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1996 - 97

NATIONAL RESEARCH CENTRE ON BANANA

(Indian Council of Agricultural Research)

TRICHY - 620 017.

RMCU

ANNUAL REPORT

1996 – 97

राष्ट्रीय केला अनुसंधान केन्द्र
(भारतीय कृषि अनुसंधान परिषद)
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(Indian Council of Agricultural Research)
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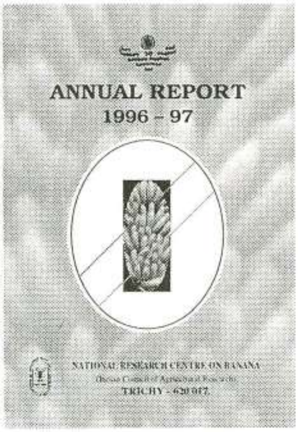

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FOREWORD

Banana and plantain (Musa sp) have great socio-economic significance in India and are inter-woven in the cultural heritage. Internationally, banana is a fourth important food crop in terms of gross value exceeded only by paddy, wheat and milk products, and is an important crop for subsistence farmers as a source of food and income. India is a largest producer of banana in the world. It accounts for 31.72 per cent of the total fruit production in the country. With the growing population and enhanced awareness among the masses about the health and nutrition aspects of banana, the requirement in the next twenty years is expected to be 25 million tonnes. Realising the importance of banana for its food and nutritional security, and to meet the growing demand, the National Research Centre on Banana was established on 21st August, 1993 by Indian Council of Agricultural Research which started functioning effectively with effect from 1st April, 1994 after resolving the problems related to land.

The mandate of the Centre is to enhance the production and productivity of banana through basic and strategic research. It is envisioned to achieve this through the utilization of genetic resources, development of new cultivars, improved production technologies, integrated management of insect pest and diseases, and development of improved post harvest techniques. Research programmes at the Centre have been formulated based on the deliberations in International Consultancy meeting as well as in the Research Advisory Committee meetings of the centre and also as stipulated in Perspective plan. This is being pursued in programme mode approach involving a multi disciplinary team of scientists.

The year 1996 was the year of new developments and initiatives for the NRCB programmes. During the year, the International Conference on "Challenges for Banana Production and Utilization in 21st Century" was organised at the Centre which helped in deciding the research programmes. At the same time, NRCB also hosted the Sixth Regional Advisory Committee Meeting of ASPNET/INIBAP. These initiatives provided *opportunities for better interactions with banana scientists from India and abroad, and in giving a final shape to our research programmes. Thus, the programmes at the Centre have been initiated under four major missions viz., Genetic Improvement, Production Technology, Plant Health Management and Post Harvest Management. Trials under International Musa Testing Programme were also undertaken which have enabled us to identify FHIA-01 (Gold finger) as promising cultivar.*

The Centre has received recognition at national and international levels, and has established one of the largest germplasm collections comprising of 607 accessions both from indigenous and exotic sources and has developed the computerised data base. Four promising accessions under different groups have been identified. Research initiatives made have yielded better outcome in the field of soil health management. Methods to study the yield loss due to insect pest, nematode and diseases are being developed. Emphasis has been given to develop better post harvest management techniques.

Budget allotted to the Centre was fully utilized. Emphasis was paid for the infrastructure development and for the improvement of research capability of scientists through training. During the year the centre has contributed 7 research papers, 5 book chapters and 6 popular articles, besides, 27 research papers presented by the scientists of the Centre in national seminars/conferences. The administrative and technical staff of the centre were encouraged to participate in training programmes in their respective fields. All the issues of the Newsletters were brought out in time.

With strengthened support, NRCB stands prepared to respond to the opportunities and to meet the many challenges it is facing. Major activities of the centre during 1996-97 are covered in this report under four major programmes. Executive summary of the report is also given. It is hoped that the report will be a valuable source of information to the Musa community engaged in research and development.

H P Singh

(H.P.SINGH)
DIRECTOR

कार्यकारी सारांश

केले की बढ़ती हुई महत्ता एवं अनुसंधान की जटिलता को ध्यान मे रखते हुए राष्ट्रीय केला अनुसंधान केन्द्र (NRCB) की स्थापना दिनांक 21 अगस्त, 1993 को भारतीय कृषि अनुसंधान परिषद (ICAR) द्वारा टास्क फोर्स की अनुशंसा से हुई और यह केन्द्र 1 अप्रैल 1993 से आधारभूत विकास एवं अनुसंधान कार्य मे पूर्ण रूप से कार्यरत है । इस केन्द्र का मुख्य उद्देश्य – मूलभूत तथा योजनाबध्द अनुसंधान द्वारा केले का उत्पादन एवं उत्पादकता मे वृद्दि लाना है । आनुवांशिक संसाधनो का उपयोग, नई किस्मों का विकास, जैव तकनीकी का उपयोग, उत्कृष्ट उत्पादन तकनीकी, पादप स्वास्थ्य व्यवस्था एवं सस्योत्तर प्रवधन द्वारा केले के उत्पादन एवं उत्पादकता मे वृध्दि राष्ट्रीय केला अनुसंधान केन्द्र का मुख्य लक्ष्य है । पिछले तीन वर्षों मे केन्द्र के आधारभूत ढाँचे और अनुसंधान कार्यो मे सराहनीय प्रगति हुई है । केन्द्र का मुख्यालय तिरुची मे स्थित है और इसका 36 हेक्टर प्रक्षेत्र तिरुची से दक्षिण–पश्चिम मे 14 किलोमीटर दुर पोदावूर गाँव मे है ।

अनुसंधान उपलब्धियाँ :

दुरदर्शी योजना एवं अनुसंधान सलाहकार समिति (RAC) के परामर्श से इस केन्द्र का अनुसंधान कार्यक्रम चार मूलभूत परियोजनाओं के अर्न्तगत प्रारम्भ किया गया है । अनुवांशिक विकास, उन्नत अत्पादन तकनीकी, केला का स्वास्थय व्यवस्था एवं सस्योत्तर प्रबंधन, इस केन्द्र का मुख्य कार्यक्रम है । आई.एम.टी.पी. (IMTP) के अन्तर्गत परिक्षन चल रही है । वर्ष 1996 मे कुछ ही वैज्ञानिक पद पर कार्यरत थे फिर भी इस केन्द्र पर आनुवांशिक विकास, उत्पादन तकनीकी एवं पाढप स्वास्थ्य व्यवस्था मे सरादनीय प्रगति हुई है ।

आनुवांशिक विकास :

अनुवांशिक संसाधन प्रवंधन एवं उपयोग :

भारत केला के विविधताओं का केन्द्र है जिसमें आनुवांशिक सम्पदा का विशेष स्थान है । अभी मुसा जनन द्रव्य मे 607 नमूने संग्रहीत हैं । शेवराय पर्वत एवं मालनाड (कुर्ग) क्षेत्रों मे खोज से बहुत सारे नमूने पहचाने गये है । होन्डूरा(विदेश) से संग्रह किये गये नमूने भी शामिल किये गये है । प्राप्त नमूने का मूल्यांकन विभिन्न गुणों के लिए किया जा रहा है । प्रारम्भिक मुल्यांकन से सभी प्राप्त नमूने को अनुवांशिक वर्ग एवं उप–वग्रो में वर्गीकृत किया गया है । मूल्यांकन के आधार पर एक ही नाम से जाने वाली केले की प्रजाति की पहचान मे प्रगति हुई है । जननद्रव्य के मूल्यांकन उपरांत पत्ती दाग (Sigatoka) प्रतिरोधक प्रजाति की पहचान की गई है। प्रारम्भिक परीक्षण से नेमाटोड प्रतिरोधक केले भी पहचाने गये हैं । कुछ प्रजाति पर मृदा क्षरीयता सहनशीलता का भी मूल्यांकन किया गया जिसमें रेशम वग्र सबसे कम सहनशील पाया गया जबकि ए.ए.बी. वर्ग एवं केवेंडीस वर्ग मे सहनशीलता अधिक पायी गयी । यूँ तो ए.ए. डिप्लायड मे सहनशीलता बहुत कम थी फिर भी कल्टीभार रोज की सहनशीलता उत्तम थी । इस जनन द्रव्य का उपयोग अभिजनन द्वारा उत्तम किस्म के केले के विकास हेतु किया जा रहा है । मूल्यांकन के आधार पर 0030–रेशम वर्ग, 0016–मोनथनु नमूने 0052 (ए.बी.बी. वर्ग), नमूने–0079 (वोना पिसांग आवाक) विभिन्न गुणों के लिए उत्कृष्ट पाई गई है । जिसका चयन कर विभिन्न प्रक्षेत्रों मे मूल्यांकन हेतु उतक संवर्धन द्वारा विस्तार किया जा रहा है ।

जैविक एवं अजैविक प्रतिरोधक अभिजनन :

उत्कृष्ट संकर किस्म एवं प्रभेदों को अन्तर राष्ट्रीय प्रजनन केन्द्र से लाये गये किस्मों के मूल्यांकन से फिया–01 जो आस्ट्रेलिया मे गोल्ड फिंगर के नाम से जाना जाता है, भारतीय जलवायु के लिए उत्तम पाया गया । यह किस्म पचानादन की तरह है जो पोम वर्ग मे समूहित होता है जिसमे मुर्च्छा रोग (Wilt) प्रतिरोध है और यह पचानादन से अधिक उपज देती है । फीया–03 एवं बोरो सेमसा द्विपयोभी (ब्लुगो) वर्ग मे उत्कृष्ट पाया गया है । उत्कृष्ट संकर किस्म एवं व्यवसायिक केले को विभिन्न जगहों पर मुल्यांकन हेतु लगाई गई है । यूँतो केला का बीज अंकुरीत नही होता फिर भी परीक्षणों द्वारा बीज से पैधा उगाने में सफलता मिली है और बीज से तैयार किये गये पौधों का मूल्यांकन किया जा रहा है । जनन द्रव्य मे नर एवं मादा निषेचकों को पहचान कर ट्राईप्लायड एवं डीलायड (Triploids and disploids) अभिजनन किया जा रहा है । साथ ही साथ सिनथेटिक डीप्लायड (Synthetic diploids) का भी विकास किया जा रहा है जिसे आगे अभिजनन मे उपयोग किया जाएगा ।

जैव तकनीकी द्वारा केले का विकास :

केला मे जैव तकनीकी कार्यक्रम का मुख्य उद्देश्य ऊतक संवर्धन (Tissue enthuse) तकनीक का उपयोग तथा जैव तकनीकी से अभिजनन में सहायता करना है । पिछले वर्ष परीक्षनों द्वारा ऊतक संवर्धन तकनीकी का विकास किया गया है जिसमे अधिक से अधिक जन्न द्रव्य का ऊतक संवर्धन संभव हो सका है । जनन द्रव्य का ऊतक संग्रहण भी किया गया है । केले के भ्रूण संवर्धन से पौधा तैयार करने में भी सफलता प्राप्त हुई है, जिससें संकर यौधो के उगाने में आने वाली कठिनाई द्रर हो जाएगी । विभिन्न चयन किये गये किस्मो का ऊतक संवर्धन द्वारा अधिक से अधिक पौधा तैयार कर परीक्षण के लिए उपलब्ध कराया जा रहा है ।

उत्पादन तकनीकी :

छः व्यवसायीक किस्मो का विभिन्न विकास अवस्था मे जलवायु मृदीय कारको के पहचानने के लिए परीक्षन किये गये । परीक्षण के आधार पर ज्ञात हुआ कि सक्रिय वृद्दि के समय कम तापमान और कम आर्द्रता मिलने से वृद्दि एवं उपज कम होती है । फल देने के समय अधिक आर्द्रता मिलने से बिमारीयों का प्रकोप अधिक होता है, पत्ती दागा (Sigatoka) विभारी का प्रकोप बढने से उपज मे अधिक हानि होती है । विभिन्न विकास कार्य में अलग अलग प्रजातियों मे तापमान और आर्द्रता का प्रभाव भिन्न पाया गया । जैविक एवं अजैविक पोषन क्षमता के परीक्षण से ज्ञात हुआ कि 25–50 प्रतिशत नेत्रजन जैविक रूप से देने से फसल की उपज मे वृद्दि होती है और अच्छे गुणवता वाले फल मिलते हैं । परीक्षण से यह भी ज्ञात हुआ कि जैविक पोषन श्रारीयता के कुप्रभाव को भी कम करता हैं । खरपतवार का कुप्रभाव का पता करने हेतु किये गये परीक्षण से यह ज्ञात हुआ कि करपूरावल्ली प्रजाति मे प्रथम छः महीने खरपतवार न हटाने पर पाढप वृद्दि मे 48 प्रतिशत हानि होती है । परीक्षण से यह भी ज्ञात हुआ कि क्षरील मृदा मे केले का उत्पादन पोटास एवं सोडियम की अनुपात पर भी निर्भर करता है और यह अनुपात 1.07 पाया गया ।

पादप स्वास्थ्य प्रबंधन :

राइजोम वीभील (कोसमोपोलिटस सोरडीडस), स्युडोस्टेम बोरर (उडीयोपोरस लोंगिकोलीस) थ्रीप्स फ्लोरम केले के प्रमुख कीड़े है । तामिलनाडू मे लेंस विंगबग (स्टीफनीटस टीपीकस) सबसे अधिक मात्रा मे पाई गई, जबकि उत्तरी पूर्व प्रदेश (बिहार) मे स्कारींग वीटल (नोडोस्ट्रोमा सबकोस्टेटम) सबसे अधिक क्षतिकारक है ।

नेमाटोड, केले के लिए बहुत हानिकारक साबित हुई है प्रेटिलिंकस काफिया, हेलिकोटैलेन्कस माल्टिसिंकटस, मेलायडोगइनी जाति नमी वाले मूभि मे अधिक पाई गई जब्कि बिहार के वालुदार चिकनी उपजाऊ मिट्टी मे माल्टिसिंहटस एवं मेलिडोगाइनी अधिक था ।

फंगल बिमारियों मे पत्ती दाग (Sigatoka) प्रमुख है । फ्युजीरियम वील्ट, रेशम एवं पिसांग अवाक प्रजाति मे पाई गई कोलेटोट्राईकम का प्रकोप भी करपुरावल्ली में अधिक देखी गई । मौसम के परिवर्तन से पत्ी दाग (Sigatoka) बिमारियों का प्रकोप में भिन्नता पाई गई, जो सितम्बर नवम्बर मे अधिक था ।

पूवन प्रजाति मे बनाना स्ट्रीक वाइरस (BSV) सभी क्षेत्र में पाई गई । नैन्द्रन, पूवर, और मोनथन प्रजाति मे बनाना ब्रेकट मोजाइक वाइरस (BBMV) का लक्षण विभिन्न पाई गई । इस बिमारियों से होने वाली हानि एवं क्षति भी विभिन्न प्रजातियों में मिल पाई गई । बी.एस.वी. का प्रकोप उपज मे हानि पहुचाती है । इलेक्ट्रॉन माइकोसकप से बी.बी.एम.वी. के सही नमूनों के अध्ययन से ज्ञात हुआ कि वाइरस चिकने, रॉड के आकार के होते है । विशांन की मात्रा पत्ती से ज्यादा फूल के पंखोडीया (Bract) मे अधिक पाई गई ।

नीरवाले का प्रकोप नेन्द्रन मे पाई गई, इस बिमारी से प्रकोपित पौधों मे फल का विकास नही हो पाता है, सभी फल छोटे ही रह जाते है । परीक्षण से यह भी ज्ञात हुआ कि यह बिमारी पुत्तल से फैलती है ।

सस्यतोर तकनीकी :

प्रारम्भिक परीक्षण से ज्ञात हुआ कि केले फल के पकने का समय और लम्बी अवधि तक रखने की क्षमता उसकी जीवन काल मे फल वृद्दि दर पर निर्भर करता है । हरी फल और हरीत्तर उम्र भी विभिन्न प्रजाति मे भिन्न पाई गई । फलों का गुणवता, फल के विकास अनुपात पर बहुत अधिक निर्भर करता है। केले फल को 20°C तापमान पर रखने से फल की गुणवता मे बढ़ोतरी होती है ।

सामान्य सूचना :

मानव संसाधन का विकास :

इस दौरान पॉच प्रशासकीय तकनीकी कर्मचारी वर्ग संगणक (Computer) मे प्रशिक्षण कराया गया और दो वैज्ञानिको. ने अपनी कार्य क्षेत्र मे विशेष प्रशिक्षन किया । सभी वैज्ञानिको ने कम से कम एक सेमिनार मे उपस्थित होकर व्याख्यान प्रस्तुत किये। केन्द्र के वैज्ञानिकों ने भी अन्तरराष्ट्रीय कार्यशाला मे अपने व्याख्यान प्रस्तुत किये । वैजानिको ने विशेष व्याख्यान एवं प्रशिक्षण पाठ्यक्रम भी दिये ।

उत्कृष्ट केला अनुसंधान एवं विकास कार्य के लिए डा.एच.पी. सिंह को अन्तरराष्ट्रीय पुरस्कार पिसांत्र राजा एवं राष्ट्रीय पुरस्कार "कदली" पुरस्कार से पुरस्कृत किया गया ।

छठवाँ ए.एम.पी.एम.ई.पी./ एनीबाप की अनुसंधान सलाहकार समिति की बैठक दिनांक 26से 28 सितम्बर 96 को राष्ट्रीय केला अनुसंधान केन्द्र, तिरूची मे कराई गई । बैठक में यह निर्नय लिया गया कि इस केन्द्र को विश्वस्तर पर जनन द्रव्य अन्वेशन कार्य हेतु सहायता दी जाएगी, साथ ही साथ इस केन्द्र को अधिक से अधिक अन्तरराष्ट्रीय जननद्रव्य उपलब्ध कराया जाएगा । दिनांक 24 से 25 सितम्बर 1996 को 21 वी शदी मे केले क उत्पादन एवं उपयोगिता पर प्रथम अन्तरराष्ट्रीय बैठक कराई गई । अनुसंधान सलाहकार समिति (SRC) की बैठक 15 जुलाई 1996 को केन्द्र मे सम्पन्न हुई ।

वर्ष 1996–97 में सात अनुसाधान दस्तावेज, एक पुस्तक, पॉच बुलेटीन एवं छः विशेष दस्तावेज प्रकाशित किए गये । इसके अलावा 27 अनुसंधान दस्तावेज भी केन्द्र के वैज्ञानिकों ने विभिन्न कार्यशाला मे / स्येमपोजियम मे प्रस्तुत किए ।

आधारभूत ढ़ॉचे :

आधारभूत ढ़ॉचे के विकास पर विशेष ध्यान दिया गया जिससे अनुसंधान मे सक्रियता आये । प्रक्षेत्र मे 200 X 100 मीटर एवं 50 X 50 मीटर की छोटी–छोटी प्लोट बनाई गई है; 1200 मीटर की कनक्रीट पथ पूरी हो गई है । प्रक्षेत्र मे प्रयोगशाला की सुविधा भी उपलब्ध कराई गई है तथा प्रक्षेत्र कार्यालय का निर्माण किया गया । सिंचाई को प्रभावशाली बनाने के लिए चार नलकूप वं तीन कूप उपलब्ध हैं । तामिलनाडू सरकार की अनुशंसा से आठ एकड़ ज़मीन भी कार्यालय सह–प्रयोगशाला केलिए प्राप्त की गई है । वैज्ञानिको के आवास एवं अतिथि गृह शहर मे एक एकड़ ज़मीन सरकार से ली गई है । कार्यालय सह–प्रयोगशाला घेरा भी पूरा हो गया है । जैविक प्रयोगसाला एवं पोषक परीक्षण के लिए सभी उपकरण उपलब्ध कराए गये हैं । अतक संवर्धन प्रयोगशाला मे अधिक उपकरण निवेस किए गए । पुस्तकालय मे 200 पुस्तके 57 भारतीय पत्रिकाएँ 2 विदेशी पत्रिकाएँ उपलब्ध हैं । पुस्तकालय प्रबंधन एवं विकास के लिए केन्द्र को कम्प्यूटराईज (Computerised) एवं एरीस (ARIS) केन्द्र भी स्थापित की गई है ।

कार्मिक एवं बजट :

केन्द्र को कुल 15 वैज्ञानिक पदों का अनुमोदन प्राप्त है जिसमें 7 पद पर ही वैज्ञानिक कार्यरत है । रिक्त पदों पर वैज्ञानिकों को कार्यारत करने हेतु परिषद को अनुरोध पत्र भेजी गई है । ए.एफ.ए.ओ. (AFAO) को छोड़ कर सभी प्रशासनिक एवं तकनीकी पदों पर कर्मचारी कार्यरत है ।

वर्ष 1996–97 के लिए 80 लाख रूपये की राशि अनुमोदित हुई थी जिसका पूर्ण उपयोग किया गया और इस वर्ष कुल 95 लाख रुपयें मात्र अनुमोदित हैं । गत वर्ष कुल 2.75 लाख रुपयों की आमदनी हुई थी ।

EXECUTIVE SUMMARY

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

A. RESEARCH ACHIEVEMENTS:

Keeping the Perspective Plan in view, and the recommendations of RAC, the programme at the Centre has been initiated under 4 major missions viz., Genetic Improvement, Production Technology, Plant Health Management and Post Harvest Technology Genetic Trials under International Musa Testing Programme were also undertaken. Although majority of the Scientists joined at the Centre in second part of 1996, Centre has made appreciable progress with respect to genetic improvement, production technology and plant health management programme.

GENETIC IMPROVEMENT:

Genetic Resource Enhancement and Utilization : Musa germplasm collection was enriched to 607 accessions. Exploration was conducted in Shevroy hills (Yercaud) and Malnad (Coorg) region which resulted in addition of few more accessions. Exotic collection was also added from Honduras. Germplasm was conserved in the field gene bank as base collection, where introduced accessions were evaluated for assigning the group. After preliminary evaluation and classification, these accessions have been planted in working collection, where the detailed characterization and classification is attempted using 120 characters as per INIBAP descriptor. Through the characterization, it has been possible to give genomic coding and sub-grouping for all the accessions. Based on the evaluation, it has now become possible to develop a key for identification of accessions.

Plants screened against Sigatoka, wilt and insect pests have helped in identification of resistance source against Sigatoka. Preliminary field screening of germplasm against nematode also indicated variability for resistance to nematodes in musa germplasm. Variability in reaction of germplasm to sodicity was also observed. Among the cultivars silk appeared to be highly susceptible while considerable resistance was observed in the cultivars belonging to genomic group AAB. Among the diploids *Musa acuminata* cv. Rose exhibited resistance under field conditions. Accessions 0030-silk, 0016-monthan continued to perform well under the field condition. Salt tolerant accession 0052 (ABB group) and accession 0079 (Dwarf Pisang Awak) and also continued to be promising.

These accessions recorded better growth and yield. Culture initiation of these accessions has been achieved for *in-vitro* propagation.

Breeding Banana for Biotic and Abiotic Stresses : From the evaluation of promising hybrids and cultivars introduced from the major breeding centres through INIBAP, *FHIA-01*, known as *Gold Finger* in Australia, appeared to be promising and has potential to substitute Pachanadan. This hybrid belongs to Pome group and is resistant to wilt under field conditions. It has high yield potential compared to Pachanadan. In Bluggoe group, *FHIA-03* and *Burro Cemsa*, appeared to be promising. Trials have been initiated to compare these promising hybrids with commercial cultivars of the group.

Through the evaluation of gene pools, male and female fertile accessions have been identified. Crosses were attempted by using triploid cultivars requiring improvement with diploid as source of resistance. Simultaneously, diploids crossing was also attempted to develop a synthetic diploid to be used in breeding programme. Seed germination was obtained in few cross combination and the seedlings are ready for evaluation.

Bio-technological Approaches for the Improvement of Banana: Success in development of protocol for accessions from different genomic groups with varying ploidy levels has helped in multiplication of a large number of accessions for its field evaluation. These accessions are also conserved *in vitro* through frequent subculturing. Experiments have also been initiated to develop protocol for embryo rescue and *in vitro* germination of hybrids. Protocol for faster multiplication of Karpuravalli, Nendran and Kanthali has been refined.

PRODUCTION TECHNOLOGY:

Trials to study the effect of edaphic factors on growth and yield of six commercial cultivars have shown that plants exposed to low temperature and low humidity during active growth stage show reduction in growth and yield. The plants exposed to high humidity during shooting had high incidence of Sigatoka. Influence of temperature and humidity at different growth stages varied among cultivars.

In a trial to find out the efficacy of organic and inorganic nutrition, the treatment receiving 25-50 per cent N from organic sources performed better with respect to growth, yield and quality of fruit. It was interesting to note that the effect of sodicity was reduced when organic source of nutrients was given, as indicated by the leaf symptoms. In other trial, weeds caused 48% of loss in growth of Karpuravalli cultivars and first six month after planting was identified to be very critical for growth. Ratio of potassium to sodium in leaf was found to be critical for the production of banana and the critical limit of Potassium to Sodium ratio was 1.07. Relative accumulation of potassium and sodium in leaf appeared to be a factor associated with susceptibility of cultivar to sodicity.

PLANT HEALTH MANAGEMENT:

Insect Pests : Among the insect pests, Rhizome weevil (*Cosmopolites sordidus*) and Pseudostem borer (*Odoiporus longicollis*) were present. Lace Wing Bug (*Stephenitis typicus*) was found to be predominant. However, in North Eastern region, Scarring bettle (*Nodostoma subcostatum*) was a serious problem.

Nematodes : Among the nematode, *Pratylenchus coffeae, Helicotylenchus multicinctus* and *Meloidogyne* sp. appeared to be prevalent in wet land system of banana. However in sandy loam soil in Bihar, *Rotylenchulus reniformis, Helicotylenchus multicinctus* and *Meloidogyne* were predominant.

Fungal Diseasese : Among the fungal diseases, Sigatoka leaf spot was predominant. Fusarium wilt was observed in Silk and Pisang Awak group of banana. Incidence of *Colletotrichum* was also observed to be serious in Karpuravalli. A new disease of Pseudostem Rot in Poovan variety was reported from a survey in Pudukottai district.

Viral Diseases : Banana Streak Virus (BSV) was found to be predominant in all the banana growing region on Poovan cultivars. Banana Bract Mosaic Virus (BBMV) was serious on Nendran, Ney Poovan, Robusta, Red Banana and Poovan. It was interesting to note that BBMV symptom expression and intensity of loss varied from cultivar to cultivar. Symptom expression of BSV in Poovan was observed to be influenced by growing condition. Any stress to the plant aggravated the loss due to BSV. Electron microscopic studies on BBMV infested sample suggests that virus has flexuous rod shaped a particle. Bract contained more virus particle than leaf sheath.

Neer Vazhai a malady of unknown etiology was found to be transmitted through suckers.

POST HARVEST TECHNOLOGY:

Preliminary investigations carried out with respect to ripening and storage suggests that the shelf life varies depending upon cultivar. It is essential to evaluate the green life and post green life as it is highly influenced by the temperature. Slow ripening at 20°C improved the fruit quality. Fruit growth rate has been found to be an indicator of the quality of the fruits. High variability for post harvest characters was observed among the genepool.

B. GENERAL INFORMATION

Human Resource Development : During the reported period, five administrative and technical staff were trained in use of computers. Two scientists attended the training in their respective field. All the Scientists attended at least one seminar during the period. Scientists of the Centre delivered two lectures in international conference and more than 7 special lectures in national seminars as well as in training courses. Prestigious International award, "Pisang Raja" was conferred upon Dr.H.P.Singh, Director, NRCB by ASPNET/INIBAP for his outstanding contribution in the field of banana research and development. "Kadali Puraskar" was also conferred upon Dr.H.P.Singh, for his contribution to banana research by Association for the Improvement in Production and Utilization of Banana (AIPUB).

Meetings and conference : Sixth Regional Advisory Committee Meeting of ASPNET/ INIBAP was hosted by NRCB and the meeting was held on 26-28 September, 1996 which has enabled to establish effective linkage. In the meeting it was decided to provide global germplasm, assist in exploration programme and help in development of research capabilities. The first international conference on Challenges for Banana Production and Utilization in 21st Century was also organised on 24-25 September, 1996.

Publications : During the period under report, 7 research papers, one book, 5 book chapters and 6 popular articles were published. Besides, 27 research papers were presented by the Scientist of the Centre in various Seminar/Symposia including international conferences. The Centre was also visited by several distinguished visitors during the period. The Centre brought out the News Letter regularly.

Infrastructure: Since the Centre started functioning from the scratch, emphasis has been given for the infrastructural development and development of research capabilities for the conduct of research.

Lay out of farm has been completed after contour mapping and making plot of 200x100m and micro plots of 50x50 m. Concrete road of 1200 m has been completed. Farm structure has been renovated for use as laboratory. A farm office was constructed during the year. Four borewells and three open wells are available for effective irrigation system. By persuasion with Government of Tamil Nadu, 8 acres of land was additionally acquired for lab-cum-office complex. One acre land in city has also been acquired for the construction of Liasion Office and residential quarters of scientist. Boundary walls to the laboratory-cum-office building was completed. Equipment required for the biotechnology lab as well as major equipments for nutrient analysis were procured. Tissue culture lab has been modernised and have facility for the *in vitro* multiplication of the plants. Library at the Centre has also been established which has the holdings of more than 200 books and 49 periodicals including 4 foreign journals. Computer programme for the management of library was also developed and holdings at the Centre has been computerised. ARIS Cell has also been established.

Staff and Budget : The Centre has the cadre strength of 15 Scientists of nine seven are in position. Requisition for filling up of three senior positions have also been sent to the Council for recruitment. Request for the filling up of 3 posts of scientists has also been sent. Under B & C category, all the posts have been filled up except for the post of AFAO.

The Centre's budget for the year 1996-97 was Rs.80 lakhs which was fully utilized. During the current financial year, total allocation is Rs.95 lakhs only which does not commensurate with programme needs and developmental plans. Even though the centre is in the developing stage, it has generated an income of Rs.2.75 lakhs during the year.

RESEARCH ACHIEVEMENTS

1. GENETIC IMPROVEMENT

The need for a wide diversity of genetically improved varieties having the potential for increased productivity and resistance to biotic and abiotic stresses is recognised for sustainable production of banana. Due to complexity in genetic improvement of banana achievements have been slow. However, recent advances in breeding techniques have made it possible to overcome many of the barrier to genetic improvement. Recent biotechnolgical breakthroughs are also expected to bring about rapid progress in banana improvement. Therefore, genetic improvement of banana, which has three major components viz., Germplasm enhancement and utilization, breeding for biotic and abiotic stresses and biotechnological approaches, is a priority programme at the centre. (Fig-1).

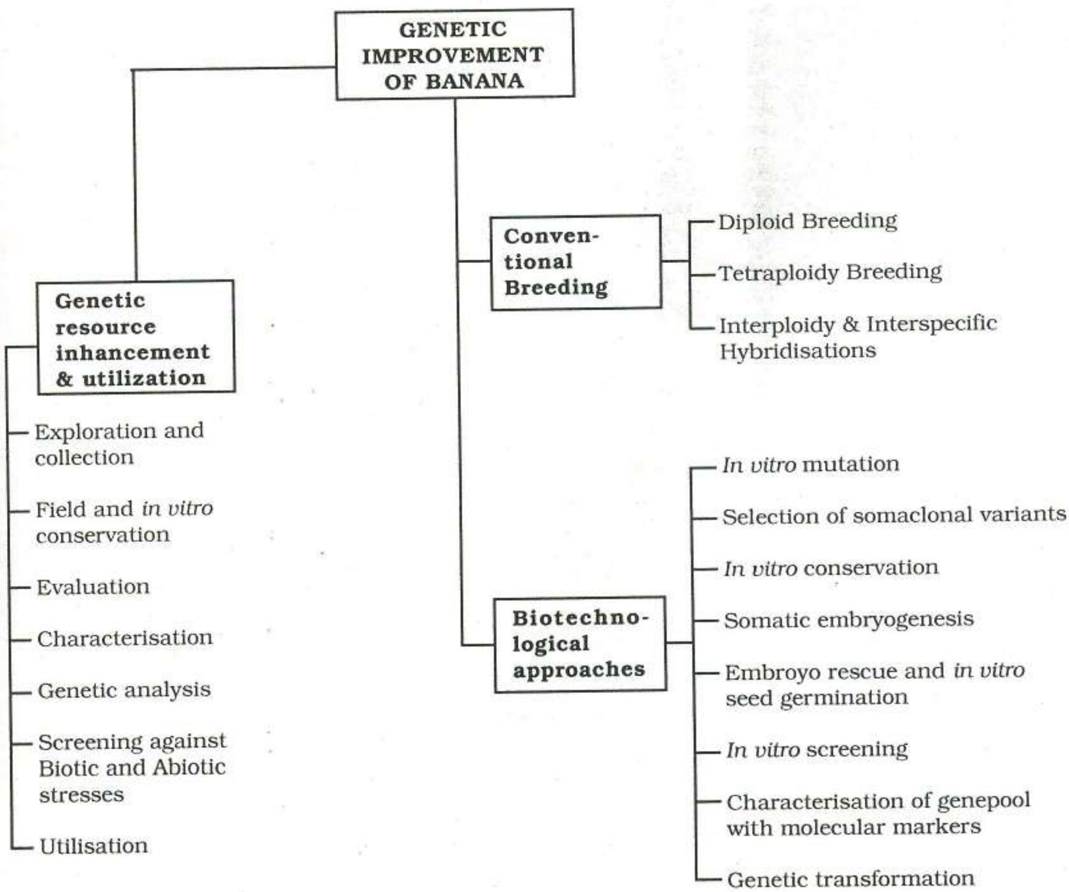


FIG. : SCHEMATIC REPRESENTATION OF CROP IMPROVEMENT IN BANANA

1.1 Germplasm enhancement and Utilization:

Since success of breeding programme depends upon increased availability of natural germplasm, germplasm enhancement and utilization, have received emphasis. The programmes aims at collection of musa diversity, its evaluation for desirable traits, conservation and development of data base having access to breeder. At the same time, if accessions are found promising it can also be used as cultivar.

1.1.1 Collection and Conservation:

During the period under report, the germplasm collection was enriched with the addition of four more accessions explored from Shevroy hills of Eastern Ghats. Three accessions of important commercial cultivars of Poovan, Pachanadan and Nendran were also added to the genepool. SH-3640 (Dwarf prata x SH 3393) belonging to AAB, Poovan subgroup was collected from Honduras. The upto date status of the germplasm collection at the centre is given in Table 1.

TABLE 1 : Germplasm holding at NRCB

Details of accessions		Number of accessions *
Musa acuminata species		6
Diploids	AA	21
	AB	30
Triploids	AAA	45
	AAB	140
	ABB	251
Tetraploids		10
Musa balbisiana clones		15
Unidentified		89

* Including both indigenous and exotic collections

Musa accessions are conserved in the field gene bank in "Base collection Block" under wet land system of cultivation. After preliminary evaluation and classification into genomic groups and sub-groups, 370 accessions were planted in working collection block, wherein under each accession 4 plants are maintained with uniform cultivation practices.

1.1.2 Evaluation of Germplasm Accessions:

Evaluation of the germplasm was carried out for agronomic characters and for their reaction to biotic and abiotic stresses.

1.1.2.1 Evaluation for Growth and Crop Duration:

Growth parameters are important indicators in selecting superior accessions as cultivar and its use for further utilization in breeding. The germplasm was evaluated for growth parameters like, plant height, pseudostem circumference, number of photosynthetically active leaves, leaf area, days taken to shooting and crop duration. Variability in morphological characters among the genomic groups is presented in Table 2. High inter and intra genomic variability observed for the traits indicate the possibility of improvement through utilization of the diversity.

TABLE 2: Range of variability in agronomic characters of musa genomic groups.

Group/ sub group	Plant ht. (m)	Pseudostem circumference(cm)	Days taken for shooting	Number of Photosynthetically active leaves	Crop duration (days)
AA	1.87-2.75	45-50	210-302	4.2-5.9	270 - 363
AB	2.90-3.00	60-70	285-375	9.0-13.2	372 - 395
AAA	1.80-3.98	78-106	290-376	7.2-8.1	343 - 387
AAB-Silk	2.15-2.87	60-72	296-365	5.6-6.2	386 - 446
AAB-Pome	2.35-2.90	65-88	239-298	3.5-6.1	359 - 416
AAB-Mysore	2.45-2.92	68-80	276-349	6.0-7.2	381 - 359
AAB-Plantain	2.63-2.70	61-65	242-325	4.2-6.0	330 - 365
AAB-Nendra Padathi	1.61-3.00	63-68	236-311	3.5-7.2	386 - 461
ABB-Pisang Awak	3.20-3.80	88-93	342-420	4.8-9.6	462 - 540
ABB-Peyan	3.30-3.45	68-78	332-362	5.7-7.3	457 - 483
ABB-Monthan	2.53-3.51	65-76	285-365	6.3-9.1	380 - 400
ABB-Bluggoe	2.50-2.60	70-73	314-397	6.5-8.1	370 - 390
Tetraploids	2.50-2.60	65-90	300-360	6.7-8.5	390 - 400
BB/BBB Clones	4.62-4.89	85-108	362-435	13.2-14.6	480 - 532

1.1.2.2 Evaluation for Yield and Quality:

The ultimate selection of variety/hybrid for commercial production depends on the yield and quality of the fruit. Hence the genepool was evaluated for bunch weight, number of hands, total number of fingers and T.S.S. (Table 3).

TABLE 3: Variability in yield and quality traits among *musa* accessions.

Group/ sub group	Yield (kg)	No. of hands	Total no. of fingers	T.S.S. (^{o}Brix.)
AA	2.1-16.5	3-9	40-115	17.5-26.2
AB	4.3-26.5	4-16	26-274	19.6-31.4
AAA	3.5-39.5	3-19	24-342	17.6-31.2
AAB Silk	4.0-26.5	4-10	46-160	17.2-27.0
Mysore	3.8-16.5	3-14	81-204	20.5-26.3
Pome	3.6-19.5	2-12	55-130	23.4-27.5
Plantain	4.7-14.3	3-6	23-92	29.1-32.2
Nendra Padathi	3.5-17.5	4-11	125-140	21.5-24.5
AAB Pisang Awak	10.0-40.5	6-17	76-236	23.4-31.5
Peyan	3.5-17.0	4-8	52-144	25.2-28.5
Monthan	6.8-28.0	5-13	37-108	17.3-27.6
Bluggoe	6.7-34.0	5-10	35-178	16.2-24.3
Tetraploids	9.5-22.0	6-11	94-162	19.1-19.5
BB/BBB clones	11-36	7-16	72-228	28.2-32.2

1.1.2.3 Evaluation for fertility:

The cultivated bananas are either male or female sterile or both. Male or female fertile accessions find their utility in breeding programmes. Hence, the germplasm were screened for pollen production and female fertility. The extent of pollen production was studied in the field and the germplasm was grouped as profuse, medium or scanty pollen source. The accessions were grouped comprising of 15 profuse, 127 medium and 46 scanty pollen parents.

Female fertility status was assigned to those having the ability to set seeds either in open or hand pollinated conditions. From the studies, 48 female fertile accessions, exhibiting seed set, with number of seeds ranging from 1 to 200 (Table 4) were identified.

Table 4: Variability in pollen production/female fertility and germination among *musa* groups/subgroups:

Group/ sub group	Pollen production (Rating)	Seeds set/fruit	Seed germination (%)
AA	Profuse	3-5	0
AB	Scanty	Nil	-
AAA	Nil-Scanty	Nil	-
AAB Silk	Scanty-Medium	Nil	-
Pome	Nil-Scanty	1-5	20-26
Mysore	Nil-Scanty	1-10	0
Plantain	Nil	0-2	0
Nendra Padathi	Nil-Scanty	Nil	-
ABB Pisang Awak	Scanty-Medium	1-22	60-88
Peyan	Scanty	0-2	0
Monthan	Medium-Profuse	0-2	0
Bluggoe	Medium-Profuse	1-27	0
Tetraploids	Profuse	0-20	0
Balbisiana clones	Profuse	10-250	100

1.1.2.4 Screening of accessions for tolerance to sodicity

In the germplasm block at research farm, soil pH ranges between 8 and 8.5. Sodium toxicity symptoms were observed in many accessions which was characterised by marginal leaf necrosis. In severe cases all the leaves were found affected. Since, variability in injury was observed due to germplasm detailed studies were conducted to screen and identify the tolerant accessions. Severity of injury was assessed in the field condition. Among the accession, silk group was found to be highly susceptible. All the diploid except *musa, acuminata* cultivar rose had high severity. Cavendish, Pisang Awak, and *Balbiciana* genome had low severity.

In an endeavor to develop a rapid method for screening of germplasm for salt tolerance, twenty accessions belonging to Pisang Awak sub group were identified and evaluated for tolerance to salt at different molar concentrations viz., 0.25, 0.50, 0.75 and 1.00 M. The central portion of the dissected mid rib of the third leaves were allowed to soak for 24 hours and then tested for salt tolerance by 2,4,5-Triphenyl tetrozolium chloride test. The ratings were given based on intensity of colour reaction at the respective molar concentration. The results showed that certain accessions of ABB group were tolerant even up to 1 M concentration of salt.

TABLE 5: Screening of Pisang Awak accessions for salt tolerance using Tetrazolium Test

Acc.No. Name	NaCl level (M)				Rating *
	0.25	0.50	0.75	1.00	
0065 Deshi Kadali	+	+	+	+	4
0044 Karpura Chakkarakeli	+	+	+	+	4
0089 Battisa Piro	+	+	-	-	2
0079 Kanthali	+	+	-	-	2
0087 Chinia	+	+	+	+	4
0453 Bankela	+	+	-	-	2
0342 Kanch Kela	+	+	+	-	3
0353 Calananul	+	+	+	-	3
0346 Gauria	+	+	-	-	2
0442 Poombidiyan	+	+	+	+	4
0070 Bor Jahaji	+	-	-	-	1
0108 Kach Kela	+	+	-	-	2
0073 Saapkal	+	+	+	+	4
0076 Gros Michel	+	+	+	+	4
0443 Mortman	+	+	+	+	4
0112 Shahil Kela	+	+	+	+	4
0227 Budida bokkisa	+	-	-	-	1
0341 Bhurkel	+	+	+	-	3
0356 Ash Monthan	+	+	+	+	4
0059 Agni Malbhog	+	+	+	+	4
0433 Shahil Baig	+	+	-	-	2
0231 Jammulapalem Collection	+	+	+	+	4

"+" - Viable (tissue turns to red)

"-" - Non-viable (no colour development)

* - 1 : Least tolerant
2 : Moderately tolerant
3 : Tolerant
4 : Highly tolerant

1.1.2.5 Evaluation for incidence of Insect pest, Nematodes and diseases

1.1.2.5.1 Insect pests

The germplasm in the working collection block was evaluated for the incidence of pests like Lace wing bug *(Stephanitis typicus)*, Tobacco caterpillar *(Spodoptera litura)*, Hairy caterpillar, Aphids, Pseudostem borer *(Odoiporus longicollis)* and Rhizome Weevil *(Cosmopolites sordidus)*.

A total of 285 accessions were observed for the natural incidence of insect pests. The lace wing bug was found to be present on all the accessions. *Spodoptera litura* incidence was recorded on 74 accessions, including Karpuravalli, Nendran, Poovan and Rasthali, which are commercial cultivars. Natural incidence of the rhizome weevil, pseudostem borer and aphid was not found. Mealy bug incidence was recorded on the plant crop of Karpuravalli, Vananth Uram and Bankela (all belonging to Pisang Awak group) and also in the ratoon. Slug caterpillar *Paraslepida* was recorded only on Karpuravalli.

1.1.2.5.2 Nematodes

A total of 468 root samples from 234 accessions were collected and observed for plant parasitic nematodes which indicated the presence of *Pratylenchus coffeae, Radopholus similis, Meloidogyne* sp., *Helicotylenchus multicinctus and Pratylenchus* sp. *Pratylenchus coffeae* was predominant in Nendran (AAB), Robusta (AAA), Monthan (ABB), Kalyanbale (ABB), Neypoovan (AB), Dole (AAB), Nendrakali (AAB), Gandevi (AAA), Govakkai (ABB), Gauria (ABB) and Singalaji (ABB). *Radopholus similis,* was recorded in accessions namely, Kalyanbale, Dole, Nendrakali and Alukel.

The Root-knot nematode *Meloidogyne* sp. was recorded on five accessions namely, Nendran, Robusta, Rasthali, Chetty and Kalyanbale, and the incidence of *Helicotylenchus multicinctus* was recorded only on Karpuravalli.

The root-lesion nematode, *Pratylenchus* sp. was recorded on ten cultivars namely, Nendran (AAB), Rasthali (AAB), Robusta (AAA), Monthan (ABB), Karpuravalli (ABB), Kanai Bansi (AA), Anaikomban (AA), Nutepong (ABB), Gauria (ABB) and Hybrid-I (AAB).

1.1.2.5.3 Diseases

Banana germplasm was evaluated for their reaction to Sigatoka leaf spot disease caused by *Pseudocercospora musae* under field conditions. Scoring was done during vegetative phase using the method developed by INIBAP. The youngest leaf spotted (YLS) was also recorded.

There were wide differences among the genomic groups for the incidence of sigatoka. Accession with more *balbisiana* genomes, comprising of BB/BBB and ABB recorded the lowest incidence of Sigatoka, ie., 20.7 per cent with a range of 11.11-21.92 per cent and highest YLS value of 17.5. The highest incidence of Sigatoka leaf spot disease was noted in *Musa acuminata* triploids, viz., Red Banana - AAA (66.10%), Rajavazhai-AAA(63.13%), Cavendish-AAA (58.27%) and Silk-AAB (61.19%) having more of 'A' genome in their genomic constitution. The YLS was very low (6.7 - 8.0) in these triploid groups showing their susceptibility to Sigatoka leaf spot disease.

Varieties such as, Local Peyan (ABB), Ennabenian (AAB), Thiruvanandapuram (AAB), Kalibow (AAB), Petite Naine (AAA), Vadakkankadali(AA) were free from symptoms of Sigatoka leaf spot disease. It was interesting to note that H_1, a hybrid with Agniswar x Pisang Lilin parentage was found to be completely free from Sigatoka incidence. These observations indicated that resistance source for sigatoka leaf spot disease are, infact, available across the genomic groups which can be better exploited in breeding programmes.

TABLE 6: Incidence of Sigatoka in Banana accessions

Sl. No.	Name of the group Genomic constitution	No.of Accn. studied	Vegetative Phase DS	Vegetative Phase YLS	Range DS	Range YLS
1.	Diploid-AA	4	54.18	14.5	51.9-56.0	6.5-8.0
2.	Cavendish-AAA	2	58.27	8.0	58.0-58.5	7.5-8.5
3.	Red banana-AAA	2	66.10	7.5	60.7-71.4	7.0-8.0
4.	Raja Vazhai-AAA	2	63.13	6.7	62.7-63.5	6.5-7.0
5.	Unique-AAA	4	47.89	10.0	36.8-53.1	9.0-12.0
6.	Ney Poovan-AB	9	45.11	11.4	26.5-62.6	7.5-15.0
7.	Kunnan-AB	14	48.04	11.1	40.8-61.7	8.0-15.0
8.	Silk-AAB	14	61.19	7.8	50.0-68.3	6.0-11.0
9.	Pome-AAB	44	49.43	9.7	31.7-62.2	8.0-13.0
10.	Plantain-AAB	2	55.44	9.5	55.5-9.5	9.0-10.0
11.	Nendra Padathi-AAB	8	42.82	9.7	30.9-49.2	8.0-14.5
12.	Poovan-AAB	12	52.24	8.3	39.2-60.7	7.0-11.5
13.	Pisang Awak-ABB	28	42.56	12.3	24.9-56.0	9.0-15.0
14.	Monthan-ABB	32	55.41	9.4	42.5-62.3	6.0-11.0
15.	Bluggoe-ABB	24	50.86	9.9	23.2-58.3	7.0-17.0
16.	Peyan-ABB	4	47.03	10.6	42.8-50.9	9.0-12.0
17.	Unique-ABB	5	47.18	12.6	42.3-52.2	11.0-14.0
18.	*Musa balbisiana*		20.70	15.3	11.1-21.9	11.0-17.5
19.	Tetraploids	3	42.25	11.8	36.3-46.6	11.0-13.0

Sigatoka incidence was not noticed in Vadakkan kadali - (AA), Petite Naine-(AAA), H1 (AAB), Ennabenian (AAB), Thiruvanandapuram (AAB), Kalibow - (AAB) and Local Peyan (ABB).

1.1.3 Taxonomic Evaluation:

Preliminary evaluation of *musa* accessions was carried out using Simmonds and Shepherds classification and score card developed by Silaloy and Chomchalow.

Accessions at the Centre's in **"Base collection block"** were assigned genomic status and tentatively classified into groups and sub-groups. From preliminary taxonomic evaluation, a **"Working collection block"** was established wherein germplasm with tentative groups and sub groups were planted and characterised in detail using INIBAP descriptors having 120 plant characters with slight modifications and a data base was developed using "GRINS" programme. An advanced version, DIP for developing germplasm information system is also being tried for the development of database. Till date, 208 accessions have been described and compiled.

Banana germplasms were critically examined for its identity in the group using 15 characters scoring for classification. From the scores, genomic status was assigned to different accession depending upon the scores obtained adopting the score card suggested by Silaloy and Chomchalow (1987).

Evaluation of scores obtained by different accessions had interesting results. The scores distinguished the large number of accessions into different genomic groups but distinction within the same group had overlapping influence. Overlapping in scoring was also observed in genomic group AAB and ABB. During the course of data collection it was observed that there is a need for refinement of score card as well as scoring characters especially to have better distinction in genomes having more characters from *balbisiana*. Thus, inclusion of some more characters for scoring and change in score card are being examined.

In an endeavour to distinguish sub-groups within the genomic group for better understanding, accessions were assessed using important characters of sub-groups. In AA diploid majority of accessions had distinct chacteristics thus, they could not be put into sub-groups while in other genomic groups it was possible to assign the sub-group to the accessions (Table 7). AA diploid accessions differed from each other for pseudostem colour, pigmentation, waxiness, blotches, bunch orientation, male bud characters and fruit parameters. Triploid acuminata (AAA) was distinguished into 5 broad sub-groups viz., Cavendish, Gross Michel, Lacatan, Red Banana and Rajavazhai. Plant stature, persistence of male bud, bunch shape and fruit characteristics are distinguishing characters for these sub-groups. Dwarf Cavendish had short stature robust plant, persistent male bract and male flower, closely spaced internodes; Plant in Robusta sub-group had tall stature and cylindrical bunch. Male axis was barren and pendulous but bent at tip. Raja Vazhai group was distinguishable with shiny, greenish yellow pseudostem, spreading petiole margin with conspicuous pink pigmentation. Bunch orientation was at an angle and fruits short, stout and rich yellow at ripeness with a prominent beak.

Table - 7 : Grouping of AA and AAA accessions into sub-groups

AA	0013	0064	0072	0185	0208	0329	0357	0380	0425
	0504	0543	0542	0548	0556				
AAA Cavendish	0002	0008	0012	0017	0022	0081	0111	0165	0200
	0238	0269	0283	0284	0295	0298	0302	0317	0324
	0370	0378	0441	0459	0460	0464	0465	0473	0484
Red Banana	0005	0035	0039	0042	0161	0318			
Raja Vazhai	0003	0069	0071	0166	0213				
Unique	0027	0105	0127	0257	0371	0372	0393		

Acuminata and Balbisiana hybrids were pooled into four major genomic groups viz., AB, AAB, ABB and tetraploids of which AAB and ABB constituted the major gene pool at the centre. AB diploids are characterized by medium stature, erect leaf orientation and long petioles. The basal colour of male flower is pink with 2-5 irregular flowers per hand. Bunch has a short peduncle and orientation is either horizontal or at an angle but never pendulous. This genomic group has been subdivided into Kunnan, Ney Poovan and Unique sub-groups (Table 8). Kunnan sub-groups is distinguishable from Ney Poovan sub-group by its erect leaf orientation, black blotches at petiolar junction and angular bunch orientation. Under the Unique sub-group Kodapanilla Kunnan and Padali Moongil find their place owing to the absence of male bud nature and elongated plantain like fruits.

Table - 8 : Grouping of AB accessions into sub-groups

AB-Ney Poovan	0062	0113	0140	0186	0237	0274	0307	0313	0316
	0361	0418	0438	0439	0440	0458	0486	0487	0511
Kunnan	0107	0114	0147	0174	0178	0234	0272	0328	0369
	0385	0388	0389	0392	0423	0482	0522	0538	0549
	0557								
Unique	0053	0232	0334						

Careful characterization of AAB genomic group led to the identification of five sub-groups (Table 9) viz., Silk (Rasthali), Mysore (Poovan), Pome (Pachanadan), Plantain (Nendran) and Nendra Padathi (Jawari Bale). Silk sub-group is characterized by yellowish green pseudostem and pink pigmentation all along the margin. Male bud is maroon in colour and flowers have an unique pink dotted stigmatic base and curved style, one or two.

Table 9 : Grouping of AAB accessions into sub-groups

AAB - Silk	0001	0006	0008	0014	0030	0057	0066	0077	0122
	0179	0214	0264	0297	0351	0355	0358	0365	0367
	0428	0444	0445	0462	0491	0512	0533		
Mysore	0010	0015	0041	0043	0045	0048	0078	0080	0136
	0143	0192	0215	0256	0279	0289	0294	0312	0362
	0422	0431	0476	0477	0478	0485	0510		
Pome	0028	0032	0036	0049	0061	0092	0093	0100	0116
	0118	0120	0128	0135	0141	0191	0196	0202	0206
	0210	0216	0218	0219	0230	0240	0241	0242	0243
	0249	0255	0258	0259	0262	0266	0275	0280	0282
	0286	0290	0292	0305	0310	0325	0327	0337	0339
	0340	0345	0348	0350	0359	0360	0364	0374	0375
	0376	0394	0396	0397	0410	0419	0420	0434	0437
	0489	0499	0518	0530	0535	0541	0542	0550	0552
	0553	0554	0558	0559	0560	0562	0563	0566	
Nendra Padathi(Tall)	0046	0187	0332	0495					
Dwarf	0074	0104	0110	0268	0278	0385	0540		
Plantain	0138	0207	0296	0468	0470	0488	0496		
Unique	0031	0125	0133	0156	0217	0308	0314	0326	0336
	0374	0466							

Mysore sub-group has members with predominant pink pigmentation including the ventral side of the midrib, ovoid male bud and acidic fruits. Members of Pome sub-group are comparatively more robust, bunch orientation is either horizontal or at an angle. Male phase is short with a whip like rachis ending with a top shaped male bud. Anthers abort and turn black at flag end stage of male phase and fruits are invariably angular. Plantain sub-group has distinct yellowish green pseudostem, pink pigmented petiolar base which is clasping in compound tepal, is orange yellow and fruits are starchy with orange coloured pulp. Nendra Padathi sub-group is characterized by the presence of persistent male bract and flowers throughout the male rachis with distinctly pink pigmented male flowers.

Characterization of ABB genomic group resulted in the identification of five sub-groups (Table 10) viz., Pisang Awak, Monthan, Bluggoe, Peyan and Unique. **Pisang Awak** is distinguished by robust pink pigmented pseudostem droopy leaves and curved laminar edges. Bunch is pendulous, compact and cylindrical with geometrically circular

Table 10 : Grouping of ABB Accessions into sub-groups

ABB-Pisang Awak	0044	0059	0065	0070	0073	0076	0079	0087	0089
	0103	0108	0112	0117	0193	0227	0231	0291	0341
	0342	0346	0347	0353	0354	0356	0417	0421	0432
	0433	0436	0442	0443	0453	481	0494	0517	0523
	0529	0551	0555	0564					
Bluggoe	0026	0034	0050	0055	0063	0085	0086	0090	0091
	0096	0097	0123	0124	0126	0131	0134	0137	0223
	0228	0239	0244	0247	0253	0265	0271	0288	0337
	0352	0366	0387	0395	0398	0399	0403	0409	0413
	0414	0416	0427	0435	0444	0490	0509	0526	0547
Unique	0338	0132	0251						
Monthan	0016	0054	0068	0082	0084	0115	0121	0129	0130
	0184	0221	0222	0226	0246	0289	0293	0306	0315
	0329	0349	0363	0401	0402	0404	0405	0412	0415
	0429	0479	0514	0519	0528				
Pacha Bontha Batheesa	0088	0505							
Ash coated Batheesa	0267	0493							
Pagar banana	0060	0102	0426	0430					
Unique	0004								
ABB-Peyan	0040	0106	0220	0321	0322	0335			

arrangement of hands around the peduncle. Fruits are ash coated with a high TSS upto 31° Brix. **Peyan** sub-group is distinguishable by circular black blotches on petiolar sides. Pink male bud which is intensely ash coated, very pointed with deep pink flowers. Fingers short, stout with 4-5 unequal sides with orange pulp. **Monthan** sub-group is characterised by yellowish green pseudostem pendulous bunch orientation and short male axis. Male bud is lanceolate and fruits have conspicuous cap. **Bluggoe** sub-group is distinguishable from Monthan by its dark green pseudostem. Bunch cylindrical with short fingers without conspicuous cap and tapering at the end. Both sub-groups have ash coated mutants.

Variability in male phase of banana genomes.

During the year under report, 370 accessions were planted in working collection as per the genomic grouping and sub-grouping. Four plants under each accessions are maintained, under uniform production system and after care. Data, both in vegetative and reproductive phases were collected using the descriptor with 120 characters. A computerised database for all the accessions has been developed using GRINS programme of IPGRI.

From the analysis of morpho-taxonomic data it has been possible to develop a system, in which different accessions can be delineated in genomic group and sub-group (fig.2). This is an attempt and may require refinement with better understanding after collection of data on other accessions.

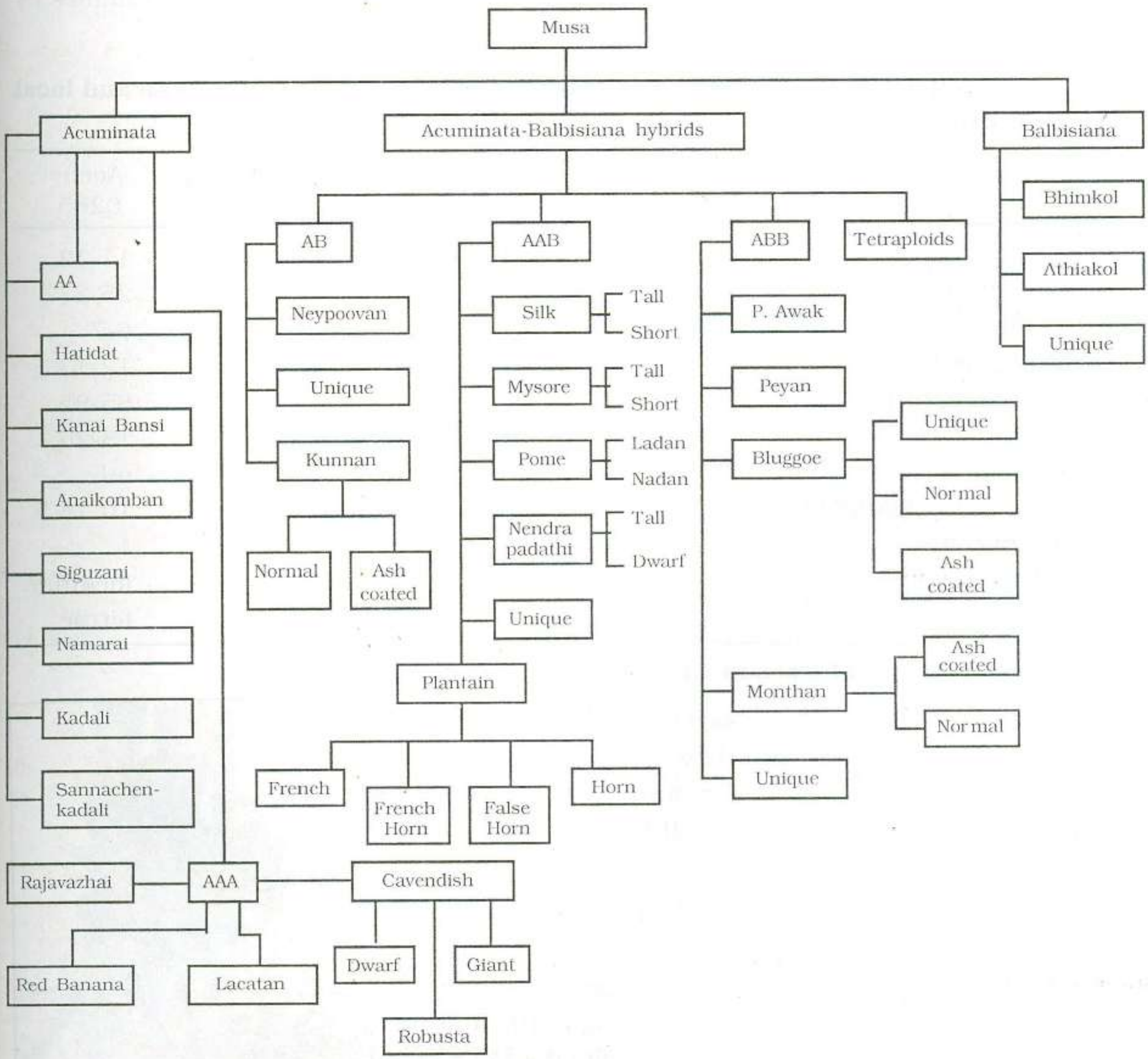


Fig. 2 : Grouping of *Musa* accessions available at NRCB.

1.1.4 Germplasm Utilization

Evaluation of *Musa* gene pool for a number of parameters led to the identification of donor parents with desirable traits. Some of the accession found their utility directly as superior selections or identified for long term conventional breeding programmes.

Accession no. 0265 belonging to Bluggoe (ABB) unique group was found to be superior with respect to stability of yield and salt tolerance. Accession 0265 is a medium tall plant growing to a height of 250-300 cm, with a pseudostem circumference of 60-70 cm. Mean bunch yield is 25 kg from 7 hands. (Table 11). This has a combination of both Monthan and Bluggoe characters. The fruits are darkgreen, long and stout like Monthan

and have sharp tip of Bluggoe. Compared to the yield of 20kg in local Monthan and 18 kg in Bluggoe, Accession 0265 is a better yielder (25-27 kg). Accession 0265 also shows minimum salt injury and finds utility in conventional breeding programmes by virtue of the fact that it has male and female fertility.

TABLE11: Comparative Evaluation of accession 0265 with local Monthan and local Bluggoe

Parameters	Local Monthan	Local Bluggoe	Accn. 0265
Crop duration	12-14	12-13	11-12
Av.bunch wt (kg)	18-20	17-18	25-27
No.of hands	4-5	4-5	6-7
Av.no.of fingers/hand	13-14	12-13	12-13
Av.no.of fingers/bunch	70-80	60-68	85-95
T.S.S. (' Brix)	18-20	18-20	18-20
Wilt incidence	nil	nil	nil
Susceptibility to sigatoka (PD1)	15-20.5	18-23.5	10-18.5
Salt susceptibility	3	4	1
Presence of pollen	scanty	nil	medium
Female fertility	nil	fertile	fertile

1.1.4.1 Performance of Ratoon Crop of promising selections

Accession no. 0016: First and second ratoons of selection 0016 were found to yield similarly with a difference of 1.5 kg in yield. Sigatoka incidence and salt injury were conspicuously less compared to local Monthan and ratoon crop duration was less by 18-25 days.

Accession no. 0030: Plant crop and first ratoon gave high yield although second ratoon was affected by wilt. In contrast, the local silk and allied accessions succumbed to wilt in plant crop itself. Selection 0030 looked promising in the first two years of crop growth and was affected by wilt later.

Accession no. 0052: First ratoon of accession no. 0052 belonging to Silver Monthan (ABB) sub group showed comparable yield with local silver Monthan under severe salt injury of score 5 and with only 6-7 photosynthetically active leaves.

A bunch of selection 0052 (ABB-Monthan sub-group)

Accession no. 0079: Ratoon of accession 0079 belonging to Pisang Awak was found superior with respect to yield and dwarf stature compared to local Karpuravalli (Table 12).

TABLE 12: Comparative performance of ratoon crop of promising selection 0079 with Karpuravalli

Parameters	Local Karpuravalli	Selection 0079
Plant Height (cm)	380-400	330-350
Crop duration (months)	14-15	14-15
Av.Bunch wt (kg)	20-21	23-24
No.of hands	11-12	13-14
Av.No.of fingers per hand	16-20	16-20
Av.No.of fingers per bunch	200-210	225-235
T.S.S.(°Brix)	28-30	28-31
Incidence of Wilt	Yes	Nil
Sigatoka (%) (PDI)	11-25	0-10
Salt Susceptibility	1-2	1-2
Pollen fertility	fertile	fertile
Female fertility	fertile	fertile

1.1.4.2 Comparative evaluation of Accn.0079 with local Karpuravalli

A trial was laid out in CRD with 8 replications and 6 plants per replication. Significant differences were observed for plant height and yield parameters (Table 13). This accession was selected for its superiority over local Karpuravalli with respect to yield and plant height.

A bunch of selection 0079 (ABB–Pisang Awak sub-group)

1.2 Breeding for Biotic and Abiotic stresses and yield potential :

Breeding for crop improvement involves crossing between male and female parents having desirable characteristics. To achieve this, the germplasm has to be screened to identify parents depending upon their fertility status. The following experiments were done with this objective in mind.

TABLE 13: Comparison of selection 0079 with Karpuravalli for growth and yield parameters

Varieties	Plant height (cm)	Pseudostem circumference (cm)	No.of Photo-synthetically active leaves	Days to shooting	Yield (kg)
Local Karpuravalli	376.22	69.44	15.44	351.56	20.34
Selection 0079	345.53	65.89	15.96	341.85	24.13
S.E	6.60	2.1093	0.2936	10.138	5.7438
LSD (P=0.05)	13.2172	N.S	N.S.	N.S.	3.724
C.V %	12.91	16.19	9.72	14.97	8.37

1.2.1 Development of resistant cultivars to biotic and abiotic stresses with high yield potential and fruit quality:

Pollen fertility studies revealed 188 pollen parents with varying degrees of pollen while female fertility studies revealed 48 potential female parents with varying number of seed yield depending on genomic group and subgroups under both open and cross pollinated conditions. Of these, 2 belong to AA, 3 to AAB (Poovan), 1 to plantain (AAB), 9 to Pome (AAB), 18 to Pisang Awak, 4 to Bluggoe and 8 to BB/BBB groups.

Among 3632 crosses made last year, (using 8 as male and 26 female parents) seed set was observed in 16 combinations but successful seed germination was noticed in only two. Seeds among eight groups and subgroups showed great variation with respect to number of seeds set, seed distribution in the fruit and germination. Members of Awak subgroup, selected members of balbisiana clones and one Pome member had 88, 100 and 26 per cent of germination respectively. The seedlings are being evaluated.

1.2.2 Evaluation of hybrids and promising cultivars against sigatoka leaf spot disease:

In order to findout the performance of hybrids along with commercial cultivar a trial was laid out in August 1996. Initially field mortality was high in most of the accessions which were replanted immediately. Excepting PV-03-22, all the accessions are still in vegetative phase of growth. Growth parameters and sigatoka incidence were recorded (Table 14).

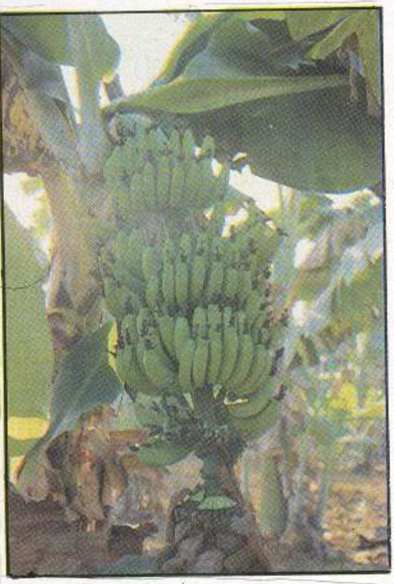
Disease incidence was recorded following 0-6 scale method, six months after planting. The youngest leaf spotted (YLS) was also recorded at the same time. Disease Development Time (DDT) and Leaf Emission Rate (LER/Week) were recorded at bimonthly intervals. The incidence of Sigatoka was noted in three varieties namely Saba, Pisang Ceylan and Robusta and the maximum disease incidence of 37.61 per cent was recorded in the variety Robusta and minimum incidence of 15.01 per cent in Pisang Ceylan. However,

TABLE 14: Growth parameters of Sigatoka test accessions

Sl. No.	Genomic Name	Height (cm) 5th month	Height (cm) 7th month	Circumference(cm) 5th month	Circumference(cm) 7th month	No. of leaves 5th month	No. of leaves 7th month
1.	FHIA-23	87.6	130.2	37.3	49.6	8.3	15.1
2.	PV-03-44	69.0	127.7	23.9	40.4	11.7	19.3
3.	PV-03-22	90.7	145.4	32.2	50.2	13.5	20.7
4.	SH-3436-9	67.7	115.4	26.9	43.8	12.4	20.8
5.	Yangambi Km-5 *	-	-	-	-	-	-
6.	Saba	107.3	188.5	40.9	59.0	13.6	21.4
7.	Pisang Ceylan	67.9	127.3	21.5	39.6	9.3	16.6
8.	Calcutta-4 *	-	-	-	-	-	-
9.	Pisang Lilin	117.0	158.0	33.3	38.0	18.0	24.3
10.	Pisang Berlin	50.1	81.1	19.5	30.3	11.9	20.4
11.	Niyarma Yik	56.3	102.6	21.3	35.7	10.4	17.9
12.	Local cv Robusta	67.5	111.8	26.6	39.0	12.7	19.7

* Plants did not establish

the YLS was maximum in Saba which was followed by Robusta and Pisang Ceylan. The Disease Development Time (DDT) in cultivars Saba, Pisang Ceylan and Robusta were 63.62, 59.67 and 59.17 days respectively. The LER/Week in Pisang Ceylan was 1.28 followed by SH-3436 (1.05) and PV-03644 (1.04). The LER was very low (0.90) in local cultivar Robusta. There was no incidence of Sigatoka in other accessions namely FHIA-23, PV-03-44, PA-03-22, SH-3436-9, Pisang Lilin, Pisang Berlin and Niyarma Yik.


FHIA-I, A hybrid banana from Honduras

1.2.3 Evaluation of hybrids and other cultivars for growth, yield and reaction to fusarium wilt.

Promising hybrids from Honduras, Brazil and Taiwan along with other commercial cultivars and donor source of resistance against Fusarium wilt pathogen were evaluated under field conditions. Cultivars and hybrid varied for growth characters and also days to shooting (Table 15).

No incidence of wilt has been observed. However, varying intensity of sigatoka was observed in rainy season (Fig. 3). Thus observations on disease severity and youngest leaf spotted were recorded. Cultivar Rose(AA), Yangambi KM-5(AAA), Pisang Jari Buaya (AA) and Pisang Lilin did not record the incidence of Sigatoka leaf spot. Among the hybrids, PV-03-44 (AAAB) PA-03-22 (AAAB) and FHIA-3 recorded no incidence of Sigatoka. Gros Michel (AAA), GCTCV-119(AAA) and GCTCV-215 (AAA) recorded high incidence of Sigatoka. Highest incidence of sigatoka was noted in williams (AAA) and Pisang Ceylan (AAB).

TABLE 15:Growth evaluation of hybrids and commercial cultivars under IMTP wilt trial.

Sl. No.	Name of the Accession	Mean Plant Height(cm)	Pseudostem circumference (cm)	Photosynthetically active leaves	Days for shooting
01.	FHIA-01	207.0	72.5	14.1	227.6
02.	FHIA-03	239.1	88.0	13.1	260.1
03.	FHIA-17 *				
04.	FHIA-23 *				
05.	PV03-44	247.8	68.2	14.6	222.8
06.	PA03-22	178.2	65.1	15.1	195.3
07.	GCTCV-119 *				
08.	GCTCV-215 *				
09.	Burrocemsa	289.0	81.4	15.2	237.6
10.	Pisang Mas	260.0	59.0	14.0	288.0
11.	Saba	308.7	82.0	15.5	258.2
12.	Pisang Nangka *				
13.	Cultivar Rose	167.9	44.6	13.6	216.5
14.	Yangambi KM-5	200.0	59.0	9.0	320.0
15.	Pisang Jari Buya	284.2	59.7	12.2	270.2
16.	Pisang Lilin	120.0	33.5	7.0	213.0
17.	Calcutta A *				
18.	Gros michel *				
19.	Bluggoe	303.5	90.0	14.5	299.1
20.	Williams	138.0	57.5	10.0	303.0
21.	Pisang Ceylan	260.0	75.0	11.0	298.0
22.	Rasthali	175.0	55.0	11.0	320.0

* These plants have not yet flowered.

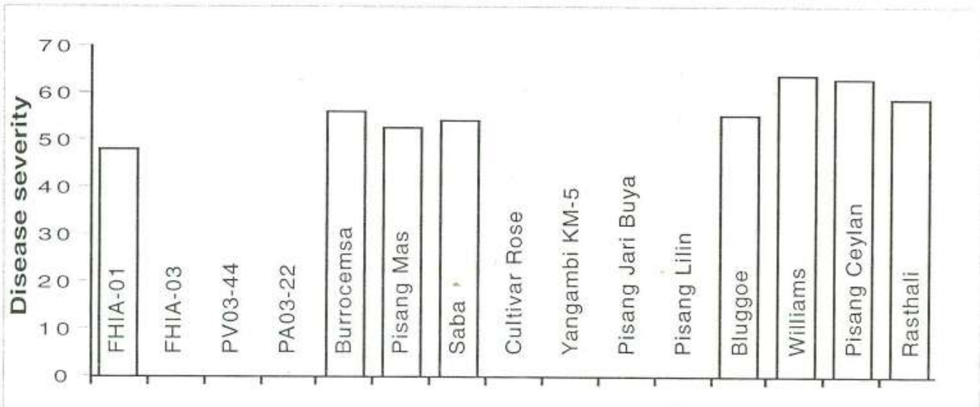


Fig. 3 : Bar Diagram showing the sigatoka disease severity

1.3 Biotechnological Approaches for Improvement :

1.3.1 *In vitro* germplasm management

Inclusion of antibiotics (0.1%) in the medium and increasing the explant size were found to prevent contamination and by this procedure several contaminated cultures were rescued, the details of which are given in table 16.

TABLE 16: Recovery of contaminated cultures in a medium containing antibiotics

Accn.No.	Genomic status	Percent recovery
0310	AB	34.8
0283	AAA	50.2
0296	AAB (Plantain)	50.2
0637	AAB (Unique)	66.6
0292	AAB (Pome)	34.0
0689	ABB (Pisang Awak)	80.6
0079	ABB (Pisang Awak)	55.5
0689	ABB (Bluggoe)	83.3
0644	ABB (Bluggoe)	50.5
0686	ABB (Bluggoe)	75.3
0626	AAAB (Tetraploid)	50.0
0628	AAAA (Tetraploid)	66.6
0629	AAAA (Tetraploid)	96.0
0631	AAAB (Tetraploid)	92.3

French plantain (AAB), Silk (AAB) and Pisang Awak (ABB) were highly sensitive to browning due to exudation of phenols. The loss of cultures during initiation due to the above was 8.7, 6.2 and 13.4 per cent respectively. Addition of charcoal and antioxidants reduced browning in AAB and ABB genomic groups but was not effective in accession 0079 of Pisang Awak (ABB) subgroup.

Response to rooting hormones among the various genomic groups showed that MS medium containing BAP (1 mM) + IAA (5 mM) followed by transfer to 1/2 MS + without growth regulators was found suited for ABB cultivars . The details are shown in Table 17.

Two Musa *acuminata* sub-species Peekeli and Macleii exhibited poor growth in a medium supplemented with 10 mM concentration of BAP. By transfering the cultures to lower BAP concentrations their growth could be restored to normal.

Freshly extracted suckers were found to be the best material for initiation of cultures. Bacterial contamination was the main bottleneck for culture initiation of germplasm transported from elsewhere. For older suckers (4-6 days after extraction) decontamination methods using Cetrimide + Streptocyclin dip for 2 minutes followed by Mercuric Chloride dip for 5 minutes was found to be effective.

TABLE 17: Rooting response of ABB cultivars to different rooting media

Parameters	TI		TII		TIII	
	0291	0644	0291	0644	0291	0644
No.of roots (after 30 days)	6-8	6-7	3-4	3-4	4-5	3-4
Length of the roots (cm)	8-10	8-10	3-4	1-2	5-6	6-7
Root ramification	Medium	Medium	Medium	Medium	Low	Low
Shoot development	Normal	Slightly lanky plants	well deve-loped	well deve-loped	Very lanky weak	Very lanky weak

Treatment details TI : 1/2 MS + NAA + Charcoal
TII : MS + BAP + 1AA
TIII : 1/2 MS + No growth regulator

1.3.2 *In vitro* conservation

In vitro propagation of banana accessions

Success in initiation of cultures varied greatly with the common protocol developed for *in vitro* multiplication of musa accessions belonging to different genomes. Most of the Cavendish cultivars (AAA) could be easily established in cultures (68.11%) except Yangambi km5 (9.3%). Initiation of tetraploid hybrids were slow and SH-3436-9 was found frequently succumbing to bacterial or mold contamination. Among the hybrids, FHIA-03 and FHIA-23 exhibited slow growth initially and improved subsequently. Among *acuminata* diploids, *M. acuminata* sp burmoniccoides exhibited poor intiation and proliferation while cv.Rose exhibited 98.6% initiation. ABB was the easiest to be initiated in cultures and showed early proliferation. Among the ABB group members, Bluggoe and Saba were better compared to Burro CEMSA with respect to initiation and proliferation. Accession No. 0079, the dwarf selection of Karpuravalli, exhibited poor culture initiation as compared to Karpuravalli and frequently got contaminated by bacteria.

1.3.3 Embryo Culture

Plans developed from excised embryo of cultivar Karpuravalli

Banana is a parthenocarpic fruit which rarely sets seeds depending on its female fertility status, season and male parent. Seed germination is the major constraint under natural conditions. In order to overcome this problem trials were conducted with a few varieties of *Musa* by culturing excised embryo on modified Murashige and Skoog's medium. Five varieties and three replications were tried. Germination was recorded after 15 days in culture.

2. PRODUCTION TECHNOLOGY

The objective of this programme is to achieve sustainable increase in production without any deleterious effects on soil health and environment through the integrated management of nutrient, water and other recurring inputs.

2.1 Agrotechniques

2.1.1 Influence of edaphic factors on growth, yield, fruit quality and incidence of leaf spot disease in different banana cultivars.

Observations were recorded on various plant growth parameters like plant height, pseudostem circumference,number of suckers, number of healthy leaves at flowering and mean leaf area which were correlated with prevailing weather parameters (Table 18). The results are presented against each of the cultivars tested (Table 19 & 20).

TABLE 18: Weather parameters during the time of planting

Treatment/ time	Temperature(°C) Max.	Temperature(°C) Min.	R.H.(%)	Rainfall (mm)	Evaporation (mm)
T1 (June)	36.9 (34.5-39.0)	25.0 (22.5-28.0)	69.8 (61.0-78.0)	22.8	6.6 (4.0-7.6)
T2(August)	36.2 (35.0-38.0)	23.6 (22.0-25.0)	78.20 (55.0-92.0)	63.0	5.0 (4.2-6.6)
T3(October)	33.6 (32.0-37.0)	22.4 (21.0-24.0)	82.7 (77.0-85.0)	299.2	5.2 (4.0-6.8)
T4(December)	31.1 (30.0-35.0)	18.9 (17.0-22.0)	82.9 (61.0-92.0)	-	5.1 (4.0-6.6)
T5(February)	34.7 (33.0-37.0)	20.5 (17.0-25.0)	75.5 (57.0-96.0)	-	6.8 (6.2-7.8)
T6(April)	39.9 (38.0-41.0)	24.5 (23.0-26.0)	69.7 (55.0-72.0)	-	7.0 (6.0-8.0)

Figures in parentheses indicate the range of values

Pachanadan

Among the treatments, April planted group recorded significantly higher plant height (265.2cm), pseudostem circumference (62.9cm), number of leaves (20.28) and mean leaf area (127.07 dm^2) than other treatments. The time taken for flowering was 281.2 days in October planted group while a maximum time of 337.86 days was recorded by those planted in December which also recorded the least values for other growth parameters.

TABLE 19: Effect of edaphic factors on morphological characters of banana cultivars Pachanadan, Nendran and Robusta.

Treat ment	Plant height (cm)	Pseudostem circumference (cm)	No.of suckers/ plant	No.of healthy leaves	Mean leaf area (dm^2)	Petiole length (cm)	Time taken for flowering (days)
PACHANADAN:							
T1	250.43	62.78	6.86	14.18	119.45	39.11	301.45
T2	241.15	60.95	4.94	15.33	93.85	38.93	316.85
T3	224.55	60.73	3.53	15.43	88.23	38.75	281.20
T4	206.50	51.00	2.88	11.83	73.28	35.37	337.86
T5	255.23	56.20	2.59	20.81	105.84	47.79	302.60
T6	265.20	62.95	4.38	20.28	127.07	47.75	305.50
LSD (P=0.05)	9.705	2.386	0.757	1.388	8.884	3.816	13.151
NENDRAN:							
T1	246.10	51.08	6.12	10.38	86.87	29.90	322.53
T2	228.13	50.92	4.87	14.55	69.50	25.94	302.98
T3	206.58	44.73	4.45	11.03	75.25	32.63	311.95
T4	195.00	50.63	4.75	9.80	74.16	32.50	289.83
T5	255.00	53.17	4.83	16.83	103.27	32.63	274.47
T6	261.88	55.50	6.13	11.75	94.31	36.88	281.68
LSD (P = 0.05)	16.748	3.841	N.S.	2.134	8.369	2.544	13.122
ROBUSTA:							
T1	196.07	53.06	3.23	11.89	78.35	33.07	373.00
T2	197.86	55.93	3.79	12.14	78.98	36.32	348.23
T3	181.25	53.35	5.70	12.50	59.28	24.38	321.73
T4	168.75	52.50	4.28	10.75	74.54	29.28	314.33
T5	203.54	56.60	4.15	10.63	100.46	32.38	316.35
T6	222.00	61.50	4.03	13.13	119.11	30.63	338.50
LSD (P = 0.05)	14.307	N.S	0.859*	0.9709*	8.969	2.438**	17.566**

Nendran

Significant differences were recorded in all the growth parameters except the number of suckers/plant. Maximum plant height (261.88cm), pseudostem circumference (55.5cm), Number of suckers (6.13) and petiole length (36.88cm) were recorded in the plants under T6 (April planted) while early flowering (274.4 days) higher leaf area (103.2 dm^2) and more number of leaves (16.83) were recorded under T5 (February planted). Among the treatments T1 (June planted) took maximum number of days for flowering (332.53 days) followed by (October planting) (311.95 days).

TABLE 20: Effect of edaphic factors on morphological characters of banana cultivars Rasthali, Poovan and Karpuravalli.

Treat ment	Plant height (cm)	Pseudostem circumference (cm)	No.of suckers/ plant	No.of healthy leaves	Mean leaf area (dm^2)	Petiole length (cm)	Time taken for flowering (days)
<u>RASTHALI:</u>							
T1	182.37	53.68	7.43	11.96	66.72	39.96	374.25
T2	183.60	55.14	7.50	14.93	66.63	45.07	381.60
T3	194.75	53.94	9.13	14.30	78.37	46.24	352.10
T4	192.85	56.94	10.69	11.02	82.91	40.88	383.48
T5	228.25	64.88	8.88	11.18	95.68	48.51	341.75
T6	241.25	63.38	6.63	9.88	106.29	41.25	346.75
LSD (P = 0.05)	13.945*	2.988**	1.230**	1.233**	9.245**	2.411**	11.589**
<u>POOVAN :</u>							
T1	232.27	56.71	4.24	11.93	85.94	42.76	371.28
T2	219.28	54.53	3.81	12.11	72.85	43.14	365.25
T3	193.88	48.75	4.69	11.87	88.41	42.13	350.65
T4	209.53	47.75	4.47	11.97	94.99	43.88	354.88
T5	246.25	58.50	4.83	11.45	111.41	48.25	330.55
T6	273.13	63.00	5.63	9.70	124.14	51.25	321.48
LSD (P = 0.05)	13.600**	3.333**	N.S	0.995*	10.822**	2.798**	12.792**
<u>KARPURAVALLI:</u>							
T1	240.96	70.29	6.39	15.33	82.82	53.04	414.13
T2	232.10	67.77	5.64	14.60	72.22	50.89	396.20
T3	259.02	66.84	5.70	14.61	98.61	45.75	385.50
T4	275.38	71.25	5.26	15.73	116.21	50.25	397.33
T5	302.13	73.50	4.38	15.19	105.47	50.73	383.25
T6	312.50	78.50	4.93	14.71	106.31	52.75	380.40
LSD (P = 0.05)	16.879**	4.279**	N.S	N.S	6.225**	N.S	8.478

Robusta

Maximum plant height (222.0 cm), pseudostem circumference (61.03cm), number of healthy leaves (13.13) and mean leaf area (119.11 dm^2) were recorded under T6 whereas the shortest plant height of 168.75 cm was recorded under T4. The plants under T4 and T5 flowered earlier (314.3 and 316.4 days respectively) and were better than plants under T1 which took 373.0 days.

Rasthali

All the growth parameters showed significant differences under various treatments. Maximum plant height (241.25 cm) and mean leaf area (106.29 dm^2) were recorded under T6 while the number of suckers (6.63) and number of healthy leaves at flowering (9.88) were the lowest. The plants under T5 flowered earlier (341.63 days) than the other treatments and the plants under T4 took the maximum number of days for flowering (383.5).

Poovan

Significant differences in all growth parameters were recorded except the number of suckers/plant. Vigourous plants with a maximum plant height (273.13 cm), pseudostem circumference (63.0), mean leaf area (124.3 dm^2), petiole length (51.25 cm) and earliness for flowering (321.5 days) were recorded under T6 while it also recorded the least no. of healthy leaves (9.98) at flowering. The time taken for flowering under various treatments varied from 321.48 days(T6) to 371.28 (T1) days.

Karpuravalli

In Karpuravalli, maximum plant height (312.5 cm) and pseudostem circumference (78.5 cm) were recorded under T6 while T4 recorded the maximum values for no. of suckers (5.26) and number of healthy leaves (15.78) with a large leaf area of 116.21 dm^2. The time taken for flowering was the minimum under T6 (380.4 days) and maximum under T1 (414.13 days).

The experiment is in progress and observations on field and quality parameters are being recorded.

2.2 Soil Health Management

2.2.1 Effect of organic and inorganic nutrition on growth and yield of different banana cultivars.

This trial was conducted with six cultivars to find out the influence of organic and inorganic source of nutrition on plant growth and soil health. Observations were recorded on growth, yield and quality parameters of six varieties. In addition, the effect of organic and inorganic nutrition on the salt injury level in different cultivars were also studied. The results are presented in Table – 21.

Rasthali

Significant differences were recorded in all the parameters studied except for the plant height. Application of 25% N FYM + 50% N neemcake + 25% N inorganic (T4) recorded maximum pseudostem circumference (58.9 cm), no. of healthy leaves (17.50), mean leaf area (82.9 dm^2), bunch weight (12.9 kg) and T.S.S. (24.5°Brix). It also recorded less salt injury (31.49%), and a crop duration of 450.4 days. Application of 200g N (100%) (T1) in inorganic form recorded the maximum salt injury level (61.8%) and also took more time for completion of life cycle (502.9 days) besides recording the least bunch weight of 10.5 kgs.

TABLE 21: Effect of Organic and inorganic nutrition on growth, yield and quality of banana

Treat ment	Plant height (cm)	Pseudostem circum-ference (cm)	No.of healthy leaves	Mean leaf area (dm^2)	Total crop Duration (days)	Bunch wt (kgs)	T.S.S. (^{0}Brix)	Salt injury level (%)
POOVAN :								
T1	220.10	51.40	12.00	76.50	497.50	12.50	15.5	50.12
T2	226.75	51.80	12.40	79.10	473.70	12.20	16.30	42.16
T3	227.30	53.30	13.00	82.50	480.20	12.70	15.90	21.86
T4	229.20	56.20	13.50	80.90	468.30	13.80	16.40	18.58
T5	229.30	56.90	15.40	88.50	430.50	14.60	17.20	9.95
T6	229.00	56.90	12.80	77.60	468.50	13.80	15.40	40.11
LSD (P=0.05)	9.27	2.50	1.16	2.92	11.26	1.08	N.S.	2.419
MONTHAN:								
T1	273.10	65.60	15.40	82.30	546.10	14.10	20.50	39.13
T2	277.90	67.40	15.90	81.30	546.10	14.10	20.50	39.98
T3	280.80	65.20	16.00	82.20	523.10	15.10	20.90	22.04
T4	295.20	72.30	18.60	88.50	504.40	16.10	22.40	20.68
T5	292.20	70.50	16.68	85.50	507.40	15.70	22.10	15.26
T6	278.70	67.80	15.90	80.80	533.20	14.10	20.60	33.02
LSD (P=0.05)	5.39	4.001	0.56	2.89	13.70	0.44	0.72	2.616
KARPURAVALLI								
T1	291.80	65.80	15.20	77.30	574.50	14.98	26.00	50.09
T2	285.90	67.20	16.00	80.60	563.70	16.42	26.43	42.07
T3	291.30	69.90	15.47	85.30	567.80	15.63	26.68	36.10
T4	297.90	77.60	18.25	91.90	538.40	17.72	27.28	23.47
T5	286.50	68.80	15.68	83.80	544.90	16.80	26.63	11.91
T6	292.70	71.70	15.99	87.37	561.10	15.73	26.40	39.45
LSD (P=0.05)	N.S.	3.652	1.245	5.162	16.811	0.775	N.S.	1.928

Robusta

In Robusta, more robust plants in terms of plant height (233.2 cm), pseudostem circumference (66.9 cm), healthy leaves (17.5), larger mean leaf area (89.6 dm^2), heavy bunches (15.8 kgs) and fruits with more T.S.S. were recorded under the treatment 25% N FYM+ 50% N Neem cake + 25% N inorganic (T5) which also recorded the least salt injury level (12.48%) and total crop duration (430.3 days). The salt injury level was found maximum under 200 g N inorganic nutrition which was significantly higher than all other treatments. The plants under 200 g N (T1) inorganic took more time for flowering as well as for maturity and in turn the total crop duration was maximum (465 days) under this treatment.

Nendran

No observations could be recorded from this variety as maximum number of plants were lodged due to heavy winds during the month of June. Now, observations are being recorded on the daughter suckers.

Poovan

The plants under the treatment, T5 with application of 25% N FYM + 50% N neemcake + 25% N inorganic nutrition recorded the maximum values for all the growth and yield parameters which was significantly higher than other treatments. Besides, it reduced the salt injury level in the leaf lamina and the total crop duration (430.5 days) as the plants under this treatment (T5) flowered and matured earlier than other treatments. The longest crop duration of 497.5 days and maximum salt injury level of 50.12% were recorded with the plants receiving nutrients as inorganic source.

Monthan

In Monthan, application of 25% N FYM + 25% N neemcake + 50% N inorganic (T4) recorded the most vigorous plants as evidenced from the fact that the plants under this treatment produced taller plants (295.2 cm) with thicker pseudostem (72.3 cm), more number of healthy leaves (18.6), larger mean leaf area (88.5 dm^2), higher bunch weight (16.1 kgs) and T.S.S. (22.4 o Brix) which were on par with T5. The crop duration was found less (504.4 days) under T5 and the plants recorded the least salt injury level of 15.26 per cent as against 39.98 per cent recorded under 25% N FYM + 75% N inorganic (T2).

Karpuravalli

In Karpuravalli, significant differences were observed among the treatments for all the growth and yield parameters except plant height and number of suckers/plant. Among the treatments, T4 (25% N FYM + 25% N neemcake + 50% N inorganic) recorded maximum plant height, pseudostem circumference, number of leaves, mean leaf area and bunch weight besides recording less salt injury level and shorter crop duration as compared to other treatments. Application of 200 g N inorganic recorded significantly higher salt injury level of 50.09 per cent and crop duration of 574.5 days.

2.2.2 Growth and yield of banana cv. Karpuravalli as influenced by weeds:

This experiment was laid out during February 1996 to study the influence of weeds at various stages on the growth and yield of banana. The aim of the experiment is to determine the critical stage of crop growth at which the influence of weed is maximal. The treatment details are given below.

T1 : No Weeding

T2 : Removal of weeds by scrapping at monthly intervals.

T3 : Traditional weeding practices i.e. removal o weeds by digging at the time of first application of fertilizers and subsequently during the second, third & fourth split application of fertilizers and also while making irrigation channels.

T4 : Weeding done from 4th month upto 12th month.

T5 : Weeding done from 7th month upto 12th month.

T6 : Weeding upto 3rd month followed by no weeding from 4th to 6th month and weeding again till harvest.

T7 : Weed free till 6th month, no weeding between 6th and 9th month followed by weed free condition till harvest.

Control : Weeding upto 9th month only.

Growth observations were recorded 9 months after planting. The results revealed that the growth parameters were significantly reduced in all the treatments. The plant height was reduced by 48.3% under T1 as compared to control. The number of suckers per plant was only 1.68 under T1 as against 4.8 in control suggesting that the presence of weed at early stages of growth adversely affects the plant growth and development (Table - 22). It is also evident that the maintenance of weed free condition during the first 6-9 months recorded no significant differences for the characters studied suggesting that the weeding during the first 6 months is critical for the satisfactory growth and development of banana.

Table 22 : Effect of weeds on the growth parameters in banana cultivar Karpuravalli at 9 months after planting.

Treatment	Plant height (cm)	Pseudostem circumference (cm)	No. of suckers	No.of healthy leaves	Mean leaf area (dm^2)
T1	87.88	39.68	1.68	13.33	43.18
	(-48.25)	(-33.68)	(-65.00)	(-33.61)	(-38.95)
T2	97.90	45.30	2.08	14.88	43.40
	(-42.35)	(-23.95)	(-56.67)	(-25.89)	(-38.64)
T3	100.13	50.08	2.68	15.38	57.70
	(-41.10)	(-16.30)	(-44.16)	(-23.40)	(-18.43)
T4	114.63	51.13	3.73	13.45	48.28
	(-32.50)	(-14.94)	(-22.29)	(-33.02)	(-31.74)
T5	89.63	41.55	3.10	13.18	44.40
	(-47.22)	(-30.55)	(-35.42)	(-34.36)	(-37.23)
T6	130.88	51.25	3.07	15.83	54.03
	(-22.93)	(-14.34)	(-36.04)	(-21.16)	(-23.61)
T7	168.38	60.55	4.90	20.55	65.62
	(-0.85)	(+1.2)	(+2.1)	(+2.3)	(-7.22)
Control	169.83	2.581	0.623	0.784	4.173
LSD (P=0.05)	6.117	2.581	0.623	0.784	4.173

Figures in parentheses indicate per cent increase(+)/decrease(-) over control.

2.2.3 Management of Soil Salinity and Sodicity

Sixty rhizosphere soil samples of five banana varieties, namely Rasthali, Robusta, Monthan, Karpuravalli and Poovan were collected. The salinity and sodicity of the samples were determined in terms of Electrical conductivity (dsm^{-1}) and ppm, respectively. Soil salinity and sodicity values were correlated with the salt injury levels which was worked out according to the formula,

$$\text{Salt Injury Level (\%)} = \frac{(n^1x1)+(n^2x2)+(n^3x3)+(n^4x4)}{N \times 4} \times 100$$

where n^1 = No. of leaves with 01-25% injury
n^2 = No. of leaves with 26-50% injury
n^3 = No. of leaves with 51-75% injury
n^4 = No. of leaves with > 75% injury
N = Total No. of leaves per plant

The soil salinity ranged from 0.1120 to 0.3992 dsm^{-1} and the sodicity ranged from 495 to 985 ppm. The salt injury levels in banana varieties ranged from 9.95 to 61.51 per cent.

The correlation coefficient (r) and coefficient of determination (d) between soil salinity and salt injury on plant were found to be 0.5769 ** and 0.3328, respectively ie., 33.28 per cent of total variation in salt injury level was due to the salinity of soil.

The "r" and "d" between soil sodicity and salt injury to plant were found to be 0.8083 ** and 0.6533, respectively ie., 65.33 per cent of total variation in salt injury level is due to the sodicity of soil.

The "r" and "d" between soil sodicity and soil salinity were found to be 0.8471 ** and 0.7176, respectively ie., 71.76 per cent of total variation in soil salinity is due to the soil sodicity.

From the above study, it was inferred that the sodic salts form the main constituent of total salts of NRCB farm soil and are highly responsible for the salt injury to different varieties of banana.

** ⟶ Significant at 0.01 per cent level

2.2.4 Soil-Plant relationships regarding K and Na

Twenty rhizosphere soil samples and corresponding plant leaf samples (Third from the youngest fully opened leaf) of 20 different accessions were collected. The soil and leaf samples were analyzed for K and Na contents. The salt injury scorings in all the 20 plants were made following 0-6 scale ratings.

The soil K content was positively correlated with leaf K. The soil K ranged from 0.36 to 2.54 cmol kg^{-1} (140 to 990 ppm) and leaf K ranged from 0.88 to 3.30 per cent. Applying the statistical and graphical procedures of Cate and Nelson, the critical limit of soil K was fixed at 2.14 cmol kg^{-1}. (Fig.4)

The soil K/Na ratio was also positively correlated with leaf K/Na ratio. The K/Na ratio of the soil ranged from 0.27 to 2.20 and in the leaf it ranged from 0.77 to 6.60. From these results the soil K/Na ratio of 1.07 was found to be the optimum to overcome salt injury in banana crop. (Fig.5)

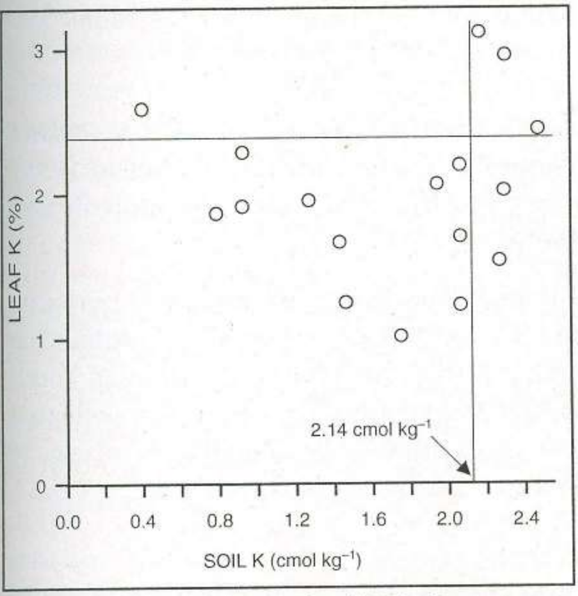


Fig. 4 : Critical limit of soil K for Banana at NRCB Farm

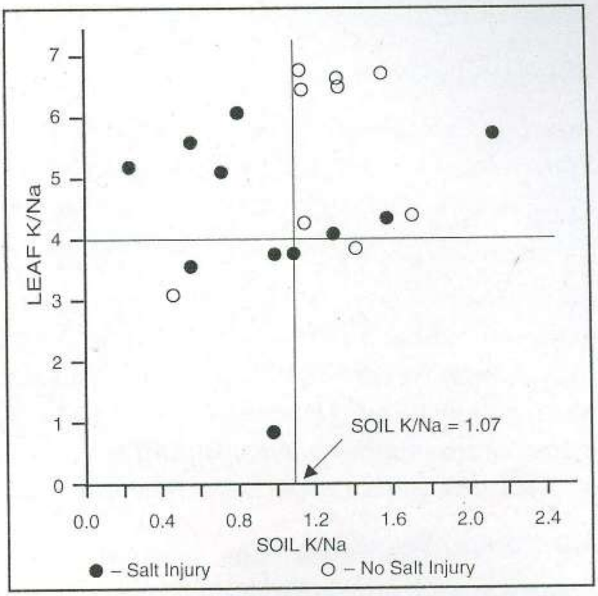


Fig. 5 : Optimum soil K/Na to overcome salt injury to Banana at NRCB Farm

From the Na and K status in leaves it is interesting to note that the accessions which were susceptible had high Na and low K level in leaves compared to the accession which were tolerant. Cavendish had high level of K and low Na in leaf while in Kadali low level of K and high Na was recorded. Thus, balance of K/Na ratio appears to determine the susceptibility. Study is in progress to understand the mechanism of tolerance to sodicity in banana.

3. PLANT HEALTH MANAGEMENT

Banana is affected by a number of insect pests, nematodes and diseases resulting in loss of quantity and quality of the fruit. This programme aims at developing management strategies for effective management of insect pest and diseases for sustainable production.

3.1 Insect Pest

In the field surveys undertaken in Trichy district and observations made at the research farm, rhizome weevil (*Cosmopolites sordidus*), pseudostem borer (*Odoiporus longicollis*), thrips (*Thrips florum, Chaetanaphothrips signipennis*), tobacco caterpillar (*Spodoptera litura*), lace wing bug (*Stephenitis typicus*), hairy caterpillars (*Pericalia ricini, Porthesia scintillens, Notolobus posticus* and *Dasychira mendosa*), slug caterpillar (*Parasa(=Latoia) lepida*) and aphid (*Pentalonia nigronervosa f.sp. typica*) were recorded.

Apart from these pests, during the visit to Bihar severe incidence of scarring beetle was also observed. This species causes heavy damage to the fruit resulting in severe reduction in quality and market value of the bunches.

Spodoptera litura was found to cause heavy losses. Thus, a trial to manage this pest was initiated. *Spodoptera* was controlled successfully by integrating chemical sprays with mechanical hand picking of grown up larvae, collection and destruction of egg masses and by setting up pheromone traps. A total of 987 adult moths were collected from 4 traps(in 2 weeks duration), out of which 685 moths were collected within 2 days following rains.

3.2 Nematodes

A survey was carried out in banana plantations in Kattuputhur area in Karur district and Alangudi area in Pudukottai district in Tamil Nadu and Katihar district in Bihar State during January-March 1997 in order to map out the occurrence and distribution of plant parasitic nematodes associated with banana.

Analysis of root samples revealed the presence of four important genera of plant parasitic nematodes associated with banana. Among them, the root-lesion nematode, *Pratylenchus coffeae* was the predominant species found in Kattuputhur and Alangudi areas of Tamil Nadu followed by *Helicotylenchus multicinctus and Meloidogyne* sp. Samples collected from Banana fields at Magadhapur in Katihar District of Bihar State revealed the presence of *Rotylenchulus reniformis, Helicotylenchus* sp. and *Meloidogyne* sp.

3.3 Fungal Diseases

A survey was conducted in Trichy and Pudukottai districts to find out the incidence and severity of fungal diseases of banana during vegetative and shooting phase of the crop. The scoring for sigatoka incidence was done on 0-6 scale.

Among the varieties, the incidence of sigatoka at the vegetative phase was more in Rasthali (36.26%) followed by Nendran (32.41%) and Poovan (24.93%). The lowest incidence of 14.41% was observed in the variety Karpuravalli. The Sigatoka incidence at shooting phase was also more in variety Rasthali (74.01%) followed by Nendran, Poovan and Karpuravalli. Fusarium wilt incidence was observed in two varieties namely Karpuravalli (20%) and Rasthali (7%).

3.3.1 Pseudostem rot : A new disease

In a survey conducted in Pudukottai district, severe incidence of pseudostem rot was observed on cultivar Poovan which was characterized by the presence of irregular, brown, watery patches at the base of the pseudostem. In the advanced stage of the disease, the base of pseudostem had rotten penetrating into the innermost leaf sheath This disease had devastated the whole plantation, as most of severely infested plants had toppled. In a few cases, longitudinal splitting of pseudostem was also observed. The disease appears to be a new record.

*Advanced stage of psuedostem rot in cultivar Poovan **Inset**: intial symptoms of the disease.*

3.4 Viral Diseases :

Fingers showing mosaic symptom induced by BBMV

Observations for the presence of BBMV symptom was done on a plant-to-plant basis except in Poovan (Trichy district), in which the size of orchard was very large (5 acres). Hence, a few plots were randomly selected. Survey for BBMV incidence in Trichy and Coimbatore districts of Tamil Nadu indicated that the cultivar Nendran had 15.93 per cent infection followed by cultivar Neypoovan (5.31%) and Robusta (4.57%). Cultivar Poovan showed cent per cent infection while Red banana recorded 56.8 per cent infection of BBMV. However, the number of plants observed was very few. In Trichy district, cultivar Poovan recorded the highest per cent of infection (28.23). Out of 14,200 plants of Nendran observed, 0.98 per cent were infected with BBMV while Robusta showed 0.75% infection.

Banana Streak Virus is a major viral disease of banana as reported earlier. Based on symptom expression, disease rating was assigned and per cent infection was calculated. Seventy per cent of plants were found to be infected with BSV and the remaining were apparently healthy (Table 23). Plants with severe streak symptoms accounted for 11.20 per cent of the total number of plants observed. A four-month-old Poovan orchard in Oravanthur had 100% infection of BSV. Fifty per cent BSV infection was observed in an orchard in Kattuputhur. This viral disease was also observed in cultivars Pachanadan, Robusta, Nendran, Karthobiumthum, Sandanavazhai and Barsain (Trichur).

TABLE 23: Survey for Banana Streak Virus in Trichy District of Tamil Nadu

Sl.No.	Symptomwise categories	Grading	% plants infected
1.	Part of a leaf showing chlorotic Streaks	+	08.75
2.	Chlorotic Streaks on one whole leaf and 2-3 leaves having partial symptoms	++	10.41
3.	Both chlorotic and necrotic streaks on leaves	+++	20.40
4.	Severe streak symptoms on leaves, petiole, pseudostem and midrib with occasional pseudostem splitting	++++	11.20
5.	Apparently healthy	-	30.00
6.	Main plant in apparently healthy state but suckers showing chlorotic streaks	+/-	05.40

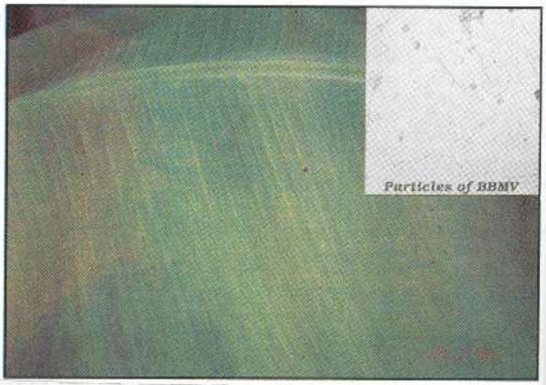
In an orchard in Sirumugai, Coimbatore Robusta was infected with BBMV. Infected bunch of Robusta had undersized fingers, which were poorly developed, hence the name 'Pencil kai' meaning, the fingers are of pencil thickness.

Both BBMV and BSV infection were recorded in Yercaud, the Shevroy hills. Sandanavazhai had streak symptoms while Sambrani Monthan was infected with BBMV. Almost 50 per cent of banana in Yercaud were affected with banana bunchy top virus. Presence of the aphid vector *Pentalonia nigronervosa* was noticed.

In Pudukottai district of Tamil Nadu, 31.2 per cent Poovan plants were affected by BBMV and 11.6 per cent by BBTV.

3.4.1 Diagnosis

3.4.1.1 Dot Immuno Binding Assay (DIBA)



A leaf showing spindle shaped chlorotic streaks, a symptom induced by BBMV. Inset : Flexous rod shaped particles of BBMV.

BSV infected leaf samples of cultivar Poovan was extracted in Tris-buffer-saline (TBS) containing 50 mM DIECA (1:1 v/v), filtered and clarified using equal volume of chloroform. The samples were spotted onto nitrocellulose membrane (NCM) which was presoaked in TBS. The NCM was washed twice with TBS-T, blocked with spray dried milk and incubated for half an hour. Then the NCM was transferred to a petriplate containing specific antiserum at required dilution made with blocking solution, incubated for an hour at 37°C and washed thrice with TBS-T. The NCM was then transferred to alkaline phosphatase labeled antirabbit IgG. The NCM was washed again and transferred to substrate solution containing nitroblue tetrazolium and bromo-chloro-indolyl phosphate for colour development. The results are presented in Table 24.

Samples from 11 BSV infected plants showing severe, mild or no symptoms were analysed by DAC-ELISA and DIBA using BSV polyclonal antiserum. Samples with mild or no symptoms gave higher absorbance than those with severe symptoms. DIBA also gave similar results excepting in two samples with severe symptoms showing strong reaction. Old and young leaves showing mild symptoms gave strongly positive reaction. The results show that the specificity and reliability of BSV antiserum is to be established. However, BSV antiserum did not react with the healthy sample from tissue culture derived plantlet.

3.4.1.2 Leaf Dip Preparation

BBMV infected bracts and leaf sheath samples were clarified with chloroform and a few drops of mercaptoethanol was added to avoid oxidation. The clarified samples were placed on formvar coated copper grid for 10 min. The excess fluid was blotted with a filter paper and the grid was washed with 15-20 drops of distilled water and dried. Negative staining was done by using 8-10 drops of 2% aqueous uranyl acetate, drained and dried before examining under electron microscope.

TABLE 24: Detection of Banana Streak Virus in leaves of Poovan cultivar using DAC-ELISA and DIBA techniques.

Sample No.	Disease rating *	Sampled from	DAC ELISA reading (absorbtion at 405 nm)	Symptoms	DIBA ratings **
1.	1	Old leaf	0.753	Mild	++
2.	4	Old leaf	0.528	Severe	+
3.	4	Old leaf	0.352	Severe	+
4.	4	Young leaf	0.872	Mild	++
5.	4	Middle	0.650	Severe	++
6.	3	Middle	0.616	Severe	-
7.	4	Old leaf	0.668	Severe	++
8.	2	Old leaf	0.921	Mild	++
9.	4	Old leaf	0.533	Severe	+
10.	0	Young leaf	0.864	No symptom	++
11.	4	Young leaf	0.694	Severe	N T
12.	0	Tissue culture plant	0.0	No symptom	-
13.	Buffer	-	0.0	-	-

* 0 - Apparently healthy
1 - Mild yellowish streaks on a part of leaf
2 - Yellow streaks present on all leaves
3 - Chlorotic and necrotic streaks
4 - Chlorotic and necrotic streaks on leaf, petiole and pseudostem with leaf rolling.

** ++ Strong reaction, + Mild reaction, - No reaction, NT, Not tested

Flexous rod shaped particles measuring 750nm X 12nm were observed. The size and shape of the particles obtained in our studies agree well with those reported on BBMV from Phillipines earlier. Bract samples contained more particles.

3.4.1.3 Immunosorbent electron microscopy (ISEM)

BBMV, BBTV, BSV and CMV infected samples were examined for the presence of virus through ISEM decoration technique. Carbon coated grids were placed on infected sap (chloroform clarified), incubated for 15 min. at room temperature and rinsed with water. The grids coated with infected sap were separately floated on drops of diluted antisera of respective virus except for BBMV sample where PVY antisera was used and incubated for 15 min. at room temperature. The grids were stained drained and allowed to dry before examining under EM.

The studies showed that BSV particles were decorated with BSV antiserum supplied by Dr.Lockhart. A few CMV particles were also decorated in ISEM. PVY antiserum did not decorate/trap any BBMV particles.

3.4.2 Transmission

Work on transmission of BBMV through banana lace wing bug *Stephenitis typicus* has been initiated.

3.4.3 Neer Vazhai

Neer Vazhai a malady of unknown etiology affects the cv. Nendran. The affected plants are symptomless and appear healthy until the emergence of the inflorescence. Very few fingers, if at all, develop to maturity and the fingers are reduced in size and the pulp turns rubbery making them unpalatable. In a trial conducted in the research farm, suckers were collected from Neer Vazhai affected plants. Five suckers each were treated with furadon (25g) and nuvacron (0.5%) and planted along with untreated controls. Observations were recorded on appearance of Neer Vazhai symptoms. The treatments did not prevent the malady making it clear that nematodes and insect pests may not have a role in the development of the malady. However, this experiment has proved that the malady is transmitted through suckers.

A malformed bunch of Nendran affected by Neervazhai

4. POST HARVEST TECHNOLOGY

The programme envisages to reduce the post harvest losses through an integrated package of practices involving pre- and post harvest factors influencing shelf-life and quality of fruits and exploit the use of value-added products. Developing post harvest technologies compatible for domestic and export markets through improvement of fruit quality by improved handling, harvesting and marketing techniques is a thrust activity of this programme.

4.1 Influence of storage temperature on shelf life and quality

A study was performed on eight varieties of banana. Bunches were harvested at full maturity, dehanded and washed in running tap water. They were then air dried and packed in 100 gauge polythene bags having 0.2% ventilation holes. These were stored at 15° C, 25°C and room temperature (30-35°C). Observations on skin colour, fruit firmness and quality were taken daily until all the varieties showed full ripening. The study showed that the shelf-life was enhanced by 5-10 days at 15°C as compared to room temperature storage. The quality of Rasthali banana ripened at 25°C as gauged by the skin colour and sweetness of pulp, was superior to those ripened at room temperature, showing that slow ripening improves fruit quality.

In another experiment, mature green banana fruits of Poovan variety packed in glass bottles under elevated CO2 in an atmosphere free of oxygen could store the unripe form for a longer time than the untreated control.

4.2 Studies on Measurement of growth rates in different varieties of banana

The rate of growth of banana fingers of six varieties viz, Karpuravalli, Rasthali, Poovan, Nendran, Pachanadan and Monthan were determined by following the increase in fresh weight, fruit volume and fruit diameter at 15-day intervals beginning from 45 days after bunch emergence till maturity of bunch. There were marked differences in the fruit growth rates (Fig.6) among the varieties which was reflected on the fruit quality parameters (Table 25).

Table 25: Fruit quality characteristics at full ripening

Variety	T.S.S (°Brix)	Acidity (%)	Brix / Acid	Specific Gravity
Pachanadan	19.6	0.657	29.85	0.972
Nendran	23.0	0.871	28.39	0.969
Robusta	16.0	0.657	24.37	0.989
Rasthali	20.0	0.777	25.73	0.983
Poovan	20.2	0.817	24.71	1.026
Karpuravalli	24.6	0.576	42.69	0.994

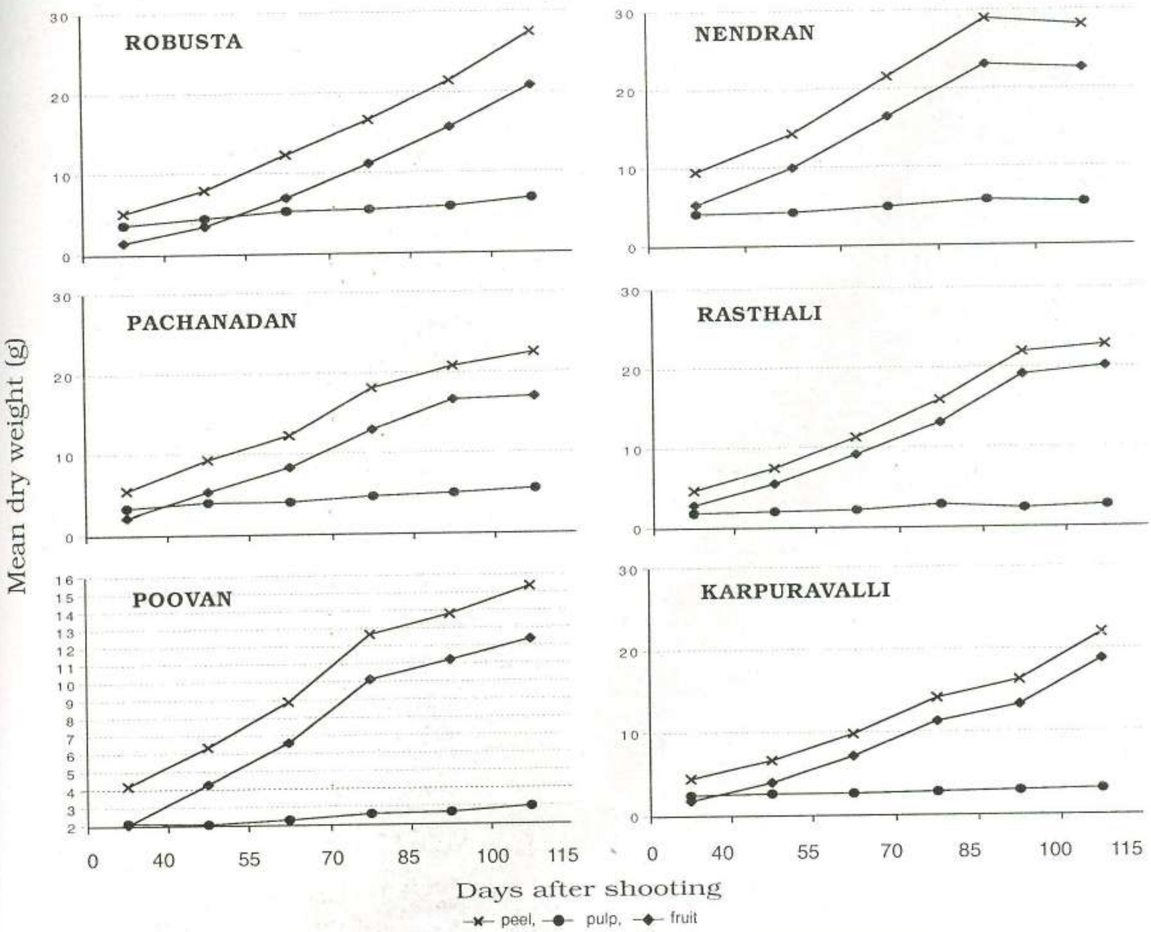


Fig. 6 : Growth pattern of fruits of six commercial cultivars

GENERATION INFORMATION

1. HUMAN RESOURCE DEVELOPMENT

In the area of Human Resource Development, the following scientists/administrative staff were trained in the thrust areas being pursued by the Institute.

Name of the Participant(s)	Major area of training interaction	Name of the Institute	Duration
R.Krishnamoorthy M.Balu	Computerization of Agril. Research Financial Infn. System	NAARM, Hyderabad	15-17 Apr.96
V.Kumar	Short course on Management of soil physical conditions for sustainable agrilcutural production.	JNKVV, Jabalpur	22.07.96 to 05.08.96
S.Vincent K.J.Jeyabaskaran	57th "FOCRAS" training programme	NAARM Hyderabad	26.08.96 to 05.02.97
N.Viswambharan M.Balu R.Krishnamoorthy	"ARFIS" computer training programme	IIHR B'lore	1-2 Nov'96
S.Karthikeyan	Reorientation programme on NICNET services	N.I.C. NewDelhi	28-29th Nov'96
S.Uma	Recent advances in Plant Bio-chemistry and Molecular biology	IARI, New Delhi	31.01.97 to 01.02.97
V.Balasubramani	Master Trainers' Training Course on "Integrated Pest Management"	NCIPM, New Delhi	17.03.97 to 22.03.97

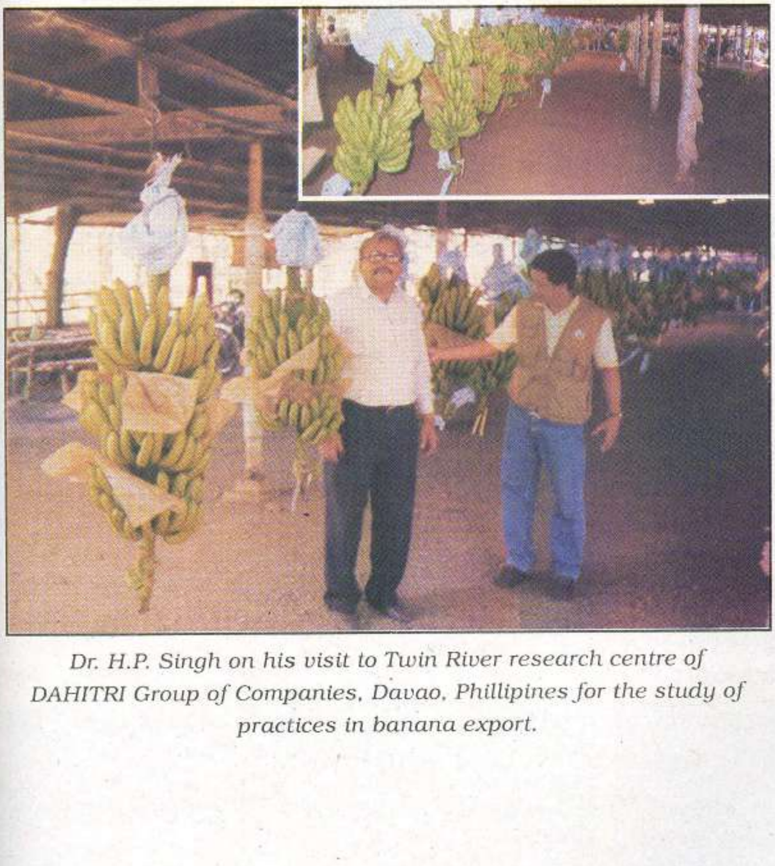
The following Scientists participated in Symposium/Seminar/Workshop/Kisan Mela.

Name of the Participant(s)	Major area of training/ interaction	Name of the Institute	Duration
H.P.Singh	Conference on Regional Infn. system on Banana and Plantain.	ASPNET, Phillipines	1-3 April 1996
H.P.Singh P.Sundararaju S.Shivashankar S.Uma R.Thangavelu V.Kumar R.Selvarajan	Conference on "Challenges for Banana Production and Utilization in 21st Century"	NRCB Trichy	24-25 Sept'96

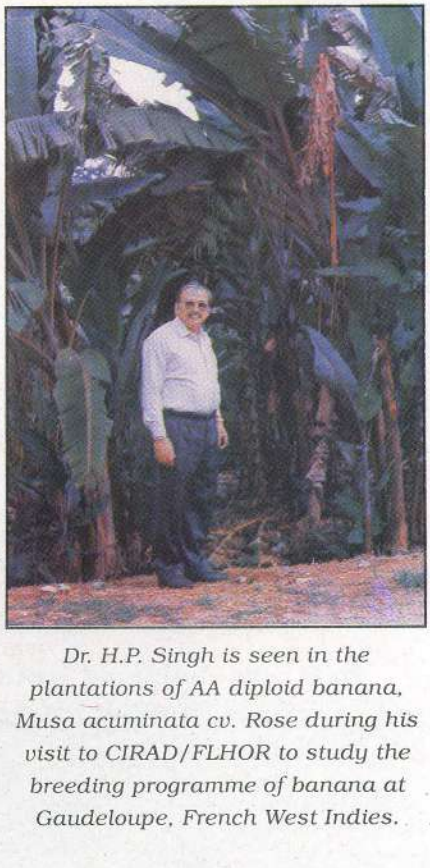
H.P.Singh	Regional Advisory Committee Meeting of Asia and Pacific Network for the improvement of banana and plantain.	ASPNET/ INIBAP	26-28 Sept'96
P.Sundararaju	4th International Workshop on Biocontrol and management of *Chromoleana Odarata*	IIHR B'lore	14-16 Oct'96
H.P.Singh S.Uma R.Selvarajan	National Symposium on Horticultural Bio-technology.	IIHR B'lore	28-30 Oct'96
P.Sundararaju	XIIth Plantation Crops Symposium (PLACROSYM-XII)	Rubber Institute Kottayam	27-29 Nov'96
H.P.Singh	National Seminar on Strategies and Horticultural Development	SCOPE Building New Delhi	4-5 Dec'96
H.P.Singh P.Sundararaju	"Kisan Mela"	Kursela, Bihar	9-12 Feb'97
H.P.Singh	Conference / Workshop on International Musa testing programme	Guadeloupe French West Indies	3-4 Mar'97
H.P.Singh V.Kumar R.Selvarajan	National Seminar on Orchard Management for Sustainable Production of Tropical Fruits.	WALMI, Patna, Bihar.	10-11 Mar'97
P.Sundararaju	2nd Group Meeting of Working Group of Agril. Research.	Directorate, of Agri., Chennai.	20th Mar'97

*A prestigious International Award **"PISANG RAJA"** was conferred to **Dr.H.P.Singh**, Director, **NRCB**, Trichy by **ASPNET/INIBAP**, Phillipines for outstanding contribution in the field of banana research and development, on 24th September, 1996.*

*A prestigious Award " **KADALI PURASKAR**" was conferred upon **Dr.H.P.Singh**, Director, NRCB, Trichy by the Association for the Improvement in Production and Utilization of Banana **(AIPUB)** for his Outstanding Contributions to Banana Research and Development in India, on 24th September, 1996.*



Dr. H.P. Singh on his visit to Twin River research centre of DAHITRI Group of Companies, Davao, Phillipines for the study of practices in banana export.



Dr. H.P. Singh is seen in the plantations of AA diploid banana, Musa acuminata cv. Rose during his visit to CIRAD/FLHOR to study the breeding programme of banana at Gaudeloupe, French West Indies.

DEPUTATION ABROAD

Dr.H.P.Singh participated in the workshop on Regional Information system on banana and plantain, held at **ASPNET**, Phillipines from 1-3 April, 1996 and presented a paper entitled "Information system on Banana - a country paper".

Dr.H.P.Singh participated and presented status report on International Musa testing programme **(IMTP)** - India in the Second **Global Conference** Phase II held on 3-4 March, 1997 at Guadeloupe, French West Indies.

INVITED PRESENTATION IN NATIONAL AND INTERNATIONAL CONFERENCES

1. **Dr.H.P.Singh presented papers on :**

a. *"Information system on Banana"* in Consultation/Workshop on Regional Information System on Banana and Plantain - Asia and the Pacific held at Phillipines from 1-3 April, 1996.

b. *"Comprehensive Banana Research Programme and Development in India"* in the Regional Advisory Committee meeting of ASPNET/INIBAP held at Trichy from 26-28 September, 1996.

c. *"Perspective of Banana Production and Utilization in India"* in Conference on Challenges for Banana Production and Utilization in 21st Century held at NRC on Banana, Trichy on 24-25 September'1996. *Ibid* pp5-7 (Abst.)

d. *"Nursery Management in Tropical Fruits"* in National Seminar on Propagation and Nursery Management held at Anand from 4-5, October, 1996.

e. *"Planting time, Planting geometry, density and replant problems in fruit crops"* in National Seminar on Orchard Management held at WALMI, Patna 10-11 March, 1997.

GUEST LECTURES

1. **Dr.P.Sundararaju delivered a lecture on :**

"Nematodes associated with Banana" in training programme on 21st November, 1996 at CPCRI Regional Station, Kayangulam, Kerala.

2. **Dr.S.Shivashankar delivered lectures on:**

   a. *"Isozyme analysis and its applications in plant research"* at Mangalore University, Mangalore on 21st December, 1996.

   b. *"Applications of plant molecular biology tools for plant improvement"* under UGC sponsored refresher course at Bharathidasan University, Trichy on 21st March, 1997.

3. **Dr.S.Uma delivered lectures on :**

   a. *"Micropropagation and its commercial application"* under UGC sponsored refresher course at Bharathidasan University, Trichy on 26th February, 1997

   b. *"In vitro propagation of Banana - a boon to banana industry"* at Holycross college, Trichy on 3rd March, 1997.

4. **Dr.R.Selvarajan delivered a lecture on**

"Production of genetically modified plants - through genetic transformation - traits conferred to insect/viral/herbicide resistance, stress tolerance, altered flowers, etc." under UGC sponsored Refresher course at Bharathidasan University, Trichy on 21st February 1997.

RADIO TALK

Dr.S. Uma and Dr. R.Selvarajan on *Recent advances in Banana Production Technology.* A brain storming session with farmers on 18th October 1996.

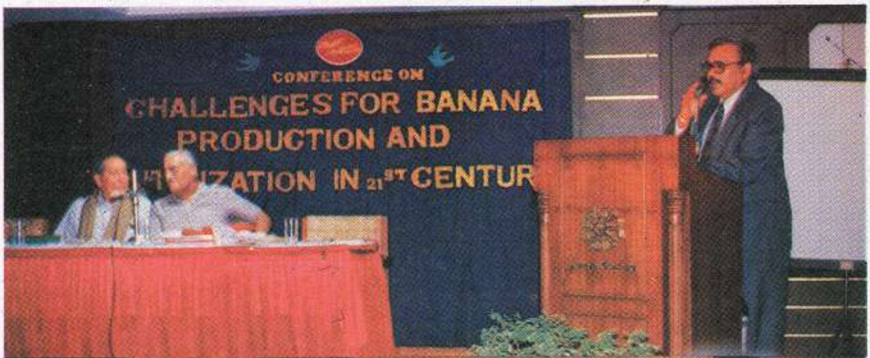
MEETINGS

Title	Period	Responsibility
VIth Regional Advisory Committee Meeting of Asia and Pacific Network (ASPNET) and International Network for the improvement of banana and plantain (INIBAP)	26-28 Sep,96	H.P.Singh
Conference on "Challenges for Banana Production and Utilization in 21st Century".	24-25,Sept'96	H.P.Singh
Research Advisory Committee Meeting	9th Dec'96	H.P.Singh
Institute Management Committee Meeting	10th Dec'96	H.P.Singh
Staff Research Council Meeting	15-16 July'96	P.Sundararaju

*Delegates in **RAC** meeting of **ASPNET/INIBAP** hosted by NRCB*

The first News letter of NRCB being released by Dr. V. R. Muthukaruppan, Vice Chancellor, Bharathidasan University

First Staff Research Council meeting of the centre


CONFERENCE ON
CHALLENGES FOR BANANA
PRODUCTION AND

A view of Exhibition arranged at NRCB.

Dr. K.L. Chadha, D.D.G. (Hort) the doyen of Horticulture is being felicitated at the farewell function hosted by the Director and Staff of NRCB.

PUBLICATIONS

Research Papers

Singh, H.P. 1996 . Growing Banana for leaf *Infomusa.* 5 : 27 – 28.

Thangavelu.R(1996) - Bract Mosaic and Streak - Two serious viral diseases of banana. *Kisan world* **23**(8): 55-56.

Singh, H.P. and K.L.Chadha (1996) - Banana and Plantain in India. *Info. Musa.,* **5** (2) 22–25.

Singh, H.P. and P.Patil (1996) - A fruit of millions. In *Indian Agriculture* 2001 (Ed.V.K.Patil) (in press)

Radhakrishnan, T.C., H.P.Singh and M.Krishna Reddy, (1996). Riddle of Kokkan disease resolved. *Plant Disease* (in press).

Krishnaprasadji,J., H.P.Singh and M.Krishna Reddy, (1996). Bract Mosaic - a new virus disease of banana in India. *Indian J.Virol.* (in press).

Books / Chapters in books

Singh, H.P. 1996 . Information system on Banana in India. Proc. of Consultation / Workshop on Regional Information System for Banana and Plantain - Asia and the Pacific (Valmayor *et al* Ed.) pp 71-79. ASPNET/INIBAP.

Chadha, K.L. and H.P.Singh (1996). Description, classification and cataloguing of genetic resources of citrus in India. *FAO Publication* pp. 240

Singh,H.P. and S.Uma 1996 - Banana Production in India. Directorate of Extension, Ministry of Agriculture, Krishi Bhawan, New Delhi - 110 012. pp. 102.

Singh,H.P. 1997 - Banana - In 50 years of crop science research in India. (Eds.R.S.Paroda and K.L.Chadha). pp. 433-444.

Singh,H.P. 1997 - Citrus - In 50 years of crop science in India. (Eds. R.S.Paroda and K.L.Chadha). pp. 445 - 462.

Singh,H.P. and S.Uma 1997 - Current approaches and future opportunities for improvement of major Musa types present in Asia and the Pacific: Silk/Pome (AAB dessert types) New frontiers in resistance breeding for Nematodes, Fusarium and Sigatoka.(Eds. E.A.Frison, J.P.Horry and D.De.Waele). pp. 149–163

Popular Articles

Singh,H.P., and Prakash Patil (1996) - Shoot tip culture of banana an overview. *Banana Conference Souvenir.* AIPUB pp.7-8.

Singh,H.P. and S.Uma (1996) - Varietal situation of banana in India. *Ibid* pp.9-13.

Sundararaju,P. (1996) - Nematode pests of banana and their management. *Ibid* pp.17-19.

Shivashankar,S. (1996) - Postharvest technology of banana. *Ibid* pp.27-28.

Singh,S.J., R.Selvarajan and R.Thangavelu (1996) - Diseases of banana in India. *Ibid* pp.21-25.

V.Kumar and K.J.Jeyabaskaran (1996) - Integrated management of nutrients and water in banana. *Ibid* pp 15-16.

Papers presented in Symposia/Seminars/Workshop

Singh,H.P. and S.Uma (1996) - "Genetic Diversity of Banana in India". Paper presented in "Conference on Challenges for Banana Production and Utilization in 21st Century" held at NRC on Banana, Trichy on 24-25 September'1996. pp 15-16 (Abst.)

Singh, H.P. and S.Uma (1996) - "Genetic Improvement of Banana in India". *Ibid* pp 27-28 (Abst.)

Singh, H.P. and S.Uma (1996) - "Performance Assessment of Commercial Cultivars in Wetland Production System". *Ibid* pp 18-19 (Abst.)

Patil.P and H.P.Singh (1996) - *In vitro* multiplication of banana varieties belonging to different genome and ploidy level. *Ibid* pp 25-26 (Abst.)

Reddy, B.M.C., and V.Kumar (1996) - "A field comparison of conventional suckers with *In vitro* derived planting material of banana cv. Dwarf Cavendish and Robusta banana plants". *Ibid* pp 27 (Abst.)

Sudha,S. and P.Sundararaju (1996) - "Reaction of some banana cultivars to the burrowing nematodes *Radopholus similis*. *Ibid* pp 53-54 (Abst.)

Thangavelu,R and H.P.Singh (1996) - "Status of banana bract mosaic virus and banana streak virus diseases in India. *Ibid* pp 56 (Abst.)

Akella Vani, M.Krishna Reddy, R.Thangavelu and H.P.Singh (1996) - Molecular diagnostics of BSV using nucleic acid probes. *Ibid* pp 57-58 (Abst.)

Singh,S.J., R.Selvarajan and H.P.Singh (1996) - Detection of banana bract mosaic virus (Kokkan disease) by electron microscopy and serology. *Ibid* pp 58 (Abst.)

Krishna Reddy,M., Akella Vani, R.Selvarajan and H.P.Singh (1996) - Immunological and Molecular diagnosis of banana bract mosaic virus. *Ibid* pp 58-59 (Abst.)

Singh,S.J., R.Selvarajan and H.P.Singh (1996) - Identification and detection of banana streak virus by serology and electron microscopy. *Ibid* pp 62-63 (Abst.)

Viswanathan,R. and R.Selvarajan (1996) - A Badna virus related to banana streak virus in sugarcane. *Ibid* pp. 63, (Abst.)

Shivashankar, S., S.Uma and H.P.Singh (1996) - Post harvest characterization of banana germplasm. *Ibid* pp 70 (Abst.)

Uma,S., Rema Menon and H.P.Singh 1996. - Search for alternative cultivars for banana chips. *Ibid* pp 71 (Abst.)

Sundararaju,P., Guljar Banu,J. and Ratnakaran,K. 1996 -*Chromolaena* leaf extract on mortality of *Radopholus similis*. - Paper presented in the Fourth International Workshop on Biological Control and Management of *Chromolaena odarata* (Abstract p.40) held at Bangalore during 14-16, October, 1996.

Singh, H.P. and S.Uma 1996 - Response of Musa genomes to *in-vitro* culture initiation. Paper presented at National Seminar on Biotechnology in Horticulture held from 28-30 October, 1996 at Bangalore. pp (Abst.)

Patil, P., H.P.Singh and Leela Sahijram 1996. International and National exchange of banana germplasm in-vitro. *Ibid* pp. (Abst.)

Singh, H.P. 1997 - Planting time, Planting geometry, density and replant problems in fruit crops. Paper presented in "National seminar on Orchard Management for sustainable production of tropical fruits" held at (Organised by Rajendra Agricultural University) WALMI, Patna, Bihar on 10-11 March,1997.

Singh,H.P. and S.Uma 1997 - High density planting in banana under different agroclimatic conditions.*Ibid* pp. 2–3 (Abst.)

Singh,H.P. and S.Uma 1997 - Performance of *in vitro* propagated banana plants. *Ibid* pp. 21 (Abst.)

Prakash Patil and H.P.Singh 1997 - Studies on *in vitro* multiplication and management of banana germplasm in relation to plant growth regulators. *Ibid* pp.21(Abst.)

Singh,H.P. and Prakash Patil 1997 - Effect on varying use of nitrogen land Potassium applied at vegetative and productive stage. *Ibid* pp. 27 (Abst.)

Kumar,V., K.J.Jeyabaskaran and S.Uma 1997 - Response of banana cultivars to organic and inorganic nutrients in saline and sodic soil. *Ibid* pp. 36 (Abst.)

Singh,H.P. and Prakash Patil 1997 - Integrated management of weeds in banana under different agroclimatic conditions. *Ibid* pp. 47 (Abst.)

Selvarajan,R., H.P.Singh and Krishna Reddy 1997 - Diagnosis of banana bract mosaic virus and its management. *Ibid* pp. 82 (Abst.)

MISCELLANEOUS

IMPORTANT COMMITTEES OF THE INSTITUTE

INSTITUTE MANAGEMENT COMMITTEE

Dr.H.P.Singh, Director,	-	Chairman
Asst. Director General, (Hort.) ICAR, New Delhi.	-	Member
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Director of Horticulture, State Govt. of Karnataka,Bangalore.	-	Member
Dean-Horticultural College & Research Institute, Periyakulam, Tamil Nadu.	-	Member
Shri Maniram Singh Guruji, CPI Office, Bhagalpur, Bihar.	-	Member
Shri Baba Saheb Thube, Ex-MLA, At & PO: Kauneer Pathar, Taluka Barner, Dist.: Ahmednagar, (M.S.)	-	Member
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Dr.B.M.C.Reddy, Principal Scientist,IIHR, Bangalore.	-	Member
Dr.R.D.Rawal, Principal Scientist,IIHR, Bangalore.	-	Member
Dr.S.Uma, Scientist (SS), NRCB, Trichy.	-	Member
Finance & Accounts Officer, Sugarcane Breeding Institute, Coimbatore.	-	Member
Mr.N.Viswambharan, A.A.O.	-	Member Secretary

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

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All scientists	-	Members
Dr.P.Sundararaju,Sr. Scientist,	-	Member Secretary

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Mr.N.Viswambharan, A.A.O. Official side	-	Member Secretary
Mr.A.Subramanian, Staff side	-	Member
Mr.C.Thangaraj, Staff side	-	Member
Mr.M.Balu, Staff side	-	Member Secretary

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Mr.Singrey Majhi, Tech. Asst.	-	Member
Mr.N.Viswambharan, A.A.O.	-	Member Secretary

MANPOWER AND BUDGET

(as on March 31, 1997)

(A) **MANPOWER**

Grade	Sanctioned	In position	Vacant
Scientific	16	10	6
Technical	15	13	2
Administration	9	7	2
Supporting	7	7	-
Total	47	37	10

B. BUDGET FOR 1996-97

(Rs. in lakhs)

Sl.	Head	B.E.	R.E.	Expenditure amount
1.	Establishment charges	5.5	16.14	16.14
2.	Travelling allowances	1.5	1.75	1.75
3.	Other charges including equipments	30.5	35.33	35.33
4.	Works	32.5	26.78	26.78
	Total	70.0	80.00	80.00

Revenue from Farm Produce : Rs.2.75 lakhs

STAFF OF THE INSTITUTE

RESEARCH MANAGEMENT:

Dr.H.P.Singh, M.Sc.(Hort.),Ph.D.	Director-in-charge (upto 26.02.97) Director (w.e.f.27.02.97)

SCIENTIFIC:

Dr.P.Sundararaju, M.Sc.,Ph.D.	Senior Scientist (Nema)(w.e.f.01.05.96)
Dr.S.Shivashankar, M.Sc.,Ph.D	Senior Scientist (PHT) (w.e.f.16.08.96)
Dr.S.Uma, M.Sc.(Hort.),Ph.D.	Scientist (SS)(Hort.)
Mr.V.Kumar, M.Sc.(Hort.)	Scientist (Hort.)
Mr.R.Thangavelu, M.Sc.(Ag.)	Scientist (Pl.Path.)
Dr.R.Selvarajan, M.Sc.(Ag.),Ph.D.	Scientist (Virology) (w.e.f.02.05.96)
Dr.K.Jeyabaskaran, M.Sc.(Ag.),Ph.D.	Scientist (Soils) (w.e.f.15.07.96)
Mr.S.Vincent, M.Sc.(Ag)	Scientist (Pl.Phy.) (w.e.f.15.07.96)
Dr.V.Balasubramani, M.Sc. (Ag.),Ph.D.	Scientist (Ent.) (w.e.f.05.07.96)

TECHNICAL:

Mr.Raghuraman,	Asst. Garden Supdt.

ADMINISTRATION:

Mr.N.Viswambharan,	Asst. Admn. Officer. (w.e.f.12.09.96)

VISITORS

The following dignitaries visited the Centre during the year.

Mr.Subbha Somu, Vice Chairman,Coconut Development Board, Govt. of India, Trichy. (07.05.96)

Dr. P.Rethinam, Director, National Research Centre forOilpalm, Pedavegi, Andhra Pradesh.(09.05.96)

Dr. V.R.Muthukaruppan, Vice Chancellor, Bharathidasan University, Trichy.(15.07.96)

Dr. Dirk Vuylsteke, Intl. Instt. of Trop Agric. (IITA), ESARC,P.O.Box 7878, Kampala, Uganda (25.09.96)

Dr. K.L.Chadha, DDG (Hort.) ICAR, New Delhi. (28.09.96)

Dr. S.P.Ghosh, ADG (Hort.) ICAR, New Delhi. (28.09.96)

Dr. Emile Frison, Director, INIBAP, France. (28.09.96)

Dr. RamonV.Valmayor,Regional Coordinator,ASPNET/INIBAP, Phillipines.(28.09.96)

Dr. J.P.Horry, INIBAP, France. (28.09.96)

Dr. Gisella Orjeda,IMTP Leader, INIBAP, France. (28.09.96)

Dr. Simon R.Gowen, Natural Resources Instt., U.K. (28.09.96)

Dr. Brain W.Cull, Queensland, Australia. (28.09.96)

Dr. Rene Espino, Phillipines. (28.09.96)

Ms. Siti Hawa Jamaluddin, MARDI, Malaysia. (28.09.96)

Dr. Det Wattanachaiyingcharoen, Thailand.(28.09.96)

Dr. S.C.Hwang, TBRI, Taiwan. (28.09.96)

Dr. Probowo Tjitropranoto, Indonesia. (28.09.96)

Dr. K.V.Peter, Director, IISR, Calicut. (28.09.96)

Dr. V.Dharmalingam, Prof.and Head, Regional Research Station, (TNAU), Virudhachalam (09.01.97)

Dr.Satyabrata Maiti, Project co-ordinator, IIHR, Bangalore. (06.02.97)

Dr.A.Abdul Kareem, Vice Chancellor, TNAU, Coimbatore. (21.02.97).

A group of banana Scientists from India and abroad on their visit to NRCB farm.

Dr. P. Rethinam, Director, NRCOP on his visit to NRCB to discuss collaborative programmes.

PMEC

METEOROLOGICAL DATA

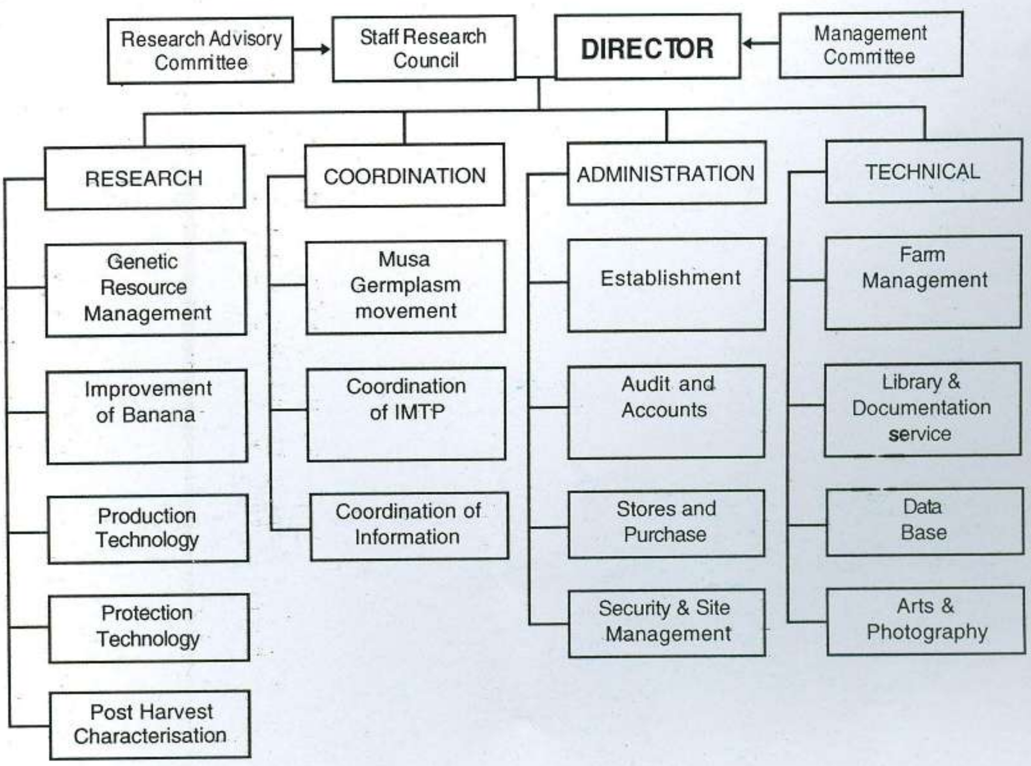
Month/Year	Temperature °C Maximum	Temperature °C Minimum	Relative Humidity (%)	Rainfall (mm)
April - 1996	39.9	24.5	69.7	123.4
May	41.0	25.6	67.0	70.0
June	38.3	23.9	72.1	79.0
July	36.4	24.6	68.6	147.0
August	35.8	23.8	70.6	150.2
September	35.4	23.4	78.9	176.0
October	34.2	23.5	73.3	47.6
November	33.9	21.7	79.5	47.6
December	31.3	19.2	82.9	-
January'1997	33.0	20.5	76.0	-
February	34.2	21.0	75.5	-
March	36.5	22.5	74.0	-

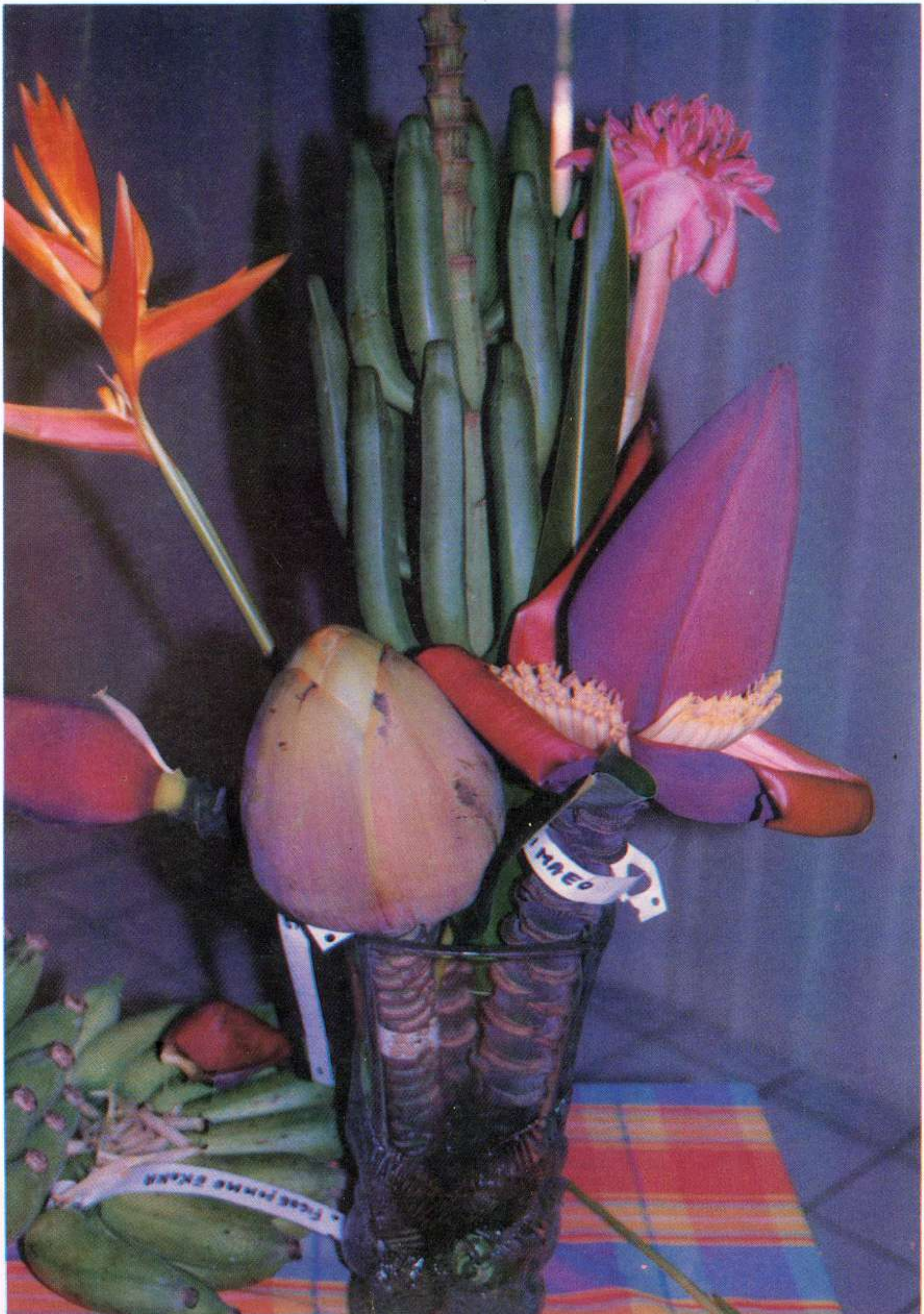
PERCENTAGE OF SC, ST AND WOMEN EMPLOYEES AT NRCB

Class of posts	Total no. of posts santioned	Total no. of posts filled	% of SC employees	% of ST employees	% of woman employees
1. Research Management	1	1	–	–	–
2. Scientific	15	8	37.5	–	12.5
3. Technical	15	13	38.5	7.69	7.69
4. Administration	9	7	28.57	–	14.29
5. Supporting Staff	7	7	57.14	14.29	–
Total	47	36	38.88	5.55	8.33

MANDATE AND ORGANOGRAM OF NRCB

* **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 International agencies in achieving the above objectives.**

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