिस में तना छेदक कीट के प्रतीरोधक शक्ती देखी गई।

तडियनकुडिसय और कंबम इलाकों में किए गए सर्वेक्षण में 16 परान्नजीव सूत्रक्रिमियों को पहचाना गया। कालोट्रोपिस प्रोसेरा, प्रोसोपिस जुली फ्लोरा, दतुरा स्ट्रामोनियम और कालोट्रोपिस जनसिया नामक जडी बूटी सूत्रक्रिमी के संख्या को कम करने में सक्षम पाया गया। नेन्द्रन में जड़ छेदक सूत्रक्रिमी के नियंत्रन में प्रेस मड एवं कारबोफूरान उपचार समक्षमता वाले पाये गये।

प्राटीलेंकस कोकिया एवं फ्यूसेरियम विल्ट कामप्लेक्स से पीडित रस्थाली केले में ट्रैकोड़रमा के उपचार से सूत्रक्रिमी की सख्या में काफी कमी पाई गई। जनन द्रव्य की मूल्यांकन में 391 किस्मों में सूत्रकिमी के प्रति प्रतिरोधक शक्ती पाई गईं।

भारत में पहली बार डिप्लाईड केले में 'आई स्पाट' बिमारी पायी गयी। पहाडी इलाके में लाल केले पर BSV एवं BBMV का प्रकोप पाया गया। जनन द्रव्य संकलन संख्य : 25 और 20 में भी

PMEC

BBMV और BSV बिमारी का लक्षण पाया गया। ELISA एवं DIBA टेस्ट के द्वारा इन बिमारीयों की तीव्रता की जौच की गयी। केले के 434 जनन द्रव्य संकलनों के मूल्यांकन से पताचला की इन में 63 किस्मे सिगटोका लीफ स्पाट के प्रती प्रतिबन्धक है और 10 किस्मे अति प्रतिबन्धक है। प्रोपिकोनज़ोल एवं हेक्साकोनज़ोल के अलग अलग उपचार या कवच से सम्मिश्रित उपचार से इस बिमारी की तीव्रता को कम कर सकते है। सफलता पूर्ण CLV का प्रेषण रोबस्टा केले से लोबिया में किया गया।

जीव दैहिकी एवं जीव रसायन

केले के 6 किस्मों में फूलने की जीव दैहिकी प्रक्रिया एवं फल का विकास का अध्ययन किया गया था। पौधे की सातवें महिने की आयु में पौध वृद्धि में विशिष्ट भिन्नता पाई गई। फसल की अवधि एवं प्रत्युत्पत्ति अवस्था Photo synthetically सजीव पत्ते की क्षेत्र फल पर निर्भर करता है। नीरवाले बिमारी ग्रस्थ एवं स्वस्थ पौधों के बीच वृद्धि राशियों में महत्वपूर्ण भिन्नता नही पाई गई। नीरवाले ग्रस्थ पौधा 2-3 कि.ग्रा. वजन के गुच्छे दिए जिनमे केवल 2-3 फल साधारण मात्रा के थे। STS, इथेरल एवं BA 25 PPM के उपचार से भी इन पौधों में कोई वृद्धि नहीं हुई। नीरवाले ग्रस्थ एवं स्वस्थ पौधों के क्लोरोफिल मात्रा में काफी विभिन्नता थी।

तकनिकी हस्तांतरण

केले की प्रसंस्करण तकनिकि में जिला उद्योग केन्द्र द्वारा प्रायोजित इच्छुक उद्योगकर्ताओं को 5 महीने का प्रशिक्षण दिया गया। 28 जनवरी 2001 को तिरुच्ची आकाशवाणी कृषक संघ एवं तोट्टियम केला कार्षिक संघ द्वारा आयोजित संगोष्ठी में कई वैज्ञानिक भाग लिए और उन्नत कृषि तकनीक के बारे में जानकारी दी गई एवं केन्द्र की सभी उपलब्दियों का प्रदर्शन किया गया।