



NRCB

National Research Centre for Banana
Tiruchirapalli - 620 102, Tamil Nadu



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FROM THE DIRECTOR'S DESK



India's production of bananas was 27 million tonnes from 0.748 million ha area in 2009-'10 against 8 million tonnes in 1991-'92. During the same period, the productivity has increased from

20 t/ha to 37 t/ha, while the area increase was from 384 thousand ha to 748 thousand ha. This giant stride in production, productivity and area expansion has been achieved despite the abiotic stresses such as drought, salinity, climate change, elevated CO₂ and temperature. In addition, the biotic constraints such as insect and nematode pests, fungal and viral diseases have an adverse impact on production and productivity of banana. It is estimated that the yield reduction by biotic and abiotic stresses for major crop plants including banana is more than 50%. Though the climate change, elevated CO₂ and temperature in general will have positive impact on production and productivity of banana, it may favour emergence of pests and diseases and aggravate the problems by such biotic factors. The NRC Banana has initiated research works in these lines and developed many technologies for the management of biotic stresses. Research work has been initiated on the identification of indicators/markers and enzymes/genes responsible for the tolerance in banana germplasm against drought and salinity. The results have indicated enzymes like catalase and SOD should be used along with physiological parameters like Membrane Stability Index, Relative Water Content and Chlorophyll Stability Index. These results are presented in this issue of the newsletter for the benefit of the banana community.

RESEARCH HIGHLIGHTS

ABIOTIC STRESSES IN BANANA

In India, 43% of 329 Mha geographical areas are used for agricultural activity, out of which 51.1 Mha is drought prone. Besides, 6.73 Mha land is affected by salinity and alkalinity. In India, 25% of ground water used for irrigation is either saline or brackish and 11.7 Mha is likely to be affected by salinity and alkalinity by 2025, which may seriously pose problem for agricultural productivity and has grave implications for our food security system. Abiotic stresses *viz.*, drought, salinity and temperature extremes are the primary causes of yield loss in agriculture. The reduction of average yield by abiotic stresses in most crop plants is more than 50%. In India, areas of bananas grown are largely along the river basins *viz.*, Gangetic plains of Bihar, Godavari river basin in Andhra Pradesh, areas around Tapti River in Maharashtra, Cauvery delta regions of Tamil Nadu and in other areas with assured water sources. The key issues to be addressed to sustain the banana production in 21st century are water availability, salinity tolerance, extreme temperatures and nutrient use efficiency. In order to meet the future challenges, NRC Banana has initiated research work in drought and salinity. The research highlights are presented.

Screening for drought tolerance

The pre-requisite for improvement of banana for drought tolerance is identification of drought tolerant genotypes. In this regard, 112 banana germplasm maintained in the NRCB was screened to identify the drought tolerance based on Leaf Water Retention Capacity.

Among the germplasm tested, balbisiana, cooking banana and Mysore (Poovan) recorded higher leaf water content (>70%) and are classified as tolerant. The genotypes recorded leaf water content of 50-69% is moderately drought tolerant. The genotypes recorded less than 50% are considered susceptible (Table-1).

In another study, twenty four AA diploid banana genotypes were screened for drought tolerance based on biochemical indicators. Among all the AA diploids, Imbogo recorded higher chlorophyll stability index (80.64), membrane stability index (42.96) and Epicuticular wax (>0.05mg/cm²) indicating tolerance for soil moisture deficit stress among the AA diploid genotypes.

Table-1: Name of banana germplasm for their reaction to drought.

BB (<i>M. balbisiana</i> , Acc.no.167)	Tolerant	70-89%
ABB (Erodekai, Acc. no. 415)	Tolerant	
AAB (Mysore, Acc. no . 362)	Tolerant	
AAB (Acc.no.721)	Tolerant	
AAB (Pisang Berlin)	Moderately tolerant	50-69%
AAB (Attunendran,Acc.no.488)	Moderately tolerant	
AB (Nattu Poovan, Acc.no.186)	Moderately tolerant	
AAA (Robusta)	Susceptible	
AAB (Nendran, Acc. no. 296)	Susceptible	<50%
AAB (Pisang Seribu, Acc. no. 579)	Susceptible	

Mechanism of drought tolerance in Banana cultivars

Saba, Karpuravalli, Poovan, Nendran, Robusta, Ney Poovan, Attu Nendran, Mannan, Ladan, and Pisang Berlin banana genotypes, after three weeks of soil water stress, recorded 30-35% decrease in chlorophyll and 37% reduction in carotenoids pigments in all the genotypes. Saba, Karpuravalli, Mannan and Nattu Poovan recorded higher ECW content (0.30 to 0.36 mg / cm²). Membrane Stability Index (MSI) and Relative Water Content (>75) were higher (> 65) in Poovan, Saba and Karpuravalli than other varieties after soil water stress. The drought tolerant genotypes *viz.*, Poovan, Saba and Karpuravalli recorded higher ECW, MSI and RWC and these are the potential traits for screening for drought tolerance in banana.

Soil moisture deficit stress imposed for three weeks caused the leaf to attain osmotic potential of -0.685Mpa while in the irrigated control, it was -0.375Mpa. At the end of treatment, stress imposed plants recorded senesced (yellowing) three lower leaves but no new leaves were produced. In control plants, two new leaves were produced and recorded no visible senescence symptoms in leaves. In Robusta, a susceptible cultivar, soil moisture stress accelerated the leaf senescence and decelerated the leaf growth and development. The antioxidative enzymes like catalase and ascorbate peroxidase has increased by 47.93%, 69.25% respectively after 21 days of soil moisture deficit stress treatment. The priming of plants with 50mM of ABA before imposition of soil moisture deficit stress increased the plant drought tolerance capacity through enhancing antioxidant enzymes i.e. superoxide dismutase and ascorbate peroxidase and decreasing the rate of leaf senescence.

Effect of drought stress at flowering

Under field conditions, water stress imposed at flowering, decreased the bunch weight in Robusta (42.07%), Karpuravalli (25%) and Rasthali (18.83%) and when water stress imposed at 30 days after flowering, the bunch weight reduction was 18.83% (Robusta), 11.25% (Rasthali) and 27.66% (Karpuravalli), but, in water stress imposed plants at 60 days after flowering, the bunch weight decreased by 16.47% (Rasthali), 16.84% (Karpuravalli) and 25% (Robusta). The results showed overall reduction in the fruit length (11-14%) as well as circumference (5.75 -16%). The maximum yield decrease

was recorded when water stress was imposed at flowering and this stage is considered as a critical stage for banana.

Amplification of DREB gene in banana

The *DREB* gene was amplified from the genomic DNA of Saba, Poovan, Pachanadan and Ney Poovan. The size of the product was 500 bp (Fig. 1).

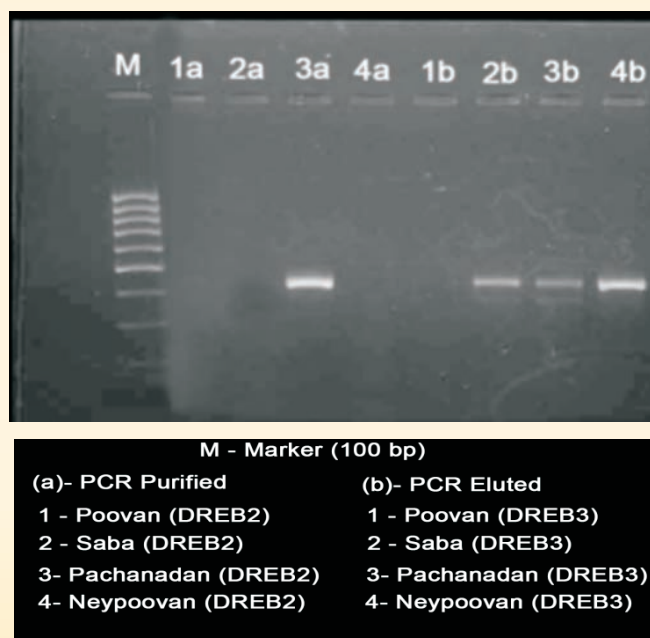


Fig -1: Amplified product of DREB gene from genomic DNA of Banana cultivars

Salt tolerance in banana

Salt tolerant Saba and Karpuravalli bananas cultivars grown in a salt affected field (EC_{1.25}=3.19 dSm⁻² pH 8.1) recorded higher Chlorophyll Stability Index (CSI) and Leaf Epicuticular Wax than susceptible cultivars like Robusta, Nendran and Red Banana. Robusta recorded higher free amino acid content than Saba (14.05 mg / g dry wt.). But, Saba and Karpuravalli recorded five-fold decrease in leaf starch content under NaCl stress. Accumulation of free amino acids and starch indicates susceptibility to salt stress in banana.

In saline-sodic soils (EC_{1.25} = 3.19 dSm⁻¹, pH 8.1.), banana suffers from salt injury with external symptoms

of marginal chlorosis of leaves, less photosynthetic activities and less finger weight leading to yield loss. Banana cv. Saba accumulated higher nitrogen content in 2nd and 3rd leaf petioles and accumulated higher N, P and K in the inner core of corm at flowering compared to susceptible cultivars (Robusta and Nendran), however, 2nd and 3rd leaf petioles recorded very low phosphorus content (0.001%). The Na⁺ and K⁺ recorded were in the range of 0.001% to 0.235% and 2.31 to 6.375% in the 3rd leaf and leaf petiole respectively. The K⁺/Na⁺ ratio (> 200) in 3rd leaf and leaf petiole recorded 50-60 fold higher in salt tolerant varieties (Saba and Karpuravalli) than susceptible varieties (Nendran and Robusta). Mg and Ca were mobilized out from corm significantly in salt tolerant varieties as compared to susceptible cultivars. The salt tolerant traits of banana maintained higher K⁺/Na⁺ ratio in leaf tissues, higher NPK contents in the corm and significant mobilization of Mg and Ca from the corm.

Alleviation of salt stress

Exogenous foliar application of acetyl salicylic acid (0.1mM) prior to NaCl (100mM, 150mM and 200mM) treatment in Grand Nain banana plants increased the superoxide dismutase as compared over negative control (NaCl stressed plants without salicylic acid foliar spray). Priming of Grand Nain tissue culture plants with either 0.1 mM acetyl salicylic acid or 0.1 mM ascorbic acid or 100 ppm ABA protects the plants from salt injury (up to 150 mM NaCl) by increasing antioxidative enzymes and delaying of leaf senescence.

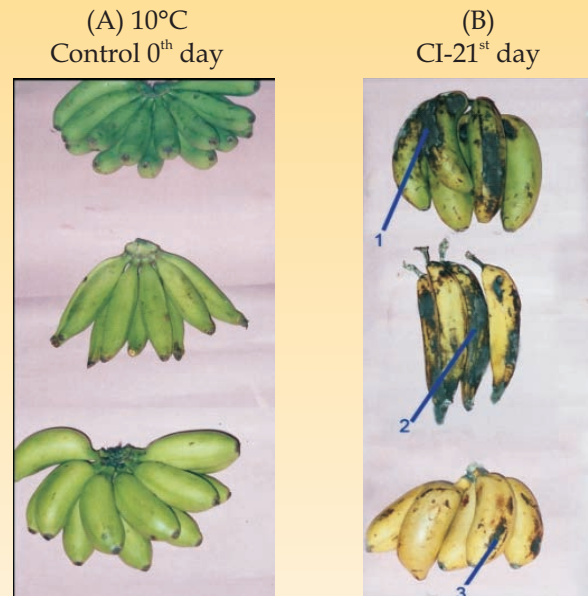
Post Harvest Physiology

Chilling Injury (CI) is a physiological disorder, which develops when the fruits are kept below the critical storage temperature. In Robusta banana, fruits stored at 10°C showed physical injury symptoms like pitting, browning on the peel (Fig-2). Chilling injury in Robusta, Rasthali and Nendran bananas stored at 10° C affected fruit ripening (Fig-3). The unripened fruit stored at 10°C recorded abnormal ripening, higher membrane leakage, less sugar content in the pulp. The fruit stored at 13.5°C ripened normally. The un-ripened banana fruit stored at 13.5 °C recorded significantly higher β-amylase activity than fruits stored at 10°C. The amylase gene (*Bmy 8*) product is involved in starch breakdown. The *Bmy8* was amplified from three banana cultivars and size of the amplicons was 900 bp (Fig-4).



Fig-2: Robusta banana stored at 10°C showing browning and pitting in the peel and browning of pulp due to chilling injury.

Fig-3: Effect of storage temperature at 10°C and 13°C on ripening



A & B - Browning & Pitting

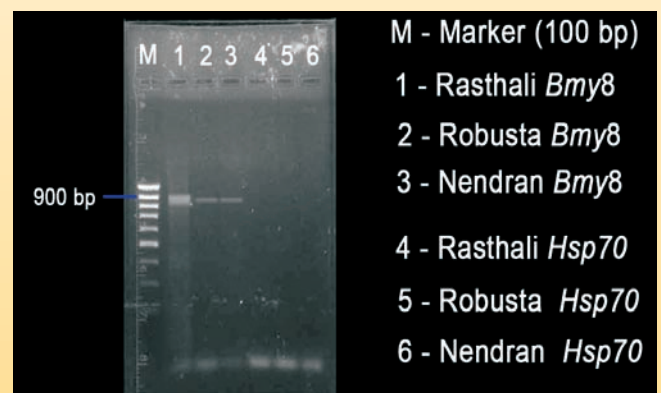
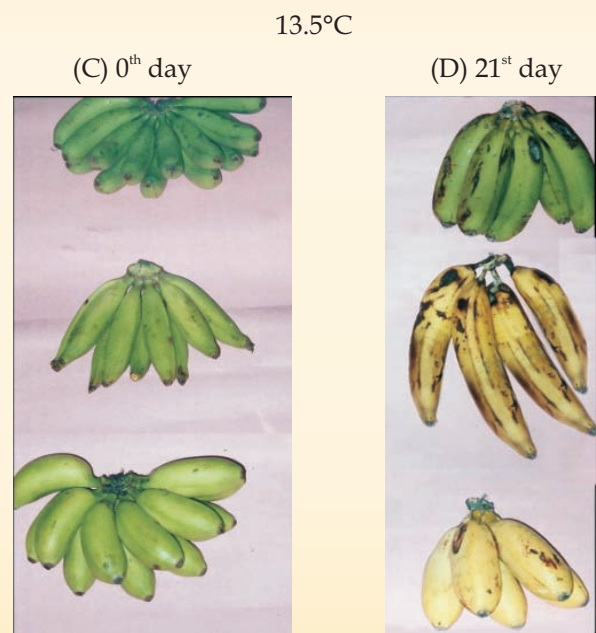


Fig 4: Amplified product of *BMY8* gene from genomic DNA of Banana

TRANSFER OF TECHNOLOGY

Transferred the technology of banana macropropagation developed at NRCB to the farmers of Kerala under SHM and Namakkal Dt. under ATMA. Imparted the

knowledge on the selection of ideal tissue culture planting material and their initial care and maintenance..

Exhibitions

Sl. No.	Name of the Events	Organized by/ venue	Date(s)
1.	Banana Festival	Ernakulum Dt. Horticulture Association, Cochin	28.04.-02.05.2010
2.	Swadesh Prem Jogriti Sangsothi-2010	UHS, Bangalore	29-31.05.2010
3.	Exhibition on Extension Reforms	TNAU & ATMA, Trichy	07.08.2010
4.	Agri. Expo.-2010	Dinakaran & State Agri. Dept., Trichy	24-26.09.2010



Exhibition on Agri. Expo.-2010, at TNAU Tiruchirapalli. Tamilnadu



Visit of TNAU - horticulture students at exhibition, NRCB Tiruchirapalli. Tamilnadu

SEMINARS/ MEETINGS/ WORKSHOPS/ CONFERENCES/ SUMMER INSTITUTES AND FARMERS TRAINING ORGANIZED AT THE CENTRE

Sl. No.	Topic	Date(s)
1	Improved Production Technology including Post Harvest Management and Value Addition in Banana for Extension Officials of Kerala	19-24.4.2010
2	Short-term training programme on Production of value added products from banana	28.06-05.07. 2010.
3	Improved Production and Post Harvest Handling of Banana	05-09.07. 2010
4	Short-term training programme on Extraction of Banana Fibre and Production of Handicrafts	12-14.07. 2010.
5	Improved Production and Post Harvest Technology of Banana	06-10.09.2010
6	Crop Production and Post Harvest Technology of Banana	15-16.09. 02010
7	Crop Production and Post Harvest Technology of Banana	22.09.2010
8	Discussion and Orientation training programme for officers from Tripura	21-23.09. 2010
9	One day training on Crop Production and Post Harvest Management in Banana for the farmers of Mohanur, Namakkal Dt., Tamil Nadu	22.09.2010



Participants of Improved Production Technology training-Extension Officials from Kerala



Hands-on training on Banana Fibre extraction and Handicrafts production

LINKAGES AND COLLABORATIONS IN INDIA AND ABROAD

AICRP on Tropical Fruits, IIHR (ICAR), Bangalore.

Development of Extruded product by blending of banana, tapioca and potato flowers in collaboration with CTCRI, Trivandrum and CPRI, Shimla.

HRC, Nagicherra, Tripura on Framing crop specific DUS guidelines for banana sponsored by PPV & FRA, New Delhi.

PUBLICATIONS

Research Papers

Nithya Devi, A., Ponnuswami, V., Sundararaju, P., Van den Bergh, I. and Kavino, M. 2009. Histopathological changes in banana roots caused by *Pratylenchus coffeae*, *Meloidogyne incognita* and *Radopholus similis* and identification of RAPD markers associated with *P. coffeae* resistance. *Acta Hort.*, **28**, pp.283-290.

Sangaeetha, G., Thangavelu, R., Usha Rani, S. 2010. Evaluation of plant oils for suppression of crown rot disease and improvement of shelf life of banana (*Musa* spp. AAA subgroup, cv. Robusta). *Food Sci. and Tech.*, **45**:10241032.

Sangaeetha, G., Thangavelu, R., Usha Rani, S., Muthukumar, A., and UdayaKumar, R. 2010. Induction of systemic resistance by mixtures of antagonist bacteria for the management of crown rot complex on banana. *Acta physiol. Plant.*, **32**: 1177-1187.

Sundararaju, P. 2009. Vertical and horizontal distribution of plant parasitic nematodes associated with banana. *Ind. J. Nematol.*, **39**:80-84.

Sundararaju, P. and Thangavelu, R. 2009. Influence of *Pratylenchus coffeae* and *Meloidogyne incognita* on the Fusarium wilt complex of banana. *Ind. J. Nematol.*, **39**:7-74.

Sundararaju, P. and Kiruthika, P. 2009. Effect of bio-control agent, *Paecilomyces lilacinus* along with neemcake and botanicals for the management of *Meloidogyne incognita* on banana. *Ind. J. Nematol.*, **39**:201-206.

Thangavelu, R and Mustaffa, M. M. 2010. First report of corm rot disease caused by *Sclerotium rolfsii* in banana, *Australasian Pl. Dis. Notes.*, **5**:3033.

Thangavelu, R. Mustaffa, M. M. 2010. First report on the occurrence of a virulent strain of Fusarium wilt pathogen (Race-1) Infecting Cavendish (AAA) Group of Bananas in India. *Pl. Dis.*, **94** (11):1379

Popular Articles

Mayil Vaganan, M., Ravi, I. and Mustaffa, M. M. 2010. Value added products from banana (Tamil). Souvenir: *Conference of Agriculture Technologies Management*, Namakkal, Tamil Nadu, 17 April, Pg. 43.

Uma, S. 2010. Exploiting banana diversity for prosperity. *Ind. Hort.*, May- June, 27-31.

Paper Presented in Conference

Uma, S., Saraswathi, M.S., Mustaffa, M.M and Durai, P. 2010. Exploitation of *Musa* diversity in the cut flower industry. In: *Proceedings of the National Conference on 'Horticultural Biodiversity for livelihood, economic development and health care'*, 29-31 May, UHS, Bangalore.

TRAININGS/WORKSHOPS/SEMINARS/SUMMER COURSES/MEETINGS ATTENDED BY THE DIRECTOR

Programme/ Venue	Period
National Consultation on Landscape Gardening for Aesthetic Value & Environmental Services, IIHR, Bangalore	29-30.04.2010
ICAR Regional Committee Meeting No.VIII, Bangalore	13-15.05.2010
Interface Meeting of Directors / PCs of Crop Science / Horticulture Division of ICAR, DWSR, Jabalpur	17-18.05.2010
National Conference on Horticulture Biodiversity for Livelihood, Economic Development and Health Care, Prem Jagrithi Sangosthi, Bangalore	29-31.05. 2010
Interface Meeting of Planning Commission Member and ICAR Instt. Directors of Tamil Nadu, TANUVAS, Chennai	22.06.2010
Scientific Advisory Committee Meeting of CREED - KVK, Ariyalur	24.06.2010
ICAR Institute Directors Conference, ICAR, New Delhi	15-16.07. 2010
Scientific Advisory Committee Meeting of Roever's College - KVK, Perambalur	20.07.2010
ICAR - Industry Interface Meet, ICAR, New Delhi	28-29.07.2010
Technical Standard Committee Meeting on Use of Ethephane for ripening of banana in cold storage, NHB-SFAC, New Delhi	13.08.2010
Stakeholders consultation Workshop on Root, Tuber, Banana (RTB) for Food Security and income, organized by Bioversity International at CTCRI, Trivandrum	16.08.2010
Project Discussion Meeting - Micronutrient, Biofortification of bananas for India - ToT, QUT, Australia at DBT-BIRAP, New Delhi	23.08.2010
State Level Workshop on Export oriented banana production - organized by MH Staet Hort. & Medicinal Board at Pune	04-05.09.2010

IMC MEETING

The fifteenth meeting of the Institute Management Committee was held on 31.7.2010 under the chairmanship of Dr.M. M. Mustafa, Director. In the meeting, the following policy decisions were discussed and recommended for approval by the Council: Revised estimate 2010 -2011, Estimate 2011 - 2012, Opening of LC for importing equipments under 'plan' and scheme during 2010 -2011.



Dr. M. M. Mustafa, Director,
Chairing the 15th IMC meeting

IMC Members

Sl. No.	Name & Address	Position
1.	Dr.M.M. Mustafa, Director, NRCB, Trichy	Chairman
2.	Dr.N. Kumar, Dean (Hort), TNAU, Coimbatore	Member
3.	Shri. S. Robert Vincent, DDH, Trichy	Member
4.	Dr.C.K. Narayana, Head-PHT, IIHR, Bangalore	Member
5.	Dr. Sukhada Mohandos, Principal Scientist, IIHR, Bangalore	Member
6.	Dr.S. Uma, Principle Scientist, NRCB, Trichy	Member
7.	Dr.V. Pandey, Principal Scientist, NRCB, Trichy	Member
8.	Shri. K.K. Hamza, F & AO, SBI, Coimbatore	Member
9.	Prof. S. Sivaramakrishnan, M/s. Shankara Group, Trichy	Member (non-official)
10.	Smt. C.Gomathi, AFAO, NRCB, Trichy	Special Invitee
11.	Shri.B.Vijayakumar, AAO, NRCB, Trichy	Member Secretary

KISSAN MELA

The National Research Centre for Banana (NRCB), Tiruchirapalli celebrated its 17th Foundation Day on 21. 08. 2010 organizing a 'Banana Field Day' with a theme on 'Use of bio-control agents in banana IPM'. The Field Day was organized mainly to highlight and disseminate the use of various bio-control agents developed by the Centre for the management of insect pests, fungal pathogens and nematodes in banana cultivation. In addition, improved production and post-harvest technologies were also highlighted. In the field day banana researchers, agriculture and horticulture officers, progressive farmers and entrepreneurs from different banana cultivating areas of Tamil Nadu participated and discussed about the various production and protection constraints and solving them in banana. Thiru T. Soundiah, District Collector, Tiruchirappalli, Thiru J. Sekar, Joint Director of Agriculture, Tiruchirappalli and Prof. B.Sivaramakrishnan, Member, NRCB Institute Management Committee participated in the function. Thiru T. Soundiah presided over the field day inaugural function and distributed the awards to the progressive banana farmers. In the technical sessions, Scientists of the NRCB delivered lecture on high density planting, fertilizer management, improved production, protection and post-harvest utilization. Also, an exhibition was arranged to demonstrate various advanced technologies on banana production developed by NRC for Banana. Other input companies related to banana production and protection like tissue culture, fertilizers, pesticides, fungicides, bio-control agents also participated.



Thiru. T. Soundiah, Collector, Tiruchirapalli,
speaking at the Kissan Mela



Participants at the Kissan Mela

STAFF NEWS

Promotions

Mr. S. Palanichamy, T5 (Technical Officer) to T6, w. e. f. 18.03.2009.

Mr. M. Krishnamoorthy, Personal Assistant to Personal Secretary, w. e. f. 18.09.2010.

Mr. R. Sridhar, Steno Grade-III to Personal Assistant, w. e. f. 18.09.2010.

Wedding Bell

Dr. C. Anuradha, Scientist (Biotechnology) weds with Dr. K. Sasikumar on 21.06.2010.

The Director and Staff of NRCB, wish the couple a Happy and Prosperous Married Life.