

NATIONAL SYMPOSIUM ON
PLANT PROTECTION-TECHNOLOGY INTERFACE
December 28th & 29th, 2007

ABSTRACTS

Editors :

**M.R.Khan
Shantanu Jha
Chitreshwar Sen**

ASSOCIATION FOR ADVANCEMENT IN PLANT PROTECTION

**PLANT HEALTH CLINIC
DIRECTORATE OF RESEARCH
BIDHAN CHANDRA KRISHI VISWAVIDYALAYA
KALYANI, 741235, NADIA, W. BENGAL, INDIA
E-mail: aapp_bckv@yahoo.co.in
Visit : www.aappbckv.org**

From the Editors' Desk :-

At the outset, we the editors express our sincere thanks for the overwhelming participation of Plant Protection scientists from all over the country and abroad in this National Symposium on '**Plant Protection-technology Interface**' organized by The Association for Advancement in Plant Protection on 28-29 Dec., '07. To provide for coverage of the ambience of this Symposium it became mandatory to invite articles on key fundamentals of the issue under the scanner. This led to a large number of communicated papers from Scientists of repute to be allocated in the module provided through Poster sessions I and II. We have no hesitation in stating that many of them deserved space for oral presentation but we had no provision to expand the time capsule in which we bound our selves without understanding the response the topic was to generate. We have always the option for the future. Our apologies for this unwanted misdemeanor and we hope you will bear with us this time by more vigorous deliberations in the proceedings presented at the podium.

Originally proposed 8 sessions of the Symposium were reorganized into five to make the essence of the interface more meaningful. The first session on molecular diagnostics following the theme lecture delivered by Dr. S. K. Datta in the inaugural session will be initiated through a lead lecture delivered on overview of the importance of molecular diagnostics in capturing the roots of microbial biodiversity which is so abundant in our country, be it air, water, soil or any other substrate/ecosystem. This is followed by invited lectures on interface of molecular diagnostics with various pest groups.

The 2nd session is primarily directed to focus on the viewpoint of the agri-based industries vis-à-vis plant protection. The flip side to the use of pesticides will be presented by Dr. Butter of PAU and there will be two presentations on the contentious issue of residues in consumables. The poster session I have many attractive and innovative ideas related to use of pesticides and other agroactive compounds among the 35 presentations.

The session III relates to the catch word of today's management strategy – biological control – headed by the *Trichoderma* pioneer of India, Dr. A. N. Mukhopadhyay. Three invited and 3 oral presentations compliment the theme lecture and there is a galaxy of support papers in the poster session II that pinpoints the emphasis the Plant Protection scientists of today are still placing on biological control as a potentially most lucrative agenda for pest management.

Session IV deals with IPM and other alternative approaches to plant pest management and received the highest number of very challenging inputs. These are organized into 2 theme lectures, and six each of invited and research presentations, giving a glimpse of what is going on in the labs and fields of today. The interface of Biotechnology in devising innovative tools for plant pest management are discussed through four lead and three invited lectures, all very illustrative of what is in the offing.

Compiling the extended and standard abstracts within a very brief time frame (we accommodated papers received till 15th Dec., '07) stretched and tested our nerves to a limit given the mosaic of formatting style and we realize mistakes may crop up in much unheralded form inspite of our best effort to make things presentable. Any errors of omission or commission are ours and we promise to improve the next time around – may be next year! Till then we request you to bear with us.

M. R. Khan
Shantanu Jha
Chitreshwar Sen

**National Symposium on
Plant Protection-Technology Interface
28-29th December, 2007**

Co-sponsors :-

- o West Bengal pollution Control Board
- o Department of Agriculture, Government of West Bengal
- o Indian Council of Agriculture Research
- o National Bank for Agriculture and Rural Development
- o Council of Scientific and Industrial Research
- o Defence Research and Development Organisation
- o Department of Biotechnology
- o Department of Science and Technology
- o National Horticultural Board
- o Department of Food Processing industries and Horticulture,
Government of West Bengal
- o West Bengal State Council of Science and Technology
- o Ministry of Environment and Forests
- o Axis Bank(UTI)

Advertisers:

- o Seababrata Bose and Associates (P) Ltd.
- o Dabur Pharma Limited
- o Dhanbad Fuels Limited(Steel Division)
- o Digital Communications
- o ASE Instruments Agency Pvt Ltd.
- o M/S. M. Enterprises

*AAPP Acknowledges
and appreciates extending their supports*

The first members of the Governing Body of AAPP

1. Prof. D. K. Bagchi : **President**
2. a) Prof. A. K. Das : **Vice President**
b) Prof. T. P. Mukhopadhyay : **Vice President**
c) Dr. J. P. Gupta : **Vice President**
3. Prof. Shantanu Jha : **Secretary**
4. a) Dr. M. R. Khan : **Assistant Secretary**
b) Prof. P. S. Nath : **Assistant Secretary**
5. Dr. S. K. Ray : **Treasurer**
6. Prof. N. Mukherji : **Member**
7. Prof. S. K. Sanyal : **Member**
8. Prof. A. K. Somchoudhury : **Member**
8. Prof. R. K. Ghosh : **Member**
9. Prof. Srikanta Das : **Member**
10. Dr. B. Bandyopadhyay : **Member**
11. Dr. Md. Abu Hassan : **Member**

ADVISORY COMMITTEE

- Dr. M. S. Swaminathan, Chairman, M.S.S.R.F, Madras
Dr.T. Ramasami, Director General, CSIR, New Delhi
Dr. Y. L. Nene, Chairman, Agri-History Society, Secundrabad, Andhra Pradesh
Dr. Seema Wahab, Advisor, DBT, Government of India, New Delhi
Dr. T. Ananthkrishnan, Loyola College, Tamil Nadu
Dr. P. K. Mazumdar, Advisor, Syngenta, Mumbai
Dr. C. D. Mayee, Chairman, ASRB, Krishi Anusandhan Bhawan, ICAR, New Delhi
Dr. S. Nagarajan, Chair Person, Protection of PVFRA, New Delhi
Dr. S. N. Puri, Vice-Chancellor, Central Agricultural University, Imphal (Manipur)
Dr. H. S. Gaur, Dean and Joint Director, IARI, New Delhi
Dr. T. P. Rajendran, ADG (Plant Protection), ICAR, New Delhi
Dr. K. V. Ramanna, ADG (Plantation Crops), ICAR, New Delhi
Dr. R. J. Rabindra, Director, PDBC(ICAR), Bangalore
Dr. H. Sen, Director, CRIJAF (ICAR), Barrackpore, West Bengal
Dr. Girish Sahni, Director, Institute of Microbial Technology, Chandigarh
Dr. Satyabrata Maity, Director, NRC for Medicinal and Aromatic Plants, Anand
Dr. S. P.S. Khanuja, Director, CIMAP, Lucknow
Prof. Siddhartha Roy, Director, Indian Institute of Chemical Biology, Kolkata
Dr. V. A. Parthasarathy, Director, Indian Institute of Spices Research, Calicut, Kerala
Prof. Hemnata Kumar Majumdar, Working Chairman, WBSCS&T, West Bengal
Prof. A.N. Basu, Chairman, West Bengal Pollution Control Board, GoWB
Dr. R. K. Sharma, Director, National Horticulture Board, Gurgaon.
Dr. D. Konar, Dir.& Ex-Officio Secretary, Agriculture Department, GoWB.
Dr. Narendra Kumar, Director Personnel, DRDO, New Delhi.

LOCAL ORGANISING COMMITTEE

PRESIDENT	: Prof. Dipak Kumar Bagchi
CHAIRMAN	: Prof. Chitreshwar Sen
ORGANISING SECRETARY	: Prof. Shantanu Jha
CONVENER	: Dr. M. R. Khan

MEMBERS :

Prof. S. K. Sanyal, Director of Research, BCKV
Dr. P. Bandyopadhyay, Director of Extension Education, BCKV
Dr. P. Pramanik, Director, Department of Horticulture, GoWB
Dr. S.K.Samanta, Joint Director, Directorate of Research, BCKV
Dr. M.K. Sarkar, State Mycologist, Agriculture Department, GoWB
Mr. G. Ahmed, Joint Director, Plant Protection & Quality Control, GoWB
Mr. A. K. Hui, Deputy Director, Biocontrol, GoWB
Dr. D. Maity, Director of Farms, BCKV
Prof. A. K. Das, Dean, Faculty of Agriculture, BCKV
Prof. P. K. Chattopadhyay, Dean, Faculty of Horticulture, BCKV
Prof. J. P. Gupta, Dean, Faculty of Agricultural Engineering, BCKV
Dr. P. K. Pal, Head, Department of Agricultural Entomology, BCKV
Dr. B. Dasgupta, Head, Department of Plant Pathology, BCKV
Dr. Anjan Bhattacharya, Head, Department of Agri Chemicals, BCKV

EXECUTIVE MEMBERS

Prof. C. Sen
Prof. M.R.Ghosh
Prof. N. Mukherjee
Prof. Sisir K.Mukhopadhyay
Prof. M.K.Dasgupta
Prof. R.K.Ghosh

Programme Summary [Technical]

Inaugural Session

Keynote Address : **Dr. Swapan K. Datta**, Rasbehari Professor, Kolkata University on
Genomics and safe use of genetic engineering for plant protection

Session I: **Diagnostics of plant pests – The technology interface** 11.15am-1.00pm

Chairman : **Dr. Tapan Chakrabarti**,
Co-Chairman : **Dr. R.K.Jain**
Rapoteurs : **Dr. Pranjib Chakrabarty & Dr. D.K. Ghosh**

- LL-1. Tapan Chakrabarti**, IMTECH
Exploration and exploitation of the unseen majority
- IL-2. R.K. Jain**, IARI
Molecular diagnostics of plant viruses
- IL-3. V. K. Gupta and V. K. Dilawari**, PAU
Molecular diagnostics in Entomology- A technological interface
- IL-4. (Mrs) S. Ganguly**, IARI
Integration of morphological and molecular diagnostic tools in systematics of entomopathogenic nematodes
- IL-5. D.K. Ghosh**, NRC-Citrus
Molecular tools for characterization, diagnosis and management of major virus and virus- like diseases of citrus
- IL-6. Pranjib Chakrabarty**, CICR-Cotton
Diagnosis of Plant Pathogens- Novel Approaches
- IL-7. Dr. Sanjoy K. Singh**, ARI, Pune
Taxonomy of foliicolous fungi: Classical vs molecular
- IL-8. B.N. Chakraborty**, NBU
Immunological diagnosis of thelygenic fungi of tea
- IL-9. A.K. Ganguly and Uma Rao**, IARI
Decades of researches in biochemical and molecular nematology at IARI
- OP-10. A. Samad, et. al.** CIMAP
Detection of a 16 Sr VI Group phytoplasma (Clover proliferation) associated with little leaf disease of Portulaca grandiflora in India

Session II: Technology - Industry Interface
2.15pm-4.30pm

Chairman : **Dr. Pradip Mazumdar**, Advisor : Syngenta
Co-Chairman : **Mr. Jayanta Chakraborty**, Indofil
Rapporteurs : **Mr. Subroto Ghosh**, Krishi Rashyan
Dr. Srikanta Das, Prof. of Plant Pathology, BCKV

- LL-1. Mr. S. Kumarsamy**, Chairman, APG (Ex CEO BASF)
Recent advances in crop protection technologies
- IL-2. Dr P. K. Guha**, GM, Technical, ISA
Integrated pest management strategies : modern agri-horticultural production systems
- IL-3. Dr. O.P. Singh**, President, Dhanuka Group
Private (Industry) – Public partnership in Agril. Extension – A success story of Hoshangabad, Madhya Pradesh
- IL-4. Dr Ajit Kumar**, GM, Technical, UPL
Nano-formulation of pesticides : issues and challenges
- IL-5. Mr.S.Thyagarajan**, GM, Technical, BASF
Producing and marketing pest-resistant GM crops : Issues and challenges
- IL-6. N.S. Butter and A.K. Dhawan**, PAU
Use of pesticides and agriculture food security and environmental safety
- IL-7. Anjan Bhattacharyya, Suhrid Ranjan Barik & Pritam Ganguly**, BCKV
New pesticide molecules, formulation technology and uses: present status and future challenges
- OP-8. Kaushik Banerjee, Pandurang G Adsule**, NRC-Grape
Recent advances in analytical methods of pesticides residue analysis in food and environmental samples

**Concurrent Poster Session I: Plant pest management using
12.30pm-2.30pm pesticides or related products**

Poster no. 1 to 34

Evaluation : **Prof. M.R.Ghosh**
Prof. N.Mukherjee
Dr. N.S.Butter

- PP-1. Aktar, Md.Wasim et al.**
Fate and behavior of Oryzalin-A herbicide in soybean under East-Indian climatic condition
- PP-2. Barui, Kironmay et al.**
Bioefficacy evaluation of propaquizafop (Agil 10 EC) on monocot weed flora in blackgram
- PP-3. Bhunia, C. K. and A. Biswas**
Effects on symptomatological development in rapeseed-mustard due to Alternaria blight disease in relation to different new fungicides
- PP-4. Bora, B. C. and B.N. Choudhury**
Integrated management of Meloidogyne graminciola in rice in organic farming system
- PP-5. Chatterjee, Hirak and S. K. Senapati**
Evaluation of some eco-benign microbes for management of Spilosoma obliqua Walker (Arctiidae: Lepidoptera)
- PP-6. Choudhury, B.N. and Aparajita Borah**
Integration of pesticidal seed treatment with deep ploughing in kharif mung for the management of Meloidogyne incognita
- PP-7. Dahal, Dipen et al.**
Population dynamics and chemical control of betel vine black fly (Aleurocathus rugosa Singh)
- PP-8. Das, S.B. et al.**
Studies on white fly (Dialeurodes pallida Lamba) with reference to seasonal abundance, mechanism of relative preference and its management in betelvine (Piper betle)
- PP-9. Das, S.B. et al.**
Study on efficacy and standardization of dose of ready-mix formulation A15397A-150ZC against pod borer complex infesting medium maturing pigeon pea and their impact on potent parasites
- PP-10. De, Rajib Kumar and R.K. Mondal**
Evaluation of fungicides in vitro on Botryodiplodia theobromae causing black-band of jute (Corchorus spp.)

- PP-11. Ghosh, Amalendu et al.**
Relative toxicity and LC₅₀ values of some new insecticides against tobacco caterpillar, Spodoptera litura Fabr.
- PP-12. Ghosh, D.K.**
Molecular detection of citrus tristeza virus during periods of optimal and non-optimal virus concentration and its application in implementation of citrus budwood certification programme
- PP-13. Ghosh, P.K. and A. Chatterjee**
An investigation on the effect of anthracnose (Colletortichum indicum) disease on cotton plant (Gossypium hirsutum L.) and its control measures
- PP-14. Jalgaonkar, V.N. et al.**
Efficacy of some insecticides against cashew tea mosquito bug Helopeltis antonii Sign.
- PP-15. Khan, M.R. and Sekhar Ghosh**
Management approaches of tuberose foliar nematode problem in tuberose cv. Calcutta Double in West Bengal
- PP-16. Khandker, Nesar Ahmed**
Efficacy of some plant extracts in suppressing the insect pests and yield of sunflower crop under different climatic conditions in Bangladesh
- PP-17. Konar, Amitava and N. Johnson Singh**
Occurrence of aphid on various potato germplasm in eastern Gangetic plains of West Bengal
- PP-18. Kumar, Sanjeev et al.**
Evaluation of fungicides/botanical against black leaf spot of ber (Zizyphus mauritiana Lamk)
- PP-19. Maiti, Asim Kumar and M. L. Chatterjee**
Bioassay studies of some new insecticides against the diamond back moth, Plutella xylostella (L.)
- PP-20. Mudigoudra, Shreenivas and Shekharappa**
Evaluation of different plant products against shoot fly in sorghum
- PP-21. Mukhopadhyay, S.K. et al.**
Studies on the bio-safety of botanical insecticides to native natural enemies in mulberry ecosystem
- PP-22. Pal, S. et al.**
Efficacy of low dose herbicides against weeds in transplanted kharif rice (Oryza sativa L.)

- PP-23. Panja, B.N. et al.**
*Comparison of path behaviour of some healthy and fruit borer (*Leucinodes arbonalis* Guenee) affected brinjal genotypes*
- PP-24. Patel, Yogesh et al.**
Efficacy of newer insecticides against cotton bollworm complex
- PP-25. Patel, Yogesh et al.**
Impact of some newer insecticides on potent predators of cotton
- PP-26. Patil, B.V. and M.H.Chavan**
Efficacy of newer insecticides against foliage feeder and head borer in sunflower
- PP-27. Patra, S. et al.**
*Bioefficacy of some new insecticides against okra shoot and fruit borer *Earias vitella* (Fab.)*
- PP-28. Roy, Sankhajit et al.**
Residue and dissipation of Antracol 70WP in onion
- PP-29. Sahoo, Ajoy Kumar et al.**
*Comparative efficacy of insecticides and neem formulations against Litchi fruit borer, *Conopomorpha cramerella* Snellen on Litchi*
- PP-30. Samui, Goutam and S. Jha**
*Studies on bio-ecology and management of *Apsylla cistellata* Bucton. on mango in West Bengal*
- PP-31. Sarkar, Bipasa et al.**
Biocidal activity of newly synthesized organotin compounds against foliar blight of wheat
- PP-32. Senapati, A. K. and N. Mandi**
*Integration of chemical, botanical and microbial insecticides for control of thrips, *Scirtothrip dorsalis* Hood infesting chilli*
- PP-33. Shekharappa**
*Biological control of ear head caterpillar, *Helicoverpea armigera* (Hubner) in sorghum*
- PP-34. Singh, K.I. et al.**
*Residual effect of four conventional and five bio-rational insecticides on the feeding activity of *Bombyx mori* Linn*
- PP-35. Singh, Paramjit et al.**
*Field efficacy of spinosad 45 % SC for the control of rice stem borer *Scirpophaga incertulas* (Walker) and leaf folder *Cnaphalocrocis medinalis* (Guenee) on paddy and basmati rice*

**Session III: Alternative approaches to pest management –
Biological control
9.00am-10.30am**

Chairman : **A.N. Mukhopadhyay**
Co-Chairman : **Pratibha Sharma**
Rapporteurs : **M.S. Rao & P.M. Bhattayacharya**

- LL-1. A. N. Mukhopadhyay**, Retd. Vice Chancellor, AAU
Challenges, changes and choices before Trichoderma based biopesticides
- IL-2. S. K. Gupta**, CU, Kolkata
Diversity of natural enemies of mite pests infesting agri-horticultural crops in India highlighting their potentiality and prospects in using those in IPM programme
- IL-3. Minshad Ali Ansari**, University of Swansea, UK.
Combined use of entomopathogenic nematodes and fungi: a novel approach to control pests of crops
- IL-4. Pratibha Sharma**, IARI
Hypovirulence in plant pathogenic fungi
- IL-5. M.S. Rao**, IIHR
Biological suppression of nematode pests of crops
- OP-6. D.K. Chakrabarti, V.P. Gaur**, and **O.P. Singh**
Source of primary inoculum of downy mildew of opium poppy and its biological management
- OP-7. M.R. Khan, S. M. Khan, F. A. Mohiddin** and **N. Khan**
A new process for the production of biopesticides to control plant parasitic fungi and nematodes
- OP-8. Someshwar, Bhagat** and **Sitansu K. Pan**
Comparative ecological behaviour of some pre and post Tsunami isolates of Trichoderma harzianum and T. Viride from Andaman & Nicobar Islands
- OP-9. A. Roy, N.Gurung** and **P.M. Bhattacharya**
Enhancement of antagonistic potential against Macrophomina phaseolina through chitin amendment in formulated biomass of Trichoderma spp.
- OP-10. K. Karmakar**
Bio-ecology and feeding potential of Agistemus fleschneri Summers (Acari: Stigmaeidae) for integrated management of mite pests
- OP-11. Mansoor Alam, Abdul Sattar, Abdul Samad** and **Abdul-Khaliq**
Bioinoculants, a vital tool for yield improvement and disease management of MAPs

OP-12. K.C. Pujari, L.K. Hazariba, Pranab Dutta and H.K. Devnath
*Beuveria bassiana - a potential biocontrol agent for rice hispa (Dicladispa
arnigera) in Assam*

OP-13. V.K. Dhingra, Biotox
*Regulatory mechanism for biopesticides : A key input for organic / sustainable
agriculture*

**Session IV: Alternative approaches to pest management II : IPM
& Other non-aggressive approaches
10.45am-1.15pm**

Chairman : **O.M. Bambawale**
Co-Chairman : **S.K. Gupta**
Rapporteurs : **M.V. Santha Kumar & A.K. Chowdhury (UBKV)**

LL-1. M. K. Dasgupta, Visva-Bharati(VB)
From epidemiology to site-specific appropriate precision agriculture

LL-2. O.M. Bambawale, NCIPM
Current biopesticidal strategies in modern crop production systems

IL-3. Ramesh K. Jain and R.V. Singh, IARI
*Role of all India Coordinated Research Project(Nematodes) for developing
nematode management technologies*

IL-4. Ramesh Chand, BHU
*Exploitation of slow disease development traits for Integrated Disease
Management*

IL-5. C. Chattopadhyay, et al. NRC-Mustard-Rapeseed, Bharatpur
*Forecasting models for major diseases and aphid of oilseed Brassicas in
India for ecofriendly crop health management*

IL-6. S.K. Mukhopadhyay, VB
New horizons in weed management

IL-7. A. K. Bajpai, CSR&TI
*Integrated management of diseases and pests in mulberry sericulture –
present scenario and future strategies*

IL-8. Abraham Verghese, et al., IIHR
*Area-wide management for greater efficacy in fruit fly control in fruit orchards
(mango & guava)*

OP-9. R. Goswami, et.al. Beyond IPM and Farmer Field Schools (FFS) :
A journey from pest management to sustainable livelihoods

OP-10. Khandker Nesar Ahmad

Effect of biopesticides in the suppression of major insect pests and yield of oilseed crops under different climatic conditions in Bangladesh

OP-11. D.K. Das and A. Dhandapani

*Weather based forwarning of gram pod borer, *Helicoverpa armigera* (Hub.) in pulse crop based agro-ecosystems of India*

OP-12. Partha Pratim Ghosh and N.C. Mandal

Efficacy of some disease management practices against bacterial wilt of potato in red and lateritic region of West Bengal

OP-13. A. Banerjee and B. Bandhyopadhyay

*Incidence pattern of pulse aphid (*Aphis craccivora* Koch) and its natural enemies on green grama in lower gangetic plains of West Bengal*

OP-14. A.K. Chowdhury, et.al.

Serological changes associated with induction of resistance in soybean plants following treatment with phytoalexin inducers

OP-15. N.K. Krishna Kumar, et al.

Tospoviruses and their vectors in India

**Session V: Biotechnological approaches to plant pest management
2.30pm-3.45pm**

Chairman : **V.A. Parthasarathi**
Co-Chairman : **Indranil Dasgupta**
Rapporteurs : **S.K. Chakraborti & Somnath Bhattayacharya**

LL-1. V. A. Parthasarathi, IISR, Calicut

Biotechnological tools for disease management

LL-2. Amitava Mitra, Univ. of Nebraska, USA

Transgenic approaches to broad-spectrum disease resistance: Novel pathways and gene silencing

LL-3. Himani Tyagi, Vidhu Verma, S. Rajasubramaniam, Shweta Sharma and Indranil Dasgupta, DU

Engineering resistance against Rice Tungro Virus in rice using RNA-interference

LL-4. Arun K. Chatterjee, Yaya Cui and Asita Chatterjee, University of Missouri, USA.

Resistance against soft-rotting disease conferred by inactivation of quorum sensing signal required for the expression of bacterial virulence

- IL-5. Shampa Das**, Bose Inst. Kolkata
Development of insect resistant rice: A genetic engineering approach towards crop management
- IL-6. Amita Pal**, Bose Inst., Kolkata
Resistance gene analogue and its application in plant protection strategy
- IL-7. S. K. Chakrabarti**, CPRI, Simla
Biotechnological approaches for plant disease management in potato

Concurrent Poster Session II: Plant pest management using non-aggressive approaches
12.30pm-2.30pm

Poster no. 1 to 35

Evaluation : **Prof. M.R. Ghosh**
Prof. N. Mukherjee
Dr. N.S. Butter

- PP-1. Banerjee, Saon et al.**
Predicting mustard aphid incidence in the Gangetic plains of West Bengal from temperature variation
- PP-2. Chand, Girish et al.**
Investigations on role of bioagents in IPM of mango malformation disease
- PP-3. Chakraborty, Ayana et al.**
*Management of damping off of chilli (*Capsicum frutescens*) through integration with bio-antagonists and botanicals under green house conditions*
- PP-4. Chowdhury, Manidipa**
*Incidence of saw fly (*Athalia lugens proxima* Klug.) as influenced by level of irrigation and fertilizers on mustard*
- PP-5. Choudhury, S. and S. Pal**
Population dynamics of mustard aphid on different Brassica cultivars under Tarai agroecological conditions of West Bengal
- PP-6. Das, D.K.**
Use of meteorological information in Integrated Pest Management
- PP-7. Das, Raju and A. K. Chowdhury**
Occurrence of groundnut stripe virus in West Bengal
- PP-8. Debnath, A. et al.**
*Standardization of index based screening technique for *Trichoderma**
- PP-9. Desai, V.S. et al.**
*Infestation of coconut eriophyid mite *Aceria guerreronis* Keifer in Konkan region of Maharashtra*

- PP-10. Dutta, S. et al.**
*Evaluation of biocontrol potentiality of native plant growth promoting bacteria against *Rhizoctonia solani* mediated damping off disease of tomato*
- PP-11. Dwary, A. et al.**
Effect of different organic and inorganic nutrient management on late blight disease of potato
- PP-12. Gogoi, Robin et al.**
Diversity of the pathogens inciting rhizome rot disease of ginger in Assam and Arunachal Pradesh
- PP-13. Hegde, K. K. and B. S Nandihalli**
Bioefficacy of some indigenous products in the management of okra fruit borers
- PP-14. Khaliq, Abdul et al.**
*Synergistic effect of arbuscular mycorrhizal fungi and *Bacillus subtilis* on the biomass and essential oil yield of rose scented geranium (*Pelargonium graveolens*)*
- PP-15. Khan, S.A. et al.**
Forewarning of mustard aphid with agrometeorological parameters
- PP-16. Laha, S. et al.**
Disease dynamics, severity prediction and loss assessment of fungal diseases of some commercial ornamentals
- PP-17. Maji, M.D. et al.**
Evaluation of botanicals for eco-friendly management of mulberry diseases
- PP-18. Mandal, Dhanajoy**
*Eco-friendly management of mealy bug, *Dysmicoccus brevipes* (Cockerell) in pineapple*
- PP-19. Mandal, Dhanajoy et al.**
Site-specific appropriate precision agriculture
- PP-20. Mishra, S.D. and Parul Agrawal**
*Antagonistic effect of neem and other plant products as seed coating against root-knot nematode *Meloidogyne incognita*, infecting chickpea*
- PP-21. Mondal, Sujoy and S.S.Ghatak**
*Bioefficacy of some indigenous plant extracts *Epilachna* beetle, (*Henosepilachna vigintioctopunctata*, Fabr.) infecting cucumber*
- PP-22. Mukherjee, U.**
*Insecticide resistance management (IRM) in diamondback moth (*Plutella xylostella* L.) – a success story*

- PP-23. Mukhopadhyay, S.K. et al.**
Studies on the bio-safety of botanical insecticides to native natural enemies in mulberry ecosystem
- PP-24. Nandihalli, B. S.**
*Utilization of botanicals in the management of the coconut perianth mite, *Aceria guerreronis* Keifer*
- PP-25. Pal, Suprakash and I. Sarkar**
Pest infecting ornamental plants in hilly region of West Bengal
- PP-26. Ray, S.K. and I. Bhattacharya**
Ecofriendly approach for guava wilt disease management in West Bengal
- PP-27. Santa Kumar, M.V. et al.**
Development of wealths-based forecasting models for major mulberry pests in Murshidabad district of West Bengal
- PP-28. Satya, P.**
*Histochemical localization of reactive oxygen species activity in the vascular bundle of rice leaves affected by *Xanthomonas oryzae* pv. *oryzae* and its relation with the activity of scavenging enzymes*
- PP-29. Satya, P. et al.**
*Temporal variability in disease progress of *Xanthomonas oryzae* pv. *oryzae* isolates from Eastern India*
- PP-30. Selvakumar, R.**
*Biological Control of *Sclerotinia* blight of cabbage using *Trichoderma* spp.*
- PP-31. Tarafdar, A. et al.**
Development of management strategy for production of transgenic citrus resistant to citrus tristeza closterovirus
- PP-31. Thakur, S.K. and P.P.S. Baghel**
*Effect of *Meloidogyne incognita* on biochemical changes in leaves of *Mentha arvensis**
- PP-32. Thakur, S.K. and P.P. Baghel**
*Effect of *Meloidogyne incognita* and *Glomus fasciculatum* on plant growth and oil content of *Mentha arvensis**
- PP-33. Yadav, R.P. and R.P. Sharma**
*Evidence of bioinsecticidal properties in aqueous phyto extract of datura (*Datura stramonium* L.) against *Helicoverpa armigera* Hub. on chickpea*



Genomics and safe use of genetic engineering for plant protection

Datta, Swapan K. Department of Botany, University of Calcutta, Kolkata-700 019, **E-Mail:** swpndatta@yahoo.com

Plant breeding is a continuous process involving farmers' innovations, natural resources and economic motivation needs to move on with time. By 2020, 30% more rice need to be produced to feed the increasing population using less land, less water, and less agrochemicals. Twenty-four percent of total rice is lost due to biotic and abiotic stress. Disease or pests control is based on the principle of maintaining yield loss below the injury level. In most cases, fungicides/pesticides and biological control including crop rotation, IPM (integrated pest management) is used for plant protection. Conventional breeding for plant protection suffers from a series of limitations that include lack of resistant genotype (e.g. sheath blight of rice caused by *Rhizoctonia solani*), reproductive barriers between plant species preventing transfer of resistant genes, etc. Plant recognizes pathogen encoded molecules through probable receptors encoded by disease resistance *R* genes. A signal transduction study provides an excellent understanding of gene for gene resistance, which explains plant pathogen co-evolution in a given environment. The first cloned *R* gene, *Hm1* was obtained through transposon tagging. Later, chromosome walking (positional cloning) and heterologous transposon tagging made it possible to clone many genes used for plant protection. Developing varieties resistant to natural enemies (virus, fungi, bacteria etc.) would provide a solution for sustainable agriculture. This approach is inexpensive, environmental friendly and management would be easier than before.

Genomics based strategies for gene discovery, coupled with validation of the transgenes by transgenesis have accelerated the identification of functional profile of candidate genes. We must look for every possible option to reduce the yield loss. Because of the vital role it plays in society, food crops including rice must be produced in the safest way possible. With the modern tools of biotechnology that we have today, it is now possible to develop rice with the desired traits in an environment-friendly manner. Genetic engineering, a powerful tool, is now being used to complement traditional plant breeding efforts to improve the crop's yield, pest and disease resistance. Studies on transgenic rice are continuing to explore possibilities of conferring such traits as resistance to bacterial blight, stem borer, sheath blight and grain quality. Non-antibiotic and marker-free selectable systems have been accomplished. Field evaluation of transgenic rice resistance to bacterial blight and stem borer showed excellent results. The current knowledge of Bioinformatics allows us to understand the integration of Genomics, Physiological Functioning, Host-pathogen/pest interaction, Genetics and Plant breeding translating into System Biology. Considering the tremendous value of genomics research for crop improvement broad collaborations in genomic research involving private and public sectors with emphasis on the need to provide the best science to serve the farmers' perspective of economic gain of agriculture growth.

Farmers require improved seeds/crops. Biotech based package of improvement as a complementary tools of plant breeding can be incorporated in the seeds which

should reach to farmers with further information and confirmation of its safety, practice and management. The availability of various cultivars with different resistance genes could significantly reduce the yield loss. Genes pyramiding for broad spectrum plant protection will have much greater economic impact when available. The policy makers should look into its potential use and make necessary access to the Intellectual Property Rights (IPR) irrespective of the nature of ownership.



Exploration and exploitation of the unseen majority

Tapan Chakrabarti, Microbial Type Culture Collection and Gene Bank (MTCC), Institute of Microbial Technology (IMTECH), Sector 39A, Chandigarh 160036, **E-Mail:** tapan@imtech.res.in

In shaping the course of evolution of life on earth, their huge number and in keeping the health of our planet, microorganisms are by far the most important components of biodiversity. A recent report estimated the number of archaea and bacteria to be 4 to 6 x 10³⁰. Until 1990 our knowledge of archaeal and bacterial diversity, both species and metabolic, came from the organisms which could be cultured in the laboratory. Many lines of evidence in the last few years suggested that most prokaryotic microorganisms can not be cultivated in conventional laboratory conditions. As a result, the presence of more than ninety percent of them remained unknown and their genetic potential remained untapped.

In the early 1990s, molecular tools were used to show that microbial species diversity of a particular ecological niche can be deciphered without subjecting them to cultivation. In recent years molecular approach has also opened up new ways to harness metabolic potential of this huge gene pool without the need to culture them.

For study of species diversity by this culture independent approach, DNA is isolated directly from a sample and the community DNA is generally processed basically in two ways depending on the question(s) one has in mind. The 16SrRNA genes are amplified by PCR and the amplicons can be analysed by different methods (DGGE, T-RFLP, ARDRA, etc) or can be cloned and sequenced followed by phylogenetic analysis. For exploiting metabolic potential of the huge diversity, metagenomic approach is employed wherein the community DNA is digested to required sizes, ligated to desired vectors and are cloned in *E. coli* or other suitable host bacteria to make metagenomic libraries. These clones can be screened for desired functions or desired sequences can be detected by using suitable probes. In a pioneering approach, Craig Venter's group used environmental shot gun sequencing of Sargasso sea (2004) and of global ocean (2007) and discovered enormous species diversity (known as well as novel), gene contents and new protein families in their samples.

Culture independent studies have also produced a wealth of information about microbial diversity in human gut, waste water sludge and many other ecological niches.

India has the distinction of being one of the megadiversity region of the world because of its rich and endemic flora and fauna but there is hardly any information about diversity of microorganisms. Here at IMTECH we have been studying, using both culture dependent and culture independent approaches, microbial diversity from many ecological niches of India (NE region, Rajasthan, Himachal Pradesh, Western Ghats etc.). Even with limited scale of study we observed rich diversity of archaea, bacteria and yeasts. We have discovered a few novel genera and quite a few novel species from these environments. Culture independent approach also revealed enormous diversity of the niches. Metagenomic libraries have been prepared from some of these samples which are ready for screening for functional diversity.

Molecular diagnostics of plant viruses

Jain, R.K. Division of Plant Pathology, Indian Agricultural Research Institute, New Delhi 110012, **E-Mail:** rakeshjain56@yahoo.co.in

Plant viruses are simple in composition but are extremely difficult to manage. The losses caused by plant viruses are enormous. In India, viral diseases of plants cause annual loss of about Rs. one thousand crores (Rs. 10 billion). Losses are greater in the tropics and semi-tropics, which provides ideal conditions for the perpetuation of viruses and their vectors. A large number of viral diseases affect various cropping systems in India, owing to its diverse climate. The largest numbers of diseases are caused by Potyviruses followed by Geminiviruses. Other groups of viruses, which are fast emerging as serious pathogens, are Badnaviruses, Ilarviruses, Nanoviruses, and Tospoviruses.

Early detection is the best protection. The last two decades have seen great advances in the area of detection technology and a number of novel serological and nucleic acid-based technologies have evolved ranging from ELISA to micro-array technology.

The sensitivity of some of the techniques like enzyme-linked immunosorbent assay (ELISA) and polymerase chain reaction (PCR) has reached the level that any known plant virus can now be detected up to "attogram (ag)" level or even in single injected seed or a single insect. Increased sensitivity has also been realized by taking advantage of the synergies derived from combining ELISA and PCR. The application of these technologies are not only increasing our understanding of the viral disease of unknown etiology, but also increasing our understanding of their etiology and epidemiology.

In India, a modest beginning has been made for the molecular diagnosis of viral diseases after the establishment of Advanced Centre for Plant Virology (ACPV) at Indian Agricultural Research Institute, New Delhi in 1988. Serological and nucleic acid-based diagnostics have been developed for viruses belonging to Badna-, Cucumo-, Gemini-, Ilar-, Poty- and Tospo-viruses. During the same period, good progress has also been made at Central Tuber Crop Research Institute, Trivandrum, Central Potato Research Institute, Shimla, Indian Institute of Horticultural Research, Bangalore, Indian Institute of Vegetable Research, Varanasi, and National Research Centre for Banana, Trichi in developing diagnostics against viruses affecting a variety of crops. However, these tools for the majority of viruses have not been validated at field levels. Likewise the diagnostic probes have not reached the level of diagnostic kits and are not commercially available. These are not widely used by the breeders, entomologists, horticulturists and agronomists in the country. Development of a sound viral disease diagnostic system is thus essential not only for monitoring of new viruses, but also for the identification of resistance sources/ genes and certification of virus free planting materials.



Molecular diagnostics in Entomology- A technological interface

Gupta, V. K. & V. K. Dilawari, Insect Molecular Biology Lab.,
Department of Entomology, Punjab Agricultural University, Ludhiana,
E-Mail : virashkgupta@gmail.com

Agricultural production today is limited by inefficient control of various insect pests and pathogens vectored by them. . Thus, correct identification of insect pest and vector has become an essential prerequisite both for the planning and monitoring of pest control interventions.

Several insect-pest species, being inconspicuous, are difficult to be identified using traditional methods. These methods are based upon morphological, behavioral and biochemical characteristics which due to their inherent limitations are proving insufficient in precise characterization of the pest. Additional problem arises particularly with those species that are isomorphic or show phenotypic plasticity linked to microhabitat adaptations. These phenotypic analyses regard the patterns of variability/similarity as a reflection of underlying genetic relationships only partially because of being correlated with the expressed phenotypes at the stage of collection/study. This problem is further compounded by emergence of new pests and pest strains resulting from unchecked chemical applications and changing environments.

Faced with such difficulties, researchers have now turned to molecular diagnostics in an attempt to clarify the taxonomic status, systematic relationships and evolution of important insect taxa. This has primarily contributed to understand the phylogeny of important insect species and precise identification of insect pests and their dispersal. Most diagnostics are based upon polymerase chain reaction (PCR) based amplification of targeted pest-specific DNA segment(s). Before the availability of information on insect-specific sequences, RAPD-PCR techniques involving comparative analysis of randomly amplified DNA segments was the only technique to distinguish amongst different but related insect species. Though, this technique could generate ample information for use in insect phylogeny, it lost its significance due to its susceptibility to repeatability. This resulted in targeting DNA regions that are considered relatively more conserved amongst related genera/species/strains, such as cytochrome oxidase I region of mitochondrial DNA (COI-mtDNA) and inter-spacer transcribed sequences of ribosomal RNA (ITS-rRNA) genes using degenerate primers. This resulted in generation of abundant information on nucleotide sequences of insect pests, beneficial insects and pathogens of importance in agriculture and forestry. Such methods could precisely differentiate amongst related genera and species in a comparative manner, but proved insufficient for application to new pest strains which emerge due to the current pressure of changing environment.

In order to achieve greater precision, recently developed molecular diagnostics are now based upon in-depth analysis of base sequences of specifically amplified mtDNA or rRNA regions for identifying species specific sequences. Such procedures have led to the development of PCR-RFLP (restriction fragment length polymorphism) diagnostics wherein amplified fragments of similar size are differentiated by restriction analysis of respective amplicons. Many of such diagnostics have been developed

and are in practice for molecular identification and survey of different types of insect pests, beneficial insects as well as pathogens of insects and crops. The advent of Real Time PCR (RT-PCR) methods based upon TaqMan probe has further resulted in precision with which molecular diagnostics are being developed and exploited for molecular identification and characterization of specific pest species as well as for the analysis of the population dynamics of insects of importance in agriculture and forestry.

Such molecular methods are finding immense scientific and diagnostic utilities, such as identification of insect species and their variants, symptom-less/inapparent infections, sources of new infestations, high risk insect biotypes exhibiting pesticide resistance, monitoring gene flow of insect pests in a specific area, generating DNA sequence data for use as specific DNA fingerprints, establishing genetic relatedness amongst different species and strains of pest/ pathogens, detection of seed borne diseases direct from the seed/seedling, measuring genetic variability in the pest/pathogen populations, determining resistance development capacity of different strains and establishing a DNA sequence database for insects of quarantine/non-quarantine significance.



Integration of morphological and molecular diagnostic tools in systematics of entomopathogenic nematodes

Sudershan Ganguly, Division of Nematology, Indian Agricultural Research Institute, New Delhi-110012, **E-Mail:** sg_nema@yahoo.com

Entomopathogenic nematodes (EPN) belonging to the families Steinernematidae and Heterorhabditidae, are soil dwelling lethal parasites of insects that are used for inundative, augmentative or inoculative biological control. These nematodes with the help of their bacterial symbionts kill the insect host within 24 to 48 h, and then emerge en masse from the cadaver within 4-10 days after completing 2-3 generations in insect hemoceol. There were only 9 species in 1990, which has now grown to 66. Application of molecular approaches in species descriptions and their phylogenetic relationships, has also made EPN systematics remarkably exciting.

Till date, there are two genera listed under Steinernematidae – *Steinernema* and *Neosteinernema*, with about 55 species in the former and only one species in the latter. Under Heterorhabditidae, there is only one genus – *Heterorhabditis* with only 10 known species. Of these, only two species have been contributed from India: *H. indica* and *S. thermophilum*. Besides, several indigenous strains of these two have been isolated, of which a few have been identified as *S. carpocapsae*, *S. feltiae*, *S. bicornutum*, *S. glaseri*, *S. riobrave*, *S. siamkayai*, *S. tami*, *H. bacteriophora* and *H. indica*, whereas large number of strains isolated by different centers are yet to be identified.

Increasing importance of EPNs in IPM demands precise identification of species and their strains for not only pursuing further research on them but also for patenting and regulatory purposes, which require a sound biosystematics base.

The classical taxonomy based on morphological features is the backbone of taxonomy and is extremely important for preliminary identification of the species. In this approach, it is mandatory to study the morphological details of infective juveniles and the adults from first and second generations. But, this approach is time consuming, and offers limited diagnostic characters in view of the large number of EPN species. The biological species concept, in combination with morphological and molecular data, has been widely applied in EPN taxonomy for establishing the precise species status (sibling species/strains) of the isolates. Interbreeding tests have resolved several early taxonomic anomalies leading to authenticated identification of different strains of *S. carpocapsae*, *S. feltiae*, *H. bacteriophora*, *H. marelatus*. However, the hybridization tests should be performed very carefully, because recently there is a report of hermaphroditism in one steinernematid species. The application of biochemical and molecular approaches has revolutionized the EPN systematics. The RFLPs and base sequence of ITS region of rDNA, including the 28S rDNA, multiple alignments with the closely related species and bootstrap analysis are being applied extensively in species descriptions and for knowing their phylogenetic relationships. But the taxonomic level at which different degrees of divergence in DNA sequence operate, is not yet fully determined, and hence is the limitation in sole dependence on this approach.

Keeping in view the advantages and disadvantages of each approach, an integrated approach combining the morphological data together with DNA analysis and interbreeding tests is the best approach for EPN biosystematics and constructing their phylogenies and its application will have a far reaching impact on all round development of research on these nematodes for exploiting their biocontrol potential in integrated pest management. Simultaneously, there is also an urgent need to have repositories of live cultures of authentically identified EPN species and their strains.



Molecular tools for characterization, diagnosis and management of major virus and virus-like diseases of citrus

D. K. Ghosh, Senior Scientist (Virology), National Research Centre for Citrus(ICAR), Nagpur– 440010. **E-Mail:** ghoshdk@hotmail.com

Diseases caused by virus and virus-like pathogens remain to be one of the most important threats to commercial and sustainable citrus industry at global level. The economic importance of these pathogens derives largely from their ability to cause systemic diseases and to persist in the vegetative parts of the plant for as long as these remain alive. Hence losses are not confined to the season in which infection occurs, but continue as long as the infected plants are in culture. Many of these diseases are universally distributed while others are new diseases and confined only to a region or country. In India about sixteen such pathogens are reported to infect citrus plant among which citrus tristeza virus (CTV), citrus ringspot virus, citrus yellow mosaic virus, citrus exocortis viroid and greening bacterium are of major concern. Nagpur mandarin (*Citrus reticulata*), acid lime (*Citrus aurantifolia*) and mosambi (*Citrus sinensis*) are three important commercial crop in India and are infected by these pathogens resulting into gradual decline of citrus orchards. These virus and virus-like pathogens, in field condition is transmitted either by insect vectors or mainly by infected budwoods. Rapid diagnosis of these pathogens in plant samples is the need of the hour. Conventional biodiagnosis procedure has its own limitation. Protein based diagnosis using pathogen specific polyclonal and monoclonal antibodies and nucleic acid based diagnosis by PCR/RT-PCR techniques are more reliable, rapid and less costly. Today a multitude of PCR based techniques viz. PCR, RT-PCR, IC-PCR, multiplex PCR etc have standardized and are being used routinely for detection of these pathogens in citrus plant samples either as single or as mixed infection. Similarly molecular diagnostics based on sequence divergence between recognized taxa is now well established as a generic approach in Plant Pathology. Genomes of viruses infecting citrus have been cloned, sequenced and their phylogenetic relationships is established. Developed countries have successfully implemented citrus budwood certification program to provide planting material free from major graft transmissible pathogens. By using the standardized biological, serological and molecular techniques similarly citrus bud wood certification program has been implemented at NRCC, Nagpur to provide quality, virus free citrus plants to the citrus growers. Similarly by adopting shoot tip grafting (STG) technique virus and virus-like pathogens have been eliminated from infected plants to develop pathogen free foundation block.



Diagnosis of plant pathogens- Novel approaches

P. K. Chakrabarty, Principal Scientist, Central Institute for Cotton Research (ICAR), Post Bag 2, Shankarnagar P. O., Nagpur – 440 010.
E-Mail: pranjibc@hotmail.com

The first and the foremost important step in management of a plant disease is to correctly identify the organisms that cause it. Rapid identification of the causal pathogen allows for the appropriate control measures to be applied, prevent development of epidemic and is needed to implement quarantine regulations. Pathogen or disease diagnosis is therefore fundamental to all aspects of Plant Pathology. Fastidious microorganisms, which do not grow on artificial media, are very difficult to identify and detect by conventional methods. Again, the conventional methods of diagnosis are not always conclusive. Advances in biotechnology have resulted in intensified efforts to develop novel methods for detection and identification of plant pathogens in recent years. The greatest efforts have been on the development of diagnostics based on serological and nucleic acid technologies.

Immunodiagnostic assay makes use of several ways for detecting antigen-antibody reaction. The process involves conjugating antibody to an enzyme that can be used to generate a colour change when specific substrate is added. The most commonly used technique that uses antibodies is called ELISA (enzyme-linked immunosorbent assay). ELISA is usually performed in a microtitre plate where the degree of colour change usually measured in a computer controlled plate reader, can be used to determine the amount of pathogen present.

Direct Tissue Blotting assay uses specific antibody as a detection tool. The infected plant parts or tissues are crushed on the surface of nitrocellulose or other suitable membranes and assayed for the presence of antigen by allowing it to react with antibodies by the protocol followed for western detection. These simple antibody based assays makes the detection and quantification of target pathogens relatively easier.

Nucleic acid based methods using probes and/or PCR have increasingly been used in recent years to develop diagnostic assays for plant pathogens. These methods, particularly those based on PCR are precise, rapid and sensitive. Nucleic acid based assays mostly detect the pathogens by detecting their DNA or RNA. Probes are single stranded fragments of nucleic acid molecules labeled with reporter molecule such as radioactive isotopes, enzymes or fluorescent dyes. They bind to complementary DNA or RNA sequences of disease-causing pathogen, which in turn can be detected depending on the type of reporter molecule used to label the probes. Nucleic acid (DNA/RNA) extracted from the infected plants can be directly applied to nylon membranes (dot blot) or can be transferred from gels (Southern blot) and detected. Hybridization will occur when like complementary sequences are present.

PCR has great potential in increasing sensitivity of various assays that use nucleic acid probes and is obviously the most important technique used for diagnosis and detection of pathogens. Here, organisms need not be cultured prior to their detection. The technique possesses extreme sensitivity with theoretical potential to detect a single target molecule in a complex mixture and is rapid and versatile.

Variety of targets can be exploited for designing diagnostic primers. These include ribosomal RNA genes and the ITS sequences, repetitive elements, IS elements, plasmid DNA and pathogenicity genes. Not all diagnostics are developed by targeting known genes. An alternative approach involves screening random regions of DNA to search for one, which is specific for the target organism. The most common strategy is the randomly amplified polymorphic DNA (RAPD) PCR to identify differences between the organisms. RAPD finger printing uses PCR and a set of short, random sequence oligonucleotides primers that produce characteristic profiles of amplified products for each organism. Many different primers are tested until a band is found that is exclusively present in the organism of interest. Potential diagnostic bands are then sequenced and used to design specific SCAR (sequence characterised amplified region) primers. Using DNA based and serological methods we have developed diagnostic tools for detection of several economically important pathogens of cotton and other plants. The results will be presented.



Taxonomy of foliicolus Fungi: Classical Vs molecular

Sanjay K. Singh, Mycology and Plant pathology Group, Agharkar Research Institute, GG Agarkar Road, Pune 411 004.
E-Mail: singhsksingh@rediffmail.com.

Fungi are an essential component of the terrestrial ecosystem. The foliicolous (leaf inhabiting) fungi contribute significantly in causing various plant diseases. Many new diseases are being identified every year and new pathogens are recorded. Plant pathogens may also introduce new genetic diversity or mating types, which could be as devastating as the introduction of a new pathogen. In foliicolous fungi, Hyphomycetes predominate and their correct identity becomes crucial for undertaking various studies relevant to agro-biology and to work out the strategies for its management. The role of taxonomists in this regard is indispensable for generating the necessary data in order to identify correctly the organisms/pathogen involved. The taxonomy of fungi in general has undergone a tremendous change because of the fact that the classical morpho-based taxonomy at certain points lead to confusion and eventually proves to be misleading. Similarly, lack of proper interpretation of DNA data creates confusion. The integration of new technologies, for example electron microscopy and analyzing of DNA sequences can provide more logical solution. These issues shall be discussed in detail in present communication with special reference to foliicolous cercosporoid fungi. Many of the genera and species of this group of fungi are known to cause significant losses to the various horticultural, medicinal and other crops.

Immunological diagnosis of pathogenic fungi of tea

B.N. Chakraborty, Immuno-Phytopathology Laboratory, Department of Botany University of North Bengal, Siliguri-734 013.

E-Mail: bncnbu@gmail.com

Immunoassays are being used routinely for the detection of plant pathogens in vegetatively propagated material and seeds in conjunction with quarantine seed-testing, seed-certification, and pathogen-indexing programmes. While the majority of these programmes are directed toward the detection of viruses and bacteria, immunoassays have also been developed that detect fungi in seed and vegetative tissue. Tests such as ELISA and IFA have demonstrated the sensitivity and specificity required to replace such time-consuming and expensive bioassays as indicator-plant inoculation, growing on tests, and dilution plating.

Tea is one of the most important cultivated crops in India and is perhaps one of the most important foreign exchange earners for the country. Being a perennial, the tea plant possibly interacts with, and samples more environmental problems than do most other plants. Polyclonal antibodies were raised against antigens of six each of tea root pathogens viz. *Ustilina zonata*, *Fomes lamaoensis*, *Spharostilbe repens*, *Rosellinia arcuata*, *Poria hypobumea* and *Armillaria mellea* and leaf pathogens viz. *Exobasidium vexans*, *Glomerella cingulata*, *Pestalotiopsis theae*, *Alternaria alternata*, *Corticium invisum* and *Curvularia pallescens*. IgG were purified following ammonium sulphate fractionation and chromatography on DEAE cellulose. These purified IgG were further packaged into PTA-ELISA formats for quick and accurate detection of root and foliar pathogens. Indirect staining of mycelia of the pathogens with their PABs and labeling with goat antirabbit IgG conjugated with FITC developed strong fluorescence in young hyphal tips of tea root and leaf pathogens, conidia of *S.repens*, *G.cingulata*, *P.theae*, basidiospores of *E.vexans*, microsclerotia of *F.lamaoensis* and sclerotia of *C.invisum*. Early detection of pathogens in soil as well as in tea root and leaf tissues were standardized using dot immunobinding assays and western blot analyses. Besides, direct detection of *E.vexans*, and *A.alternata* in leaf tissues whereas detection of *S.repens* and *F.lamaoensis* in root tissues using non-fluorescent stain (Fast blue BB salt) were also standardized. Cross reactivity among tea root and leaf pathogens were also tested using PTA-ELISA, indirect immunofluorescence, dot blot and western blot analyses for development of immunodiagnostic kits for specific detection of individual fungal pathogens of tea causing various root rot and leaf blight diseases. In addition, an intense immunogold labelling of *E.vexans* in blister blight infected tea leaf tissues has been explored. Ultrastructural observations on penetration, colonization and cytological modifications in blister blight infected tea leaf tissues were made. Biochemical and immunological characterization of pathogen induced (PI) protein in tea leaf tissues triggered by *E.vexans* has been achieved using PAB of the pathogen following western blot analysis. Immunodiagnostic kits developed for fungal pathogens of tea root and leaf diseases are being used for early detection of pathogens in soil during planting of tea cuttings in the field as well as refilling of cuttings in the tea gardens.



Decades of researches in biochemical and molecular nematology at IARI

A. K. Ganguly, and Umarao, Division of Nematology, IARI, New Delhi -110012, **E-Mail** : akganguly@iari.res.in

Like any other branch of Agricultural Sciences, the Division of Nematology at IARI, initiated researches in the exciting field of biochemistry and molecular biology of plant parasitic nematodes during the early seventies of last century. The main research areas were biochemical mechanism of resistance against phytonematodes and diagnostics of economically important plant parasitic nematodes. Specific isozymes have been identified for differentiating the important root knot nematodes species of India belonging to the genus *Meloidogyne*. Further molecular markers like RAPDs, AFLP, SSRs and PCR – RFLP of rDNA have been employed to study the molecular genetic diversity in major root knot and cyst nematode species of India to assist the breeding program for developing resistant varieties and other purposes like regulatory and nematode diagnostics. Attempts have also been made to understand the molecular signaling events during compatible plant nematode interactions by identifying the genes during the transition from preparasitic to parasitic stage in ear cockle nematode and molya disease of wheat. Currently attempts are being made to utilize RNAi technology to identify the genes targets for the management of root knot and cyst nematodes. In this paper some of the success stories of the technology developed by the scientists at IARI are being discussed.

Detection of a 16SrVI Group phytoplasma (clover proliferation) associated with little leaf disease of *Portulaca grandiflora* in India

A. Samad, P.V. Ajayakumar, A. K. Shasany, M.K. Gupta, M. Alam and S.P.S. Khanuja, Microbiology and Plant Pathology Division, Central Institute of Medicinal and Aromatic Plants (CIMAP), P.O. CIMAP, Lucknow-226015, India,
E-mail: samad_cimap@yahoo.co.in

Portulaca grandiflora (Portulacaceae), known as moss-rose purslane, is widely grown in temperate climates and is popular as an ornamental as it blooms all summer long. *Portulaca* is also used for medicinal purposes, very rich in vitamins A, B1 and C and has antimicrobial and cytotoxic activity. Since March 2005, 30–50% of *P. grandiflora* plants in the ornamental gardens as well as in pots at CIMAP, Lucknow, have displayed symptoms resembling phytoplasma infection. The disease symptoms start as a typical bud proliferation, downward curling and diminishing size of leaves, followed by overall stunted growth and yellowing of the whole plant during the months of April-June. Some plants also formed rosettes and had a typical proliferation of axillary shoots resulting in a witches' broom appearance. Typical pleomorphic bodies, mostly spherical to oval, of sizes ranging from 340–1100 nm were observed only in the sieve elements of infected samples under TEM. These appeared to be



Recent advances in crop protection technologies

S. Kumarasamy, Chairman, Agrochemicals Policy Group,
E-mail: kumars@apgindia.com

With the advancement in the fields of chemistry, biotechnology and crop production, the science of Crop Protection is also seeing enormous changes. This is also necessitated by the realization that whatever is done to protect the crops, it should not have any adverse impact on human health, flora & fauna and environment. The tougher regulatory requirements have also added to the impetus of discovering newer crop protection technologies.

As the focus is slowly shifting away from chemistry, the scientific community is looking at other possibilities. Lately, "Seed" has received a lot of attention, as a vehicle, delivering crop protection solution. Screening, selecting and evolving pest resistant crop varieties, combining with high yield capabilities continue to engage the attention of plant breeders, as in the case of hybrid rice.

To hasten up the process of bringing out pest resistant crop varieties, genetic engineering (gene modification) is being deployed in a big way. The origin of BT cotton is a case in point. BT cotton, with strong insecticidal capabilities against the dreaded American bollworm (*Helicoverpa*) has helped achieve significant break through in yields all over the cotton growing world. India has emerged as the second largest cotton producer in the world, thanks to the spread of BT cotton. The use of insecticides in cotton has come down steeply and the cotton growers have realized far higher economic returns. Similarly, genetically modified soybeans has been conferred with resistance against glyphosate herbicide.

"Seed Treatment" for prolonged protection from fungus and insect pests is getting a lot more emphasis, as newer seed treatment chemicals and seed coating technologies are spreading fast amongst the farming community.

Newer plant Protection chemistry

Even while looking for new pesticide molecules, greater emphasis is being given to products which are friendly to the user, consumer and to the environment. Some of the new products have been developed, simulating nature. For instance, the strobilurin group of fungicides have been developed from the wood decaying mushroom, such as *Strobilurus tenacellus*.

Spinosad and Abamectin are examples of microbial insecticides, being the fermentation products, derived from certain soil bacteria. These products have superior bioefficacy and better safety profile. They are required in much smaller dosages and at longer intervals. They are replacing conventional organochlorine and organophosphorus insecticides and help reduce the insecticidal load in the environment.

Chitin inhibitors like Novaluron and Buprofezin act on insects of different order by inhibiting chitin formation. They are particularly good against Lepidopteran larvae. Thus, chemosterilants are used to manage the population dynamics of the target pests so that their damaging effects on the crop are well below the economic threshold levels.

Integrated pest management is getting greater focus and its widespread adoption in the field is constrained by poor extension methodologies and lack of reliable, quality inputs.

Newer formulations are developed with a clear goal of reducing wastage of active ingredient and preventing drift on soil & water and better safety to the applicator. Electrostatic spraying and micro-emulsions are some of the new technologies in the area of formulation & application.

GAP (Good Agricultural Practice) is a standardized farming procedure, with greater emphasis on documentation, approved by accredited certification agencies. Strict compliance with label directions, spray intervals, pre harvest waiting period and tracking capabilities, in case of customer complaints are the salient features. It is being widely adopted by the grape growers of Maharashtra.

Product stewardship, Resistance Management and farmers education on the right use ensure enhancing the life of existing products.

Successful technology is one which is adopted by a large number of people, under different & difficult use conditions. It has to be robust, reliable, cost-effective & safe. That is why synthetic pesticides continue to be the most widely used crop protection technology, in spite of negative publicity by certain vested interests and NGOs.

Integrated pest management strategies : modern agri-horticultural production systems

P.K. Guha, Senior Manager, Registrations and Field Development, Isagro (Asia) Agrochemicals Pvt. Ltd., Mumbai. Member, Core Group-Registration & Regulatory Affairs, Crop life India.

E-mail: pkguha@isagroasia.com

Population development is related to less land per person for food and fiber production. The IPM program emphasizes on the healthy crop development with minimal possible disruption to the agro-ecosystem.

Integrated Pest Management is careful consideration of available pest management techniques and subsequent integration of appropriate measures that restricts the pest development. This includes pesticides and other interventions to levels that are economically justified and reduce risks to human health and the environment. IPM keeps the basis on the aim to increase quality, yields and sustainability in Agri-horticultural sectors.

Plant Science Industries provide customers with safe and effective technologies to protect against adverse effects caused by weeds, diseases and insect-pests.

The aim is sustainable agriculture to produce sufficient affordable food and fiber production economically, environmentally and socially sensitive manner, maintaining the natural resource base for future generations. The Stewardship program of these Industries helps the farming community to understand the safe and judicious use of pesticides and pest control methods.



Acceleration of transfer of technology through public-private partnership- a case of Hoshangabad district, Madhya Pradesh, India

O.P.Singh, President, M/S Dhanuka Agritech Limited, Dhanuka House, 861-862, Joshi Road, Karol Bagh, New Delhi-110005, India,
E-mail: opsingh@dhanuka.com

In order to meet the food requirements of burgeoning population, a wide untapped reservoir for enhancing crop productivity by minimizing the yield gaps through intensive transfer of technology programmes along with creating appropriate infrastructure net works, and providing necessary market intelligence is urgently called for. Though the Public extension system at the State levels is expected to undertake transfer of agriculture technology, yet over the years, these have largely become non-performers. There is thus a great challenge for public-private partnership (PPPs) and developing growth oriented environment that will benefit all the stakeholders and lead to agricultural sector-led development and growth.

Based on the recommendations of a Workshop to work out modalities of Public-Private Partnership (PPS) in Agricultural Extension on 24 August 2001 at Bhopal (Madhya Pradesh) organized by MANAGE, Hyderabad, M/s Dhanuka Agritech Limited was the first to join hands with the Government of Madhya Pradesh for undertaking agriculture transfer of technology programmes in Hoshangabad District. The focus is on transfer of recent technical know-how jointly by the State Government and Industry so as to reduce cost and increase efficiency of extension system. The partnership also encourages formulation and implementation of Private Agricultural Extension Policy. Thus an innovative PPPs programme was formally launched on 5 November 2001 aiming at disseminating modern technologies to farming community for increasing their crop production and productivity, thus improving their standard of living.

The Department of Agriculture transferred the functioning and maintenance of the existing Soil Testing Laboratory, Powerkheda to M/s Dhanuka Agritech Limited. In order to advise the farmers for balanced use of fertilizers for optimum utilization of resources and to maintain soil health, farmers' training, demonstrations, farmers' meetings, advisory services, the Company appointed 14 staff members , including 7 Agricultural Extension Officers (AEO) and 8 new soil sample Collection Centers and provision for easy advisory services..

As a result, 63182 soil samples analyzed and advisory services provided. Over 150 field demonstrations, mass awareness through group meetings, and field visits were carried out, and over 89,000 farmers trained and 60,000 brochures on improved agriculture technology made available to the stakeholders. Besides, sixty-six trainings were exclusively organized for AEOs, Agriculture fortnights were organized jointly with the Department of Agriculture.

In recognition of excellent outcome of this PPP in Agricultural Extension, a National Productivity Council Award was also conferred. The independent evaluation by MANAGE reported a very good impact of this partnership in enhancing crop productivity and thereby enhanced income. Accordingly, this PPP has been further

renewed in July 2006.

This PPS has demonstrated how the existing untapped potential can be tapped for achieving sustainable crop productivity in the long-run. It is planned to have a paradigm shift from present Production-led Extension to Market-led Extension. It is suggested that the Government may provide for 150% tax rebate on expenses incurred by a Private partner on Agricultural Extension, and also exemption in Fringe Benefit Tax. M



Use of pesticides and agriculture food security and environmental safety

N.S. Butter and A.K. Dhawan, Department of Entomology, Punjab Agricultural University, Ludhiana. **E-mail:** nsbutter@rediffmail.com

Pesticides are bound to stay in agriculture as one of the components of integrated pest management (IPM). By the year 2050, the population of the world would cross 10 billion mark, which would necessitate the need to triple food production. The options are either to increase the area under cultivation by three times or enhance the production potential. But both seem improbable with the pressure on land due to modernization.

Pests are known to consume more than one-third of the global food production. The monetary loss to the tune of Rs. 90000 crores (20 percent) has been estimated in India. A substantial quantity of food can be made available for human consumption in case the losses are reduced to 50 percent. The environment consciousness and the adoption of IPM drastically reduced the pesticide consumption to 43,584 metric tonnes during 2000-01. Simultaneously the use of botanicals and biopesticides has also increased. The pesticide use has come down from 570 to just 220 g/ha and the reduction was mainly attributed to the use of insecticides. The increase in pest damage, productivity and insecticides use showed upward trend during green revolution. The ill effects of pesticides use have necessitated a relook and a critical appraisal of the utility and prospects of pesticide in Indian agriculture vis-a-vis food security and safety to environment.

The pesticide poisoning of human being is a major public health concern. According to one estimate about 750000 cases of pesticide and roughly 13800 deaths have been reported annually in the world due to indiscriminate use of pesticides. Apart from being occupationally hazardous in developing world, it is today posing a serious threat to human health. Nearly 80 percent of world pesticide production is consumed in developed and industrialized countries, but the pesticide poisoning cases are 13 times higher in the developing world. Despite the restrictions and regulations on pesticides use, India experiences nearly 1/3 of pesticide poisoning cases in the world. Several instances of blindness, cancer, liver problem and nervous system disorder due to pesticide poisoning have been identified in India.

The large scale use of pesticides to control pests has resulted in the development of resistance. Today the number of resistant pest has risen to above 500. In India, 14 insect pest of public health and household importance, 7 of agriculture crop and 6 of stored commodities have developed resistance to insecticides. Among these,

brown plant hopper, *Nilaparvata lugens* (Stal), Green leaf hopper, *Nephoie virescena* (distant), American bollworm *Fielicoverpa annixera*, diamond back moth *Plutella xylostella* have developed high degree of resistance to organophosphates, carbamates and pyrethroids.

The problem of resurgence is also assuming serious proportion in vegetable, rice and cotton crops involving use of organophosphates, carbamates and pyrethroids. The insect pests known to resurge include brown plant hopper, *N. lugens*, Green leaf hopper, *N. virescena*, whitebacked plant hopper, *Sogatella furcifera* (Horvath); whitefly, *Bemisia tabaci* (Gennadius) and aphid, *Aphis gossypii*. The repeated use of pesticides on cotton fruits tobacco and other crops has destructive effects on insect pollinators, biocontrol agents in soil, wild aquatic life. Soil microorganisms responsible for breakdown of cellulose, nitrification, turn over of organic matter and other biological material may be adversely influenced by pesticides.

The occurrence of pesticide residues in food is viewed with great concern. The available data showed that 60 percent of food commodities are contaminated with pesticides residues in India, out of which 14 percent contains residues above the maximum residues limit (MRL). In addition, pesticide residues in agricultural commodities have a significant influence in international trade.

The long term strategy is to evolve resistant/tolerant varieties, exploit the use of botanical and natural enemies' complex to reduce the use of toxic chemicals. The farmers should be educated through live demonstrations about the risks of resurgence with use of insecticides. The need of farmers' field schools to educate the farmer is suggested as a vital tool to check the misuse of insecticides. The policy planners while recommending or allowing the sale of insecticides must take in to the resurgence risk involved with the use of these molecules. The emphasis should be on effective forecasting for awareness system for pest and disease outbreak, surveillance system to monitor resistance, development of effective and sound IPM or IRM modules, improvement in pesticide application techniques and to identify new and safe pesticides crop cultivars, effective utilization of natural enemies alone or in combination with pesticides, regulation of pesticides, utilization of biotechnology tools and imparting training and education in the pesticides by stakeholders.

**New pesticide molecules, formulation technology
and uses: present status and future challenges**

**Anjan Bhattacharyya, Suhrid Ranjan Barik & Pritam
Ganguly**, Department of Agricultural Chemicals, Bidhan Chandra Krishi
Viswavidyalaya, Mohanpur, West Bengal. PIN 741252.

E-Mail: anjan_84@rediffmail.com

Since the dawn of time mankind has had two primary goals - obtaining enough food to survive and improving the quality of life. The single most important task facing a society is the production of food to feed its population. A country or society has to feed its people before it can devote resources to education, arts, technology or recreation. In some areas of the world this remains the primary focus of the entire population, producing or accessing food to feed its people. In these countries food can account for over 60% of annual income needs. Other societies, like ours, are more fortunate as we have made tremendous strides in the area of food production - to the point where a healthy diet only requires an average 11% of our annual incomes. Today, more than 60% of our population is involved in agriculture, producing enough food for not only our population, but for others around the world. A basic reason for our ability to increase our productivity is our ability to control pests - weeds, insects, and diseases using crop protection products. Many in our society feel we have only been using pesticides over the last few decades. In fact, mankind has a history of using crop protection products in the production of our food supply and protection of our environment.

The modern era of synthetic pesticides began in 1930. The research behind the medical and military uses funded research that led to the discovery of many pesticide families that are still in use today. After the prolonged use as well as the publication of famous book '*Silent Spring*' by Rachel Carson, the scientists became interested to undertake studies on the fate and behavior of pesticide molecules in different eco-systems. This resulted in huge databank not only with the crop but with non-crop situations including our water bodies also. The entire scientific community vis- a - vis the giant corporates of developed countries like USA and Europe have taken the responsibility of discovering new molecules with new chemistry, new biology including toxicology etc. The major impetus on this area was started at the beginning of 90's to counter the threat it posed to mankind for hazardous toxic pesticides and their metabolites distributed in different components of our environment. In recent past thousands of molecules are available globally for plant protection purposes. Significantly, India has also registered a good number of molecules as crop protecting chemicals. In last ten years, three different chemistry evolved namely neo-nicotinoid chemistry, macro-molecular chemistry, sulfoxamide-pyridine chemistry and more and more different chemistry are in the anvil. India has already received good molecules like Imidacloprid, Acetamiprid, Clothianidin, Abamectin, Emamectin, Milbemectin, Spinosad etc. Nowadays the major emphasis is given on the discovery of the molecules firstly within the framework of molecular weight range, water solubility, biodegradability, target specificity etc. Simultaneously, significant improvement has also been observed in formulation and application technology. The advent of all these faculties coupled with innovation of new crop protecting chemicals will definitely provide food security as well as environmental safety.

Recent advances in analytical methods of pesticides residue analysis in food and environmental samples

Kaushik Banerjee¹, Pandurang G Adsule, National Research Centre for Grapes, P.O. Manjri Farm, P.B. No. 3, Pune, Maharashtra-412 307, INDIA,
E-Mail: kbgrape@yahoo.com.

Monitoring of pesticide residues in agricultural commodities is a challenging task. At international level, the regulations regarding pesticide residues in food and environment are becoming more stringent in many countries and thus compliance to the MRL requirements has become a mandatory pre-requisite for ensuring food and environment safety for export. As the MRLs are approaching lower and lower levels, the associated uncertainty levels for residue estimations also increases. Thus, while attempting single or multiresidue analysis, it is important to achieve simultaneous quantification with confirmation.

Internationally, the application of hyphenated techniques like GC-MS and LC-MS for pesticide residue analysis is gaining utmost importance and for this reason, the sample preparation techniques have been simplified for rapid analysis. There is a need for rapid turn-around time so that a single chemist could process at least 25-30 samples over a day of 8 working hours. The analysis mostly involves extraction of 10-25 g representative samples with suitable solvent like ethyl acetate or acetonitrile, cleanup by dispersive solid phase extraction (DSPE) with primary secondary amine (PSA) or a mixture of PSA, C18 and graphitized carbon black (GCB) in different combinations as well as ratios and final estimation by gas chromatography – mass spectrometry (GC-MS) or liquid chromatography – mass spectrometry (LC-MS), whichever is applicable. In sample cleanup, DSPE improves the sample recovery significantly when compared to cartridge-based SPE cleanup. Mass spectrometric analysis is compulsory for trace level residue analysis at parts per million or billion (ppm or ppb) levels. Usually, for any sample, either GC-MS or LC-MS cannot assure the analysis of complete range of pesticides. GC-MS is applied for the analysis of non-polar and thermally stable compounds; whereas, the polar and thermally unstable compounds are usually analyzed by LC-MS. In GC-MS, the analysis is predominantly accomplished with electron impact ionization followed by estimation in full-scan or selected ion monitoring (SIM) or tandem mass spectrometry (MS/MS). In case of LC-MS, the analytes are ionized by atmospheric pressure ionization like electrospray (ESI) or atmospheric pressure chemical ionization (APCI) and MS/MS is the mostly applicable technique. Besides monitoring the presence of characteristic ions or MS/MS transitions, their ratios are used for confirmatory analysis. In full-scan analysis, there are possibilities of identifying unknown non-target compounds by comparing with the reference mass spectra of library like NIST. On the other hand, the SIM and MS/MS are target-oriented analysis, where the confirmation of identity is carried out by four-point system as per the AOAC guidelines, which means, four characteristic ions (m/z) monitored for the SIM and two mass transitions monitored for the MS/MS. In GC-MS, the comprehensive two-dimensional gas chromatography coupled with time-of-flight mass spectrometry (GCxGC-TOF) is a novel technique that offers unprecedented separation power in multiresidue analysis. Combination of a long non-polar with a short and polar capillary column connected in series through a

thermal modulator provides enormous peak capacity, which is utilized in separating mixture of large number of compounds in two orthogonal phases in single chromatographic run with full-scan library-searchable confirmation.

The modern technique of sample preparation for residue analysis is quite fast and has minimized the usage of extracting solvents and exposure of solvent vapour to the chemists. Thus, the concept is designated as quick, easy, cheap, efficient, rugged and safe.

In mass spectrometric analysis, the detections and confirmations are accomplished as per the guidelines of the AOAC international. Besides single laboratory validation, it is important to account for the uncertainty components to be estimated with regards to calibration, precision (man-to-man and day-to-day variations) and accuracy (man-to-man and day-to-day) so that subsequently, the global uncertainty could be estimated for each of the compounds at their limits of quantifications.

In India, complete mass spectrometry based residue analysis system has been implemented in export grape under the leadership of the National Research Centre for Grapes in collaboration with the APEDA, Ministry of Commerce, Government of India. A multi-residue monitoring system has been developed for simultaneous analysis of around 100 pesticides, where 80% compounds are analyzed on LC-MS/MS with chlorinated hydrocarbons and synthetic pyrethroids being analyzed by GC-MS.

Fate and behaviour of oryzalin – a herbicide in soybean under East-Indian climatic conditions

Aktar, Md. Wasim, Sudeb Mondal, M.Paramasivam and Anjan Bhattacharyya, Pesticide Residue Laboratory, Department of Agricultural Chemicals, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, Nadia, West Bengal, India. **E-Mail:** wasim04101981@yahoo.co.in

A two-season supervised field trial was conducted in/on soybean (*Glycine max*) to understand the nature of dissipation of Oryzalin (40% SC), a dinitroaniline herbicide in cropped soil and plant following its application @ 1500 g (T_1) and 3000 g a.i. ha⁻¹ (T_2) at early vegetative stage in between rows of the crop. Oryzalin residues were analyzed by HPLC using UV detector. The initial residues of oryzalin in soil were found in the range of 1.07 to 1.28 µg g⁻¹ and 1.65 to 1.87 µg g⁻¹ at recommended (T_1) and double the recommended (T_2) doses respectively. In soil, oryzalin residue dissipated more than 90% within 30 days after application for both of the doses and seasons. No residues were detected in cropped soil on and from 60 days after application irrespective of any dose and season. The dissipation followed first order reaction kinetics and the half-life values were found to be 5.74 – 6.76 days and 7.34-7.69 days in soil at recommended (T_1) and double the recommended (T_2) doses, respectively. No residues were detected in foliage part of the plant and harvested pods irrespective of any dose and season.

Bioefficacy evaluation of propaquizafop (Agil 10 EC) on monocot weed flora in black gram

Barui Kironmay, R. K. Ghosh, M. Roy, and A. Doloi, Department of Agronomy, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur - 741252, Nadia, West Bengal, **E-Mail:** kironmay_b@rediffmail.com

Black gram (*Vigna mungo* L.) occupies an average of 35 % area among the total pulse crop area in West Bengal. Being leguminous and short duration habit with higher quality protein it has the advantage of growing in all three seasons (summer, kharif and pre rabi) and thus enable to fit suitably in our different cropping sequences. An average of Rs. 7,000-10,000 net income could be achieved easily by following improved method of cultivation. One of the reasons for the lower yield of black gram in the Inceptisol is lack of proper weed management for which around 15-20 % yield losses were recorded. Keeping this in view a field experiment was conducted in Gangetic Inceptisol with pH of 6.8 and sandy loam in texture at the 'C' – Block Farm, Bidhan Chandra Krishi Viswavidyalaya, West Bengal during Pre-kharif 2006 with the objective of increasing production by managing weed flora using propaquizafop 10 EC (Agil 9 EC) a new herbicide molecule . The experiment was laid out in a Randomised Block Design having eight treatments and replicated thrice. The variety of the Black gram was Sarada (WBBU-108).The herbicide propaquizafop was applied with four different doses (25, 50, 75 and 100 g a.i. ha⁻¹) at 15 days after sowing (DAS) along

with two standard herbicide quizalofop 5 EC (Targa Super 9 EC) @ 50 and fenoxaprop-p-ethyl (Whip Super 9 EC) @ 100 g a.i. ha⁻¹. The other two treatments were hand weeding at 20 DAS and weedy check. Spraying was done with knapsack sprayer with floodjet deflector WFN 040 nozzle using spray volume @ 500 litre ha⁻¹.

The dominating weed flora of the experimental field were *Echinochloa colona*, *Eleusine indica*, *Dactyloctenium aegyptium*, *Digitaria sanguinalis*, *Cyperus rotundus* among sedges and among the broadleaves *Digera arvensis*, *Physalis minima*, *Amaranthus viridis*, *Phyllanthus niruri*, *Scoparia dulcis*, *Euphorbia hirta* and *Alternanthera sesilis*. The results revealed that all tested molecules were effective against monocot weeds only and propaquizafop @ 75 and 100 g a.i. ha⁻¹ were most effective among the chemicals. Weed control efficiency of more than 85% - 88% was recorded with these two treatments. Maximum grain yield (12.55 t ha⁻¹) was observed in hand weeded plots followed by Propaquizafop @ 100 g a.i ha⁻¹. Among the standard quizalofop @ 50 g a. i ha⁻¹ gave 10.48 t ha⁻¹.

The results of this experiment revealed that test herbicide propaquizafop @ 75 – 100 g a.i. ha⁻¹ was more effective than quizalofop 5 EC (Targa Super 10 EC) or fenoxaprop-p-ethyl and could be recommended for replacing the traditional cost effective hand weeding.

Effects on symptomatological development in rapeseed-mustard due to *Alternaria* blight disease in relation to different new fungicides

Bhunja, C. K. and A. Biswas, Pulses and Oilseeds Research Station, Berhampore – 742101, West Bengal. **E-Mail:** biswas.arunava@rediffmail.com

Alternaria blight caused by *Alternaria brassicae*. is the most destructive and widespread disease of rapeseed-mustard in India. It affects the leaves, stems and siliqua (pods) causing serious yield loss of 47% in Indian mustard (*Brassicajuncea*). When too many spots are formed on the leaves, the latter die prematurely thus affecting the yield. Pods also develop spots and infection of seed results in loss of seed yield and germinability. Most of the present day cultivated varieties are susceptible though there may be variations in the degree of their susceptibility. Therefore, the use of fungicides appears to be the only practical method of its control at the present moment and thereby to realize the full yield potential of the crop variety. A study on symptom development in host due to *Alternaria brassicae* infection was done by recording the number of spots (indicating primary infection) and the diameter of the spots on the leaves (indicating secondary spread) sprayed with six different fungicides. The observations were recorded separately for the spots with and without yellow halo. Study reveals that the average number of spots with yellow halo per leaf is always greater than the number of spots without yellow halo. Fungicides had visible effects on the number and diameter of spots compared to the control. The order of decreasing efficacy being exhibited by Score, Nativo, Amistar, Topas, Dithane M-45 and Neemarin, respectively. Application of Score has resulted in the least number of spots per leaf with the lowest average diameter of spot compared to other treatments. Nativo has resulted in the lowest

average diameter for both types of spots. But the effectiveness of the treatments is different for the two types of spots. Hence, it may be said that first spraying of Score (0.1 %) followed by a second spray with Nativo (0.1 %) are very effective for management of Alternaria blight disease of rapeseed-mustard.

Integrated management of *Meloidogyne graminciola* in rice in organic farming system

Bora, B. C. and B.N. Choudhury, Department of Nematology, Assam Agricultural University, Jorhat, Assam, **E-Mail:** bcbora05@yahoo.co.in

Field experiments were conducted during summer in 2003-2005 in direct seeded rice to study the efficacy of organic amendments viz. neem seed kernel powder @10% w/w as seed treatment, castor cake, neemcake and FYM @100g/m² as presowing treatment. In another treatment, *Trichoderma viride* @20g/m² was also used. Carbofuran 3G @ 0.3g ai/m² was used to compare the other treatments. In all the years *T. viride* @20 g/m² was found to be best in reducing *M. graminciola* population where 28.2-38.6% nematode population declined. In this treatment, the yield of rice was also highest (52.5q/ha). Among the organic amendments, neemcake @100g/ m² was found to be better where up to 20.4% nematode population declined and yield was increased by 25.5% (50.75q/ha in 2003). But the Carbofuran 3 G @ 0.3 g a.i./m² was found to be always best in all the years where nematode population was declined by 41.9% and yield was increased by 41.1% (57.5q/ha).

Evaluation of some eco-benign microbes for management of *Spilosoma obliqua* Walker (Arctiidae; Lepidoptera)

Chatterjee¹, Hirak and S. K. Senapati^{2, 1} Department of Plant Protection, Palli Siksha Bhavana, Visva-Bharati, Sriniketan-731236. ² Department of Agril Entomology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar -736165, **E-Mail:** hirakchatterjee65@yahoo.co.in

In view of the changing agrarian scenario coupled with new connotations of farming system and hazardous nature of the chemicals, use of eco-friendly microbes are being felt more and more. Such an endeavour was taken to evaluate the potentiality of naturally occurring bacterial isolates viz; *Bacillus thuringiensis* var *thuringiensis*, *Serratia marcescens* and the fungal isolates viz; *Fusarium semitectum*, *Paecilomyces lilacinus* as compare to commercial biopesticides like *Bacillus thuringiensis* var. *Kurstaki* (Btk-55000 SU /mg), Avermectin-1.8% w/v, *Beauveria bassiana*-1x10⁷ spore /ml and azadirachtin-1500 ppm against 3rd instar larvae of *Spilosoma obliqua* Walk feeding on jute leaves. Except *Fusarium semitectum* all other natural entomopathogens were significantly superior to that of control, azadirachtin and *Beauveria bassiana* but less effective than avermectin and Btk. The percent larval mortality (after 120 h of treatment) effected by these isolates were recorded in the parenthesis as *Serratia marcescens* @ (5.72 ± 1.99) x 10⁸ CFU/ml (35.34%) > *Paecilomyces lilacinus* @ ((8.33 ± 1.41) x 10⁶ spore/ml)(32.10%) > *Bacillus thuringiensis* var *thuringiensis*

@ $((7.03 \pm 2.05) \times 10^9$ CFU/ml)(25.52%) > *Fusarium semitectum* @ $((5.11 \pm 2.1) \times 10^7$ spore /ml)(18.42%) Whereas toxicity of the biocide, avermectin (1.8% w/v) @ 1000 ppm was found highest against *S. obliqua* affecting 91.66% mortality after 72 hr of treatment followed by B.t.k. - 55000 S.U. /mg @ 1000 ppm causing 89.44% and azadirachtin @ 3000 ppm provided 21.33% mortality. The efficacy of *Beauveria bassiana*-1 $\times 10^7$ spore/ml against this pest was not satisfactory due to lack of proper incubation which gave only 24.67 % mortality. Therefore successful manoeuvring of these natural and commercial entomopathogens could provide good protection against *Spilosoma obliqua* and at the same time reduce pesticidal load in the environment.

Integration of pesticidal seed treatment with deep ploughing in kharif mung for the management of *Meloidogyne incognita*

Choudhury, B.N. and Aparajita Borah, Department of Nematology, Assam Agricultural University, Jorhat, Assam, **E-Mail:** bchoudhury@aau.ac.in

Field experiments was conducted during Kharif 2001 -2005 to study the efficacy of integration of pesticidal seed treatment and deep ploughing in kharif mung against *Meloidogyne incognita*. Three ploughings at an interval of 15 days were applied before sowing of seeds. Carbosulfan 25 SD @ 3.0%w/w was used as seed dressing and Carbosulfan 25 EC @ 0.1 % was used as seed soaking. From the 5 years experiments, it was observed that 3 ploughings before sowing of seeds reduced the population of *M. incognita* and increased the yield by 6.0% to 13.2% over no-ploughing. In this main treatment, the yield was 7.68q/ha to 8.46q/ha. Seed dressing was found to be better than seed soaking in reducing nematode population and increasing yield, when seed soaking and seed dressing were combined with ploughing and no-ploughing. From the interaction studies, it was observed that the nematode population decreased upto 49.8% and yield was increased upto 56.0% over control. In this treatment, the yield of mung was recorded from 8.75q/ha to 9.8q/ha in different years of studies.

Population dynamics and chemical control of betel vine black fly (*Aleurocanthus rugosa* Singh)

Dahal, Dipen, P.S. Medda and Joydeb Ghosh, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar-736165.

Studies were conducted to investigate the population dynamics and efficacy of different insecticides against black fly (*Aleurocanthus rugosa* Singh) on betel vine (*Piper betle* L.). The black fly was found active throughout the year but the highest population of black fly (to the tune of 20 numbers per leaf) was observed in the 44th meteorological week (1st week of November). Among the ten (10) chemical and botanical insecticides tested, imidachlorpid (0.0023 %) was found to be effective in suppressing the population of black fly and produced 89.87 %, 73.43 % and 60.31 % mortality at 3 days, 8 days and 14 days after spraying.

Studies on white fly (*Dialeurodes pallida* Lamba) with reference to seasonal abundance, mechanism of relative preference and its management in betelvine (*Piper betle*)

Das, S. B., O.P. Veda and S. K. Sengupta *, Department of Entomology, College of Agriculture, J. N. Agricultural University, Jabalpur – 482 004 (M.P.), India, * Department of Horticulture, **E-Mail:** shoumitra@yahoo.com

Betelvine (*Piper betel* L.) is an important plantation cash crop of Madhya Pradesh grown in about 5000 ha in nearly 24 districts. Deshi Bangla, Bilehri, Cuttak and Kalkatia are the most commercial popular varieties grown throughout the state. The important limiting factor in profitable betelvine cultivation is the heavy losses caused to the crop due to several insect pests, out of which white fly, *Dialeurodes pallida* Lamba (Hemiptera: Aleyrodidae) is one of the major damaging pest of the crop. In view of the above, the present investigations were conducted in the Betelvine Garden, Department of Plant Pathology Experimental Field, College Of Agriculture, J. N. Agricultural University, Jabalpur (M.P.) during 2005-06.

The white fly was first noticed in the 33rd SW and reached its peak intensity during 39th SW. All the weather factors included in the study did not seem to influence the white fly population. However, multiple regression computed with certain weather factors was:

$$Y = 5211.3 - 16.8 x_1 + 1.7 x_2 + 154.9 x_3 - 1.1 x_4 - 5.7 x_5 + 1.7 x_6 - 293 x_7 \quad (R^2 = 0.99)$$

where x_1 = morning %RH, x_2 = rainfall, x_3 = morning vapour pressure mm, x_4 = evening vapour pressure mm, x_5 = rainy days, x_6 = maximum temperature °C and x_7 = minimum temperature °C respectively.

Out of 17 betelvine cultivars screened, no cultivar was found to be free from whitefly infestation. However, 9 cultivars *viz.* Kanker, Kallipati, Hirapan, Bilehri, SGM-1, Godi Bangla, Jabalpur Bangla and Bhaichaguri were least susceptible to white fly infestation. Upper leaves of the plant canopy were highly preferred by white fly, followed by middle and lower leaves, respectively. Studies on the mechanism of host plant susceptibility to white fly was carried out on certain bio-physical parameters of leaves and plants (*viz.* leaf length and width, petiole length, length of internode, stomatal number and size). These revealed that betelvine accessions, which had broader leaves with greater leaf area having less number of stomata, were highly preferred by white fly. Chemicals were found to be highly effective against white fly and also proved their superiority over botanicals and animal urine.

Studies on efficacy and standardization of dose of ready-mix a formulation A15397A-150ZC against pod borer complex infesting medium maturing pigeonpea and their impact on potent parasites

Das, S.B., O. P. Veda and N. D. Mazumder *, Department of Entomology, College of Agriculture, J. N. Agricultural University, Jabalpur – 482 004 (M.P.). * Indian Institute of Pulses Research, Kalyanpur, KANPUR – 208 024 (U. P.), India
E-Mail: shoumitra@yahoo.com

Efficacy of a readymix formulation of insecticide A15397A-150ZC *viz.* Chlorantraniliprole + λ -Cyhalothrin at four different doses along with a single dose of their individual counterparts and commonly recommended insecticides (as standard checks) *viz.* endosulphan 35EC and indoxacarb 14.5SC were evaluated against pigeonpea pod borer complex (pod fly and *Helicoverpa*) infesting medium maturing pigeonpea (*cv.* Asha) and their impact on potent parasites at J. N. Agriculture University, Breeder Seed Production Unit, Jabalpur (MP) during 2006-2007. Besides this, phytotoxic effects of the above insecticides on pigeonpea, if any, were also studied.

The results revealed that the readymix formulation of Chlorantraniliprole + λ -Cyhalothrin at 300 ml/ ha significantly reduced the pod borer complex infestation over their individual counterparts and standard checks and also registered higher grain yield. Further, they were found to be quite safe against *Carcelia* sp., a larval / pupal parasite of *Helicoverpa armigera*. All the different doses of insecticides included in the study did not exhibit any phytotoxic effect on the pigeonpea crop.

Studies further revealed that yield loss of 49.6 and 80.3 Kg / ha was obtained for every unit percent increase in pod and grain damage by *Helicoverpa armigera* respectively. Similarly, yield loss of 30.54 and 40.89 Kg / ha was obtained for every unit percent increase in pod and grain damage by *Melanagromyza obtuse*, respectively.

Evaluation of fungicides *in vitro* on *Botryodiplodia theobromae* causing black band of jute (*Corchorus* spp.)

De, Rajib Kumar and R.K. Mandal, Crop Protection Division, Central Research Institute for Jute and Allied Fibres, (Indian Council of Agricultural Research), Barrackpore, Kolkata 700 120, India, **E-mail:** rkde1@indiatimes.com

Jute (*Corchorus olitorius* L. and *C. capsularis* L.) is an important fibre crop of eastern India and is cultivated in around 8.5 lakh ha with average yield of 21.8 q/ha. Among the biotic stresses of jute crop, black band disease caused by *Botryodiplodia theobromae* is one of the important diseases responsible for lowering fibre yield and deterioration of quality. This was a minor disease earlier but now is gradually increasing. It attacks both the species of jute in all the jute growing areas but intensity is not very alarming till date. Often fibre and seed may not be obtained from infected plant. Stem may break at the point of infection and plants die. The symptom is often confused with stem rot because of similarity. But on rubbing with finger on the spots, profuse black sooty powdery mass of spores adhere to the fingers which is not found in case of stem rot. Crops raised from infected seeds show seedling blight symptoms.

B. theobromae is seed-borne as well as air borne and has a very wide host range. Three fungicides, namely, carbendazim, (Bavistin 50 WP, BASF India Limited, Mumbai), copper oxychloride (Blitox 50 WP, Rallis India Limited, Mumbai) and mancozeb (Indofil M 45, Indofil Chemicals Company, Mumbai) were tested on the growth of an isolate (from seed sample of variety JRO 524) of *B. theobromae in vitro* on potato dextrose agar media following standard poisoned food technique at 2-5000 µg/ml concentration. The radial growth of *B. theobromae* was measured after incubation at 28 ± 1 °C at 24 hr intervals and percent growth inhibition was calculated. Carbendazim completely inhibited the growth of *B. theobromae* at 2 – 5000 µg/ml levels. No inhibition of growth was observed up to 100 µg/ml of copper oxychloride and at 5000 µg/ml 68 % inhibition was recorded. With mancozeb only 2 % growth of *B. theobromae* was inhibited at 10 µg/ml, 47 % at 100 µg/ml and 100 % at 5000 µg/ml. It is concluded that, carbendazim, being more effective on *B. theobromae* at lower doses than mancozeb and copper oxychloride, may be further tested for their field efficacy for recommendation as presowing seed treatment of jute.

Relative toxicity and LC₅₀ values of some new insecticides against tobacco caterpillar, *Spodoptera litura*

Ghosh, Amalendu, Rajat Biswas, A. Samanta and M. L. Chatterjee,
Department of Agil. Entomology, F/Agriculture, BCKV, Mohanpur, Nadia,
West-Bengal, India, **E-mail:** amal_ento@rediffmail.com.

A trial was conducted under laboratory conditions to assess the relative efficacy of some new chemicals viz. emamectin benzoate, indoxacarb, flubendiamide, fipronil and methoxyfenozide against third instar *Spodoptera litura* larvae under laboratory conditions. Fresh castor leaves were fed to *Spodoptera litura* larvae. Among the different methods of bio-assay studies 'treated larvae–treated food' was chosen. Observations were recorded 24 and 48 hr after application of insecticide(s). The relative toxicity of insecticides was worked out by calculating the percentage of mortality of the test insects and then subjecting the data to probit analysis. It is evident from the results that the acute toxicity i.e. LC₅₀ values of flubendiamide was 4.75 ppm and was relatively more toxic to the 3rd instar larvae of *Spodoptera litura* than the other insecticides tested. On the basis of LC₅₀ values, the next best insecticides in order of descending effectiveness were emamectin benzoate (5.09 ppm), indoxacarb (7.86 ppm) and fipronil (136.48 ppm). Methoxyfenozide showed lowest acute toxic effect with highest LC₅₀ value (738.41 ppm). The order of relative toxicity of different insecticides after 24 hr of exposure to *Spodoptera litura* was found as follows: flubendiamide (155.35) > emamectin benzoate (144.93) > indoxacarb (93.93) > fipronil (5.41) > methoxyfenozide (1.00). With the increase of exposure time all the chemicals showed steady decrease in LC₅₀ values upto 48 hr. All the insecticides followed the same order of toxicity as 24 hr. Thus, in this experiment flubendiamide closely followed by emamectin benzoate showed the best efficacy in controlling the test insect in laboratory conditions.

Molecular detection of citrus tristeza virus during periods of optimal and non-optimal virus concentration and its application in implementation of citrus budwood certification programme

Ghosh, D. K. National Research Center for Citrus , Amravati Road , Nagpur-440
010 , India, **E-mail:** ghoshdk@hotmail.com

Citrus Tristeza Virus (CTV), an aphid transmitted clostero virus causes tristeza disease which is economically the most important disease of citrus worldwide. Virus particles are flexuous having a size of 2000x 11 nm. It has single – stranded RNA genome of about 20 kb that contains 12 open reading frames (ORFs) that potentially encode at least 19 proteins. The virus is genetically and biologically diverse and can cause stunting, slow decline, stem pitting or no symptoms depending on virus isolate, time of infection, rootstock, citrus cultivars and environmental conditions.

Conventional biodiagnosis procedure has its own limitations. Protein based diagnosis using pathogen specific polyclonal and monoclonal antibodies and nucleic acid based diagnosis by PCR/RT-PCR techniques are more reliable, rapid and less costly. In the present studies reverse transcription polymerase chain reaction (RT-PCR) technique was compared with enzyme-linked immunosorbent assay (ELISA) for detection of CTV in field grown Nagpur mandarin (*Citrus reticulata*), acid lime (*Citrus aurantifolia*) and mosambi (*Citrus sinensis*) plants throughout the year in Vidarbha region of Maharashtra. By ELISA technique, the virus could be detected satisfactorily only during periods of higher virus concentration (Oct - March) in field grown plants. However, through RT-PCR technique CTV could be detected both during periods of non optimal virus concentration (April–Sept.) as well as periods of optimal virus concentration inside plant. Thus, identification of time periods suitable for CTV detection by different simple, reliable techniques like ELISA and RT-PCR at different months will be applicable both for research and diagnostic needs. Developed countries have successfully implemented citrus budwood certification program to provide planting material free from major graft transmissible pathogens. Similarly, by using the standardized biological, serological and molecular techniques citrus bud wood certification program has been successfully implemented at our center to provide quality, virus free citrus plants to the citrus growers.

An investigation on the effect of anthracnose (*Colletotrichum indicum*) disease on cotton plant (*Gossypium hirsutum* L.) and its control measures

Ghosh, P. K. and A. Chatterjee, Centre Advanced Study in Cell and Chromosome Research, Department of Botany, University of Calcutta, 35 Ballygunge Circular Road, Calcutta-700019, India, CSB, CSR&TI, Berhampore-742101, West Bengal, India.

The object of the present investigation was to find the effect of anthracnose disease on cotton plant and how to control this disease for increased production of lint quantitatively and qualitatively.

An intensive investigation showed that anthracnose (*Colletotrichum indicum*) disease on cotton plant (*Gossypium* L.) affect the seedlings and all the parts of the adult plants. The lesions occurred on the cotyledons, leaves, stems and bolls. Small reddish to light coloured spots are found on the cotyledons, hypocotyls and young plants. Brown spot occur on the leaves and stem. On the bolls sunken brown spots with reddish margins appear. To control this disease (1) surface disinfection of seed with Ceresan or Ceresan M @ 25 g/10 kg seed, (2) spraying the seedlings with Bordeaux mixture helps in checking the disease in seeding stage, (3) one year rotation and ploughing under the diseased debris after harvesting the crop was quite effective in eliminating the source of primary inoculum, (4) defoliation of the bolls results in rapid drying of the bolls and lint after the rains, thereby reducing the disease.

Efficacy of some insecticides against cashew tea mosquito bug *Helopeltis antonii*

Jalgaonkar, V.N., M.S.Gawankar, V.W.Bendale and P.D.Patil, Regional Fruit Research Station, Vengurle, Dist. Sindhudurg, Maharashtra,
E-Mail: vnjalgaonkar@rediffmail.com

Cashew is one of the major sources of foreign currency for our country and it is also one of the important crops of Konkan region of Maharashtra State. Nearly 60 different pests have been reported on cashew, among them the Tea Mosquito Bug, *Helopeltis antonii* Sign. is the most serious one, which is responsible for considerable yield losses in cashew. A field trial was conducted during 2005 at Cashew Research Farm, Regional Fruit Research station, Vengurle, Dist. Sindhudurg, (M.S.) with an objective to find the effective insecticide for management of Tea Mosquito Bug in comparison with Recommended Spray Schedule. The results indicate that, out of six treatments selected, the treatment of 0.003 % Lambda - Cyhalothrin (T4) was observed significantly superior over all other treatments followed by 0.01% Triazophos (T3) which was also significantly superior over rest of the treatments.

Management approaches of tuberose foliar nematode problem in tuberose cv. Calcutta double in West Bengal

Khan, M. R. and Sekhar Ghosh¹, AICRP on Nematode, Directorate of Research, ¹Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia-741235, India, **E-mail:** mrkhan_nema@yahoo.co.in

A field experiment was conducted for two years period (2005-2006) at Central Research Farm, Gayespur, Bidhan Chandra Krishi Viswavidyalaya, Nadia with six treatment combinations and each treatment was replicated four times to manage the foliar nematode (*Aphelenchoides besseyi*) problem in tuberose in West Bengal. The tuberose bulbs procured from farmer's field was planted in 30cm x 30cm spacing and four plots were planted with untreated bulbs served as control plot. Individual plot size was 3.9mx2.1m. The treatment combinations were as T₁ = Presoaking of bulbs overnight followed by three sprayings with cartap hydrochloride at 1g/litre at 15 days interval (DI), T₂ = Dipping of bulbs in NSKE-4% + first spraying with cartap hydrochloride 50WP at 1.5g/litre, second, third and fourth spraying with azadirachtin 5% at 1ml/litre at 15 DI, T₃ = Presoaking of bulbs overnight followed by dipping in benomyl at 3g/litre for 15 min. + 4 alternate spraying with benomyl(1g/litre) and NSKE 4% at 15 DI, T₄ = Presoaking overnight followed by soil application with carbofuran 3G at 1kg a.i/ha + four sprayings with NSKE-4%, T₅ = Unsoaked bulb and application of pesticides as disease appears in the field and T₆ = untreated control. The results of two years experiment(2005-2006) revealed that presoaking of bulbs overnight followed by dipping in benomyl at 3g/litre for 15 min. + four alternate spray with benomyl and NSKE 4% at 15 DI (T₃) was found to be most effective to reduce the nematode infestation in tubersoe. Among the other treatments, the order of performance agianst *A. besseyi* was evaluated as T₂ > T₁ > T₄.

Efficacy of some plant extracts in suppressing the insect pests and yield of sunflower crop under different climatic conditions in Bangladesh

Khandker, Nesar, Ahmed, BCSIR Laboratories, Dhaka, Dhaka-1205, Bangladesh, **E-Mail:** khandkerahmed@yahoo.com

Sunflower (*Helianthus annuus* L.) is an annual herb not extensively cultivated in Bangladesh. During cultivation, the coccinellid beetles i.e., *Micraspis discolor* (F.) and *Epilachna* sp. severely attacked the foliage and florets in the capitulum (inflorescence). The minor pests encountered were *Spilosoma obliqua* (Walker), *Heliothis armigera* (Hb.), an unidentified big red hairy caterpillar and *Epilachna septima* Dieke. The efficacy of four kinds of plant extracts or botanicals, viz. Neem (*Azadirachta indica*) seed oil, a mixture of Neem seed oil and sesame (*Sesamum indicum*) oil, custard apple (*Annona squamosa*) leaf extract and Bara Bishkatali (*Polygonum orientale*) leaf extract were sprayed and tested against the pest infestation. A 10 % solution of these botanicals were applied fortnightly under field conditions prior to pest attack. The treatment of the mixture of Neem seed oil and sesame oil exhibited most effective result in respect of pest control and crop yield. The other treatments also produced better results in comparison to control followed by *A. squamosa*, Neem seed oil and *P. orientale*. The yield of sunflower was 432 and 480 kg per acre in Patgram, Lalmonirhat and BCSIR Lab, Rajshahi centres, respectively.

Occurrence of aphid on various potato germplasm in eastern gangetic plains of West Bengal

Konar, Amitava and N. Johnson Singh, AICPIP Unit, Agricultural Research Complex, BCKV, Kalyani-741235, Nadia, West Bengal.
E-mail: konar_amitava@rediffmail.com

A field investigation was conducted for two consecutive of years 2003-04 and 2004-05 at Adisaptagram Block Seed Farm Hoogly, West Bengal to find out the incidence pattern and population dynamics of aphids on various potato genotypes. The common potato germplasm viz Kufri Chandramukhi, Kufri Jyoti, Kufri Jawar along with three processing varieties like Kufri Chipsora-1, Kufri Chipsora-2 and Atlantic were screened against aphids. Potato seed tuber was planted by fourth week of November following all standard agronomic practices except insecticide application. The aphid species viz *Myzus persicae* (Sulzur) and *Aphis gossypii* Glover were recorded first during third week of December and cross the threshold limit (20 aphids/100 compound leaves) during first to second week of January in Kufri Chandramukhi where as in Kufri Jyoti and Kufri Jowar, the pest was observed first by fourth weed of December and attained the critical level during second to third weed of January. But the pests were first initiated during early to mid January in K. Chipsona-1, K. Chipsona-2 and Antantic and reached the threshold limit in between end of January to early February. Maximum population of aphid was found during mid to end February

in Kufri Chandramukhi, K. Jyoti and K. Jawahar whereas it was recorded in between end February to early March in Kufri Chipsona-1, Kufri Chipsona-2 and Atlantic. Therefore the population of aphid species was stated to decrease due to age of the crop and increasing effect of temperature. It is also concluded that K. Chandramukhi was susceptible to aphid, K. Jyoti and K. Jawahar tolerant to aphids while K. Chipson-1, K. Chipson-2 and Atlantic genotypes of potato were quite resistant. Therefore, it may be inferred that Kufri Chipsona-1, Kufri Chopsona-2 and Atlantic need only one or two insecticide application at 15 days intervals during late January to protect the crop against the aphids while other varieties will require the insecticide spraying during early January onwards to manage the crop from such infestation.

Evaluation of fungicides/botanicals against black leaf spot of ber (*Zizyphus mauritiana*)

Kumar, Sanjeev, Hemant Kumar Singh, A.L. Yadav and H. K. Singh, Department of Horticulture, N.D. University of Agriculture & Technology, Kumarganj, Faizabad-224229. Uttar Pradesh, India, **E-mail:** dkcnduat@yahoo.com

Black leaf spot disease of ber (*Zizyphus mauritiana*, Lamk) caused by *Isariopsis indica* f. sp. *zizyphi* Gupta and Madan was reported first time from Haryana. The disease also causes severe damage to the crop in Punjab and Uttar Pradesh. The disease appears as black spots, circular to irregular in shape on lower surface of leaves. Later the spots enlarged covering larger area. The leaf area on the upper surface corresponding to the spots on lower surface shows yellowish-brown discoloration.

To control black leaf spot disease (*Isariopsis indica* f. sp. *Zizyphi*, Gupta and Madan) of ber (*Z. mauritiana*, Lamk) a field trial was conducted with different fungicides and botanicals. Among the fungicides Score 10 WP (Difenconazole) 0.1% and Result 25 EC (Propiconazole) 0.1% sprayed twice at 15 days interval immediately after appearance of the disease most effectively reduced the disease severity.

Bioassay studies of some new insecticides against the diamond back moth, *Plutella xylostella* (L.)

Maiti, Asim Kumar and M. L. Chatterjee, Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur – 741252, Nadia, West Bengal, India.

The diamond back moth (DBM), *Plutella xylostella* (L.) (Lepidoptera : Ponomeutidae) is one of the most important cosmopolitan pest and has attained status of an international pest of crucifers. In India, DBM has become important limiting factor in the production of cruciferous crops such as cabbage, mustard, cauliflower, rapeseed etc. In view of the extensive use of synthetic insecticides for the control of these pests and reported development of resistance to almost all the major groups of insecticides especially by *P. xylostella*, it has become necessary to search for suitable alternatives that can substitute the existing recommendations.

To find out the toxicity of some insecticides viz. spinosad, cartap hydrochloride, Novaluron and Dodeci (buprofezin + deltamethrin) on third instar larvae of *P. xylostella*, two sets of experiments were conducted in laboratory by taking DBM population in two seasons – pre-winter (November) and post winter (February). On the basis of LC₅₀ value, the most toxic insecticide was spinosad followed by Dodeci and Cartap hydrochloride. Novaluron was the least toxic. For both in pre-winter and post-winter strains of DBM, the same order of relative toxicity was found but post winter strains is less susceptible than pre-winter strains and represent higher LC₅₀ values of same chemical.

The phenomenon of less susceptibility of post-winter population is probably due to their adaptive nature and development of tolerance against various factors and physiological reasons such as detoxification, metabolism, etc. that develops after the end of winter season.

Evaluation of different plant products against shoot fly in sorghum

Mudigoudra, Shreenivas and Shekharappa, Sorghum Research Scheme, University of Agricultural Sciences, Dharwad-580 005, Karnataka,
E-Mail: shekhar1993@yahoo.com

The field experiment was conducted to know the efficacy of different plant products against sorghum shoot fly during Kharif 2005 at University of Agricultural Sciences, Dharwad. The different plant products used in the study were, *Vitex Negundo*, NSKE, *Adathoda vesica*, *Pongamia glabra*, *Vinca rosea*, *Butea monosperma*, *Aloe vera* @ 5% concentration and were compared with carbofuran 3 G @ 30 kg/ha to know its efficacy on shoot fly in sorghum ecosystem. The results clearly indicated that NSKE (5%) recorded least eggs of shoot fly (0.40egg/plant), per cent dead heart (14.97%) and maximum grain yield of 13.22 q/ha among different plant products. The next best plant product was found to be *V. negundo* @ 5% in recording less incidence of shoot fly and obtaining higher grain yield. However, both the treatments were found next best only to carbofuran 3G.

Studies on the biosafety of botanical insecticides to native natural enemies in mulberry ecosystem

Mukhopadhyay S. K., M. V. Santha Kumar, P. Mitra & A. K. Bajpai, Entomology Laboratory, Central Sericultural Research & Training Institute, Berhampore – 742 101, W.B., India, **E-mail:** swapan_man@yahoo.co.in

Mulberry (*Morus alba*.) is damaged by three major pests viz., thrips (*Pseudodendrothrips mori*), mealy bug (*Maconellicoccus hirsutus*) and whitefly (*Dialeuropora decempuncta*) causing a leaf yield loss ranging from 11 – 24 %. As chemical control measures are costly and cause residual toxicity to silkworm if

applied without observing the safe period. Therefore this Institute has identified various concentrations and combinations of pongamia oil, neem oil, and nicotine extract, for effective control of pest incidence. In the present study, different effective concentrations and combinations viz. 1.5% & 2% pongamia oil, 1% & 2% neem oil, 1% & 2% nicotine extract, 1% pongamia + neem oil, 1% neem oil + nicotine extract, 1% nicotine + pongamia oil were evaluated for the impact on the native natural enemies of the major mulberry pests. The observations have revealed that all the concentrations were found safer to the predators, viz., *Micraspis crocea*, *Micraspis discolor* and *Scymnus bourdilloni* when exposed to leaves after four hours of spray compared to 100% mortality observed when the predators were exposed to the leaves treated with 0.1% dimethoate, a chemical control measure. Thus botanicals can safely be used as being safer for natural enemies. It will be discussed in the paper.

Efficacy of low dose herbicides against weeds in transplanted *kharif*rice (*Oryza sativa* L.)

Pal, S., H. Banerjee and N. N. Mandal, Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia – 741252, West Bengal, India
E-mail: sukanta.agron@rediffmail.com

A field experiment was carried out for two consecutive *kharif* seasons of 2005-06 and 2006-07 to study the comparative efficacy of low dose herbicides against weeds in transplanted *kharif*rice at the Regional Research Sub-Station (New Alluvial Zone), Chakdaha under Bidhan Chandra Krishi Viswavidyalaya. The experiment was laid out in a randomized block design (RBD) with 7 treatments and 3 replications. Major weed flora associated with the transplanted summer rice during dry season was mainly comprised of *Echinochloa crusgalli* (30 %), *Cyperus difformis* (20 %), *Monochoria vaginalis* (30 %) and *Ludwigia parviflora* (30 %). Penoxsulam 24 SC @ 0.0225 kg a.i./ha applied at 8-12 days after transplanting (DAT) was most effective to check all types of weed population and their growth. The same treatment gave the maximum grain yield (3.93 t/ha) and straw yield (3.95 t/ha) of rice resulting in highest harvest index (48.57 %). Therefore, Penoxsulam 24 SC @ 0.0225 kg a.i./ha applied at 8-12 days after transplanting (DAT) may be recommended to replace the tedious, time consuming and expensive hand weeding practice of weed control in transplanted *kharif*rice.

Comparison of path behaviour of some healthy and fruit borer (*Leucinodes arbonalis* Guen) affected brinjal genotypes

Panja*, **B.N.**, **M.K.Pandit¹**, **S.B.Chattopadhyay¹**, **D. Majumder²**, **A. K. Sahoo³**, **P. Pal³**, **A. K. Senapati⁴**, * Department of Plant Pathology, ¹Department of Vegetable Crops, ²Department of Agricultural Statistics, ³ Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia-741252, West Bengal, India, Regional Research Station, BCKV, CSZ, Kakdwip, South 24-Parganas, India.

Fruit and shoot borer (*Leucinodes arbonalis* Guen.) of brinjal (*Solanum melongena* L) is a serious pests in coastal saline belts of West Bengal reducing plant growth and fruit yield to a considerable extent. India being its place of origin, there exists a great variability in brinjal and the selection with respect to desired character could be made possible from the cafeteria of such genotypic variability. Fruit yield often considered the most desired character is an interactive resultant of many growth variables and yield attributing characters. It's not wise to judge the superiority of a genotype, based solely on its yield performance *per se*. Keeping this in view an investigation was carried out with fifteen brinjal genotypes at the Regional Research Station of Bidhan Chandra Krishi Viswavidyalaya, Coastal Saline Zone, Kakdwip, South 24-Parganas during 2003-2005 to see the direct and indirect contributions of each character on yields of healthy and *L. arbonalis* infested genotypes through path analysis. Observations on fifteen growth and yield attributing characters viz. plant height, stem girth, number of twigs/plant, number of secondary branches, total number of twigs/plant, number of leaves/plant, length of leaf, leaf breadth, fruit length, fruit breadth, fruit stalk length, fruit stalk diameter, fruit volume, number of fruits/plant and fruit weight/plant were recorded for the study. Simple correlation studies of these parameters with yield under healthy and fruit and shoot borer infested conditions revealed that only the fruit number per plant had significant positive correlation followed by fruit stalk length in both the cases. Partitioning of correlation values through path analysis study showed that fruit number per plant and fruit stalk length exhibited positive and direct significant effect on fruit yield. It was evident from the results that these two parameters should be given top priority when selection procedure for the varietal development would be taken up even from shoot borer infested field.

Efficacy of newer insecticides against cotton bollworm complex

Patel, Yogesh, H.B. Sharma and S.B. Das***, Zonal Agriculture Research Station, J.N. Agricultural University, Chhindwara (M.P.) India, *Department of Entomology, College of Agriculture, J. N. Agricultural University, Jabalpur – 482 004 (M.P.) India. ** Mathura (U.P.) India, **E-mail:** yogeshpatel2@rediffmail.com

Insecticides have been recognized as one of the most important inputs for increasing the agricultural production. It is the only practical approach so far available to the farmers for effective control of cotton insect pests. In spite of availability of effective chemical control measures, they have not been used judiciously by the farmers which has resulted in the development of resistance and resurgence of many insect pests against some of the old traditional insecticides. In view of the above facts, a trial was conducted with six newer insecticides namely Emamectin benzoate 5% WSG, Spinosad 45% SC, alpha-cyhalothrin 5% EC, Indoxacarb 14.5% SC, Profenophos 50% EC and Cypermethrin 10% EC to evaluate their efficacy against cotton bollworm complex at Regional Agriculture Research Station, JNAU, Khandwa (M.P.) during two consecutive years 2004-05 and 2005-06 respectively.

All the insecticides tested against cotton bollworm complex were found significantly superior and controlled the larval population and bollworm complex infestation over control. Avermectin a newer class of insecticide which included Emamectin benzoate 5% WSG when applied @ 9.8 g a.i./ha was found to be most effective. It recorded minimum larval population and minimum bollworm damage in squares, bolls and locules and registered maximum seed cotton yield and weconomical. Another more recent class of insecticide Spinosyn containing Spinosad 45% SC when applied @ 100 g a.i./ha was found to be the next effective insecticide during both the years of study. It significantly reduced the larval population and cotton bollworm infestation and increased the seed cotton yield significantly. These newer compounds can be incorporated in the pest management programmes in order to achieve the desired control against the cotton bollworm complex.

Impact of some newer insecticides on potent predators of cotton

Patel, Yogesh, S.B. Das* and H.B. Sharma**, Zonal Agriculture Research Station, J.N. Agricultural University, Chhindwara (M.P.) India. *Department of Entomology, College of Agriculture, J. N. Agricultural University, Jabalpur – 482 004 (M.P.) India, ** Mathura (U.P.) India, **E-mail:** yogeshpatel2@rediffmail.com

The role of predatory insects has long been recognized for their contribution in the suppression of population of insect pests. Several species of predators have been recorded in cotton agro ecosystem. The impact of these predators become more apparent when their population is adversely affected by the use of broad spectrum insecticides which lead to pest resurgence and secondary outbreaks. In view of this non-judicious use of insecticides by the farmers in the insect pest control in cotton is becoming an increasingly costly affair these days. Therefore, a study was conducted at Regional Agriculture Research Station, JNAU, Khandwa (M.P.) during 2004-05 and 2005-06 to assess the impact of six newer insecticides namely Emamectin benzoate 5% WSG, Spinosad 45% SC, alpha-cyhalothrin 5% EC, Indoxacarb 14.5% SC, Profenophos 50% EC and Cypermethrin 10% EC on the predator population *i.e.* Lady Bird beetle, coccinellids and green lacewings, chrysopids.

The study revealed that mean predator population *i.e.* Lady Bird beetle, coccinellids and Green lacewings, chrysopids was low in all the insecticidal treated plots in comparison to untreated control. However among the insecticidal treatments, significantly highest population was recorded in plots treated with Emamectin benzoate @ 8 g *a.i.* /ha followed by Emamectin benzoate @ 9.8 g *a.i.* /ha, Spinosad 45 SC @ 75 g *a.i.* /ha and Spinosad 45 SC @ 100 g *a.i.* /ha respectively. The minimum reduction in population of natural enemies Lady Bird beetle, coccinellids and Green lacewings, chrysopids over control, were recorded in plots treated with Emamectin benzoate @ 8 g *a.i.* /ha followed by Emamectin benzoate @ 9.8 g *a.i.* /ha, Spinosad 45 SC @ 75 g *a.i.* /ha and Spinosad 45 SC @ 100 g *a.i.* /ha respectively. On the basis of the present study it can be concluded that Emamectin benzoate had minimum negative impact on the predator population followed by Spinosad. These insecticides also have been found to be very effective in restricting the bollworm infestation therefore these may be considered as ideal safe chemicals for use in Integrated Pest Management Programmes.

Efficacy of newer insecticides against foliage feeder and head borer in sunflower

Patil*, B.V. and M.H. Chavan, Oilseeds Research Station, Latur-413 512 (M.S.), India, **E-Mail:** patilbvors @ rediffmail.com.

Sunflower (*Helianthus annuus* L.) is an important oilseed crop in the world. Sunflower crop is known to be infested by several pests. Among harmful insects, seedling insect pests, head borer (*Helicoverpa* sp.) foliage feeder (*Spodoptera litura* Fabricius, *Thysanoplusia orichalcia* Fab., *Trichoplusia ni* etc.) are of major importance. The loss in seed yield due to defoliators in a rain fed *kharif* crop was up to 268 kg /ha recorded at Bangalore (K.S.) India. The yield loss also goes up by ca. > 50 % under severe incidence of head borer. This situation led to test the efficacy of some newer insecticides to evaluate effective chemical(s) against foliage feeder and head borer. The field study was carried out at Oilseeds Research Station, Latur (M.S.) during *kharif* 2004-06. Variety Morden was sown in RBD. in three replications. Six insecticides i.e. thiodicarb, indoxacarb, spinosad, profenofos, chlorpyrifos and dichlorvos were tested along with untreated control. Three years pooled results revealed that treatment of thiodicarb @ 0.075 % was most effective against foliage feeder and head borer followed by indoxacarb. This treatment also registered highest seed yield 1106 kg/ha (which was +29.0 % increase over control) followed by indoxacarb. However treatment of profenofos @ 0.05 % was proved to be most economical treatment for control of foliage feeder and head borer which recorded highest insecticidal cost benefit ratio i.e. 1:7.0

Bioefficacy of some new insecticides against okra shoot and fruit borer *Earias vitella* (Fab.)

Patra, Sandip, Shanowly Mondal, Arunava Samanta and M.L. Chatterjee, Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741 252, West Bengal, India, **E-mail:** shanowly@yahoo.co.in

A field experiment was conducted at Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India to evaluate the efficacy of some new insecticides viz. Emamectin benzoate (Proclaim 5 SG), Lufenuron (Match 10 EC), Spinosad (Success 2.5 SC), Indoxacarb (Avaunt 14.5 SC) and Methoxyfenozide (Runner 24 SC) against okra shoot and fruit borer, *Earias vitella* (Fab.) (Noctuidae: Lepidoptera) during *kharif* season, 2006. Insecticides were sprayed at 50 and 65 days after sowing. All insecticidal treatments were significantly effective in reducing shoot and fruit borer infestation as well as in increasing fruit yield over untreated control plots. Of these, the overall best control and yield was observed in case of Emamectin benzoate (mean infestation 5.42% and mean yield 97.25 q/ha) followed by Spinosad (5.86% and 96.1 q/ha), Indoxacarb (6.38% and 92.8 q/ha), Methoxyfenozide (7.83% and 84.2 q/ha), Lufenuron (7.89% and 83.4 q/ha) whereas in control plot the infestation was 25.1% and yield was 49.3 q/ha.

Residue and dissipation of Antracol 70WP in Onion

Roy, Sankhajit , Pritam Ganguly, Tirthankar Banerjee, M. Paramasivam, D. Banerjee and Hemanta Banerjee, All India Network Project on Pesticide Residues, Department of Agricultural Chemicals, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal-741235, India,
E-mail: roysankha@yahoo.co.in

A residue trial was conducted on onion (variety sukhsagar) with propineb @ 1225 (T_1) & 2450 (T_2) g a.i./ha, applied thrice at an interval of 10 days during the year 2006-2007 at the farmers field, Kalyani, Nadia, West Bengal. Propineb residue was measured spectrophotometrically at 435 nm in terms of CS_2 (mg/kg). The limit of quantification (LOQ) was found to be 0.2 mg/kg in terms of propineb for green onion leaves, immature and mature onion bulb. The initial deposit of propineb in green onion leaves was found to be 5.338 and 11.721 mg/kg for T_1 and T_2 respectively which declined gradually with the increment of time and dissipated to about 95% on 10 days and became below LOQ on 14 days. The half-life value ranged from 2.25 – 2.30 days. Considering the MRL value of 0.5 mg/kg, the calculated safe waiting period for T_1 was found to be 8.62 days and for T_2 it was 11.23 days. Interestingly no residue could be quantified in immature onion bulb since after last application and the same phenomenon was observed in case of mature onion bulb. Thus propineb can be safely recommended in onion for the consumption of mature and immature onion bulb.

Comparative efficacy of insecticides and neem formations against litchi fruit borer, *Conopomorpha cramerella* Snellen (*Gracillariidae: Lepidoptera*)

Sahoo, Ajoy Kumar, Anusmriti Roy and Sujit Kumar Ray, Department of Agril. Entomology, B C K V, Mohanpur; AICRP on Sub Tropical Fruits ,Kalyani, Nadia, West Bengal, India, **E-mail:** drasahookly@yahoo.com

Conopomorpha cramerella Snellen was recorded to be very destructive to litchi fruits in West Bengal. During the present study it was found that the larvae infest both the tender leaves and fruits. During July–November it was as leaf minor and during March -June it appeared as fruit borer. During harvesting period it was observed that 46% fruits were damaged due to *C. cramerella*. From the study of bioefficacy of various insecticides against this pest, dichlorvos (0.076%) and endosulfan (0.07%) were found to be very effective and resulted in lower fruit infestation as compared to other chemicals .But from the export point of view, application of azadirachtin (6ml/L) was found to be most effective.

Studies on bio-ecology and management of *Apsylla cistellata* Bucton. on mango in West Bengal

Samui, Goutam and S. Jha, Department of Agril Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia- 741252. **E-mail:** shantanu_jha@hotmail.com

Mango is attacked by various insect pests among which mango shoot gall psylla *Apsylla cistellata* Bucton. (Psyllidae, Hemiptera) is one of the important one in the districts of Malda and Murshidabad, West Bengal. Studies on the bio-ecology of the pest from West Bengal was scanty and has been taken up and results presented in this study. Adult females of the pest has been found to lay eggs at the sides of the mid ribs from first week to end of March. Incubation period lasted from first week of March to middle of August. Eggs hatched in the middle of August and gall formation had been found to start from first week of September. Nymphal period lasted from mid of August to end of February. Adult emergence occurred from fourth week of February which continued up to third week of March. Nymphs initially fed on mid rib of leaf then entered into the gall which appeared on the emerging vegetative buds resulting in total failure to put forth inflorescence properly. Repeated spraying without proper understanding of the life cycle did not give good results in managing the pest. Hence application of insecticides had to be synchronized with the emergence of nymphs. To manage the shoot gall psylla, mechanical control (pruning) and insecticidal control measure were taken up in the district of Murshidabad. In mechanical control, both pruning of 15cm and 30cm of affected shoots resulted in formation of lower number of gall/shoot as compared to control. But pruning at 30cm had been found to be most effective in managing the psyllid gall. In insecticidal control, lowest number of gall per shoot could be recorded on the branches treated with monocrotophos (0.35 galls/shoot) followed by quinalphos (0.73 galls/shoot) and imidacloprid (1.03 galls/shoot). However, the performance of all three insecticides were statistically at par.

Biocidal activity of newly synthesized organotin compounds against foliar blight of wheat

Sarkar, Bipasa, Abhijit Roy and Apurba Kr. Chowdhury*, Department of Chemistry, University of North Bengal, Raja Rammohanpur, Derjeeling, West Bengal, * Department of Plant Pathology, U.B.K.V., Cooch Behar, 736165, West Bengal, India **E-mail:** apurba1996@yahoo.co.in

Organotin chemistry is a subject of interest for years due not only to its rich structural chemistry but also for its versatile applications. The thiosemicarbazides having the general formula $\text{NH}_2\text{-C(S)-NH-NH}_2$, predominantly exist in the thione form whereas in solution state, they exhibit a thione–thiol tautomerism. The chemistry of thiosemicarbazides and their substituted derivatives are well explored. Condensation of these thiosemicarbazides with aldehydes and ketones with potential donor sites yield Schiff bases termed as thiosemicarbazones and they have extended conjugation

and enhanced activity. Complexation of these active Schiff bases with di-organotin compounds were explored for their biocidal activities against foliar blight pathogen of wheat, *Bipolaris sorokiniana*.

When assayed for their in-vitro fungitoxicity, most of these newly synthesized compounds exhibited weakly toxic activity at 50 ppm concentration. In vivo tests showed that these chemicals inhibited the lesion length by 77% to 92% in wheat leaves.

The biochemical responses following treatment with these chemicals in susceptible wheat varieties were also investigated. Increased accumulation of phenol and ortho-hydroxyphenol and enhanced activities of polyphenoloxidase and peroxidase in treated plants indicated that these compounds may primarily act on the pathogen through host mediated responses.

Integration of chemical, botanical and microbial insecticides for control of thrip *Scirtothrip dorsalis* hood infesting chilli

Senapati, A. K. and N. Mandi, Regional Research Station (CSZ), Bidhan Chandra Krishi Viswavidyalaya, Kakdwip-24 Pgs. (South), PIN-743347, India
E-mail: niru_bckv@yahoo.com

A field experiment was conducted during winter season of 2004-05 and 2005-06 to evaluate the effectiveness of different conventional & eco-friendly insecticide (synthetic and biological origin) against thrips (*Scirtothrip dorsalis* Hood) infesting chilli (*Capsicum frutescens*). The effectiveness of four insecticides acetamiprid 0.004% (Dhan preet-20% SP), thiamethoxam 0.005% (Anant-25% WG), neem pesticide 0.4% (multineem 1% W/W) and *Bacillus thuringiensis*, sub sp. Kurstaki (BT) at 1g/l was evaluated in the field of Coastal saline zone of West Bengal against thrips. It is evident from the results presented that acetamiprid and thiamethoxam were most effective to minimize the thrips population by 93.3% and 89.93% respectively. Neem pesticide (54.2%) and microbial pesticide BT (43.43%) were found moderately effective against thrips. However, two sprays of acetamiprid and thiamethoxam followed by two sprays of neem pesticide and BT proved to be effective for management of thrips and it gave highest marketable yield, higher cost benefit ratio and percent reduction in thrips population.

Biological control of earhead caterpillar, *Helicoverpa armigera* in sorghum

Shekharappa, Senior Scientist (Entomology), Sorghum Research Scheme, University of Agricultural Sciences, Dharwad-580 005, Karnataka,
E-Mail: shekhar1993@yahoo.com

A field experiment was conducted with biopesticides viz., *Nomurae rileyi* (Farlow) Samson and NPV of *Helicoverpa armigera* (HNPV) and compared with chemical control with Melathian 5% @ 30 kg/ha for the management of ear head caterpillar *H. armigera* in sorghum ecosystem of University of Agricultural Sciences, Dharwad. The mycoinsecticide *N. rileyi* was highly infective at both the dosages 1×10^8 conidia per litre. & 2×10^8 conidia per litre against *H. armigera* as compared to Ha NPV 250 LE per hectare and chemical control in mitigating the pest population as well as in obtaining the higher yield.

Residual effect of four conventional and five bio-rational insecticides on the feeding activity of *Bombyx mori* Linn.

Singh, K.I., A.R. Devi, M.P. Singh and M.K. Gupta, Department of Entomology, College of Agriculture, Central Agricultural University, Imphal-795004, Manipur (India).
E-mail: singhki_ento@yahoo.com

Feeding effects of four conventional (malathion, dichlorvos, Endosulfan and Monocrotophos) and five biorational insecticides (Nimbecidine, Vijayneem, Agrineem, Larvoceel and Cow-urine + *Melia azedarach* extract) sprayed leaves on the larval mortality, cocoon quality, moth emergence and fecundity of mulberry silkworm, *Bombyx mori* Linn. was carried out during March, 2007 to September, 2007 at the College of Agriculture, Central Agricultural University, Imphal and Research Farm of Regional Tasar Research Station, Mantripukhri, Imphal. The significant findings generated revealed that cent per cent mean mortality of *B. mori* 3rd instar larvae was recorded in the leaves treated with Malathion 50 EC, Dichlorvos 76 EC, Endosulfan 35 EC and Monocrotophos 36 WSC each @ 500 g a.i. kg ha⁻¹ after 15 days of feeding in comparison to the neem-products (13.33 – 36.67 per cent larval mortality). Larvoceel (*Beauveria bassiana*) @ 2.5 kg ha⁻¹ treated leaves caused 43.33 per cent larval mortality after 15 days of application, while it was only 13.33 per cent in case of Cow-urine + *M. azedarach* extract @ 12500 ml ha⁻¹. Pooled mean larval mortality of four post – treatment observations (1, 5, 10 and 15 days after treatment) indicated that higher larval mortality of *B. mori* was observed in all the conventional insecticides sprayed leaves ranging from 33.33 – 98.79 per cent which minimum being recorded in Dichlorvos and maximum in monocrotophos as against 4.17 (Agrineem @ 1000 ml ha⁻¹) – 21.67 (Nimbecidine @ 2000 ml ha⁻¹) per cent in neem products, 23.33 per cent in Larvoceel and 3.33 per cent in Cow-urine + *M. azedarach* treated leaves. However, the mean larval mortality noticed in the leaves treated with all the biorational insecticides did not differ significantly from one another. Further, the

present study also showed that the number of harvested cocoon, per cent moth emergence and fecundity was affected considerably by conventional insecticides in compared with neem-products and Larvocol. Cow-urine + M. azedarach extract exhibited highly promising treatment with respect to cocoon harvest (79 per cent), moth emergence (22 per cent) and fecundity (289.65 eggs). The present investigation clearly indicated that use of neem products, Larvocol (*B. bassiana*) and Cow-urine + M. azedarach were quite safer to *B. mori* larvae and grainage parameters than conventional insecticides.

Field efficacy of spinosad 45 % SC for the control of rice stem borer, *Scirpophaga incertulas* (Walker) and leaf folder *Cnaphalocrocis medinalis* (Guenee) on paddy and basmati rice

Singh, Paramjit, Ramandeep Kaur¹ and Parminder Kaur², PAU Farm Advisory Service Scheme, Krishi Vigyan Kendra, Usman, Amritsar, India
E-Mail: pramjit_gandhi@yahoo.com

Paddy and *Basmati* rice is widely grown in all districts of Punjab. Most of the area under *basmati* rice falls in Amritsar district. Rice is attacked by number of insect pests. Among these yellow rice stem borer (*Scirpophaga incertulas*) and rice leaf folder (*Cnaphalocrocis medinalis*) are regular pest and some times cause serious damage to the crop. Many insecticides are recommended for their control. In order to provide a wide and better choice to the farmers to select the chemical for their control present studies were conducted at the farms of Krishi Vigyan Kendra, Usman, Amritsar.

The per cent attack of rice stem borer (*S. incertulas*) varied from 1.93 to 2.83 after 45 days of spray. spinosad 45 % SC @ 125 ml and 162.5 ml per hectare were significantly better than control. However, chlorpyrifos was significantly better than all treatments after 45 DAS. White ear heads were significantly less where spinosad @125 ml was used followed by spinosad @ 162.5 ml and chlorpyrifos 20 EC @ 2500 ml per hectare. Per cent attack was non significant in *basmati* rice.

Per cent attack of leaf folder varied 1.09 to 1.70, 1.22 to 1.86 in paddy and 0.95 to 1.92, 1.23 to 1.89 in basmati rice after 45 DAS and 60 DAS respectively. Spinosad 45 SC @125 ml and 162.5 ml and chlorpyrifos @ 2500 ml were significantly better than monocrotophos @1400 ml and spinosad @100 ml and control. Higher doses of spinosad were significantly better in controlling rice leaf folder in paddy and *basmati* rice.



Challenges, changes and choices before *Trichoderma* based biopesticides

A.N. Mukhopadhyay, Former Vice-Chancellor, A.A.U. and Dean, G.B. Pant University of Agriculture & Technology. *Present address:* Sangini, 151, Akanksha, Udyan II, Raibareilly Road, U.P., 226025, India.

During last decade, species of *Trichoderma* have emerged as most powerful bioprotectants for management of a wide variety of plant diseases. This is most true in the context of the fact that there is considerable public pressure from environmental scientists to reduce emphasis on chemical protectants and use bioprotectants. The genus *Trichoderma* by virtue of its broad-spectrum action against a number of plant diseases caused by fungi, bacteria, viruses and even nematodes has occupied the top position among the bioprotectants developed for plant disease management. *Trichoderma* based biopesticides have been proved successful in a large number of field, vegetable, fruit and flowering crops for the management of diseases. Because of its eco-friendly nature and low cost when compared with chemical protectants, the technology has been very widely adapted all over the world. The literature accumulated on the subject during last decade is quite vast. *Trichoderma* strains exert biocontrol against phytopathogens either indirectly by competing for nutrients and space, modifying the environmental conditions, or promoting plant growth and plant defensive mechanisms and antibiosis or directly by mechanisms such as mycoparasitism. These indirect and direct mechanisms may act coordinately and their importance in the biocontrol process depends on the *Trichoderma* strains, the antagonized fungus, the crop plant and the environmental conditions, including nutrient availability, pH, temperature, moisture and iron concentrations. *Trichoderma* species are plant symbiont opportunistic virulent organisms, able to colonize plant root by mechanism similar to those of mycorrhizal fungi. Root colonization by *Trichoderma* species frequently enhances root growth and development, crop productivity, resistance to abiotic stress and the uptake and use of nutrients. Root-fungus associations also stimulate plant defensive mechanisms. *Trichoderma* added directly to rhizosphere as seed treatment protects plants against numerous classes of pathogens, e.g. those that produce aerial infections, including fungal, bacterial, nematodes and viral pathogens. This reveals induction of resistance mechanisms similar to the hypersensitive response (HR), systemic acquired resistance (SAR) and induce systemic resistance (ISR) in plants. The low cost technology has opened up a new vista for plant disease management and is likely to be a boon for seed industries who would like to provide protection to seeds against a large number of seed and soil borne diseases.

While dealing with a fungus like *Trichoderma* we have to have a critical look at the following aspects, which have been hindering its successful applications as bioprotectants. Greatest limiting factor is very short self-life (4-6 months) under tropical and subtropical conditions. There is a strong need to increase the shelf-life to make *Trichoderma* application practically feasible. Sensitiveness of *Trichoderma* to higher pH 7 and above and higher temperatures are very important limiting factors restricting its application. Modern biotechnological tools may be applied to get rid of these factors limiting its application. Poor quality and substandard *Trichoderma*

preparations marketed by so-called biopesticides companies are causing tremendous setback in many areas. Efforts must be on to work on the above issue by interdisciplinary approach involving biotechnologists, physiologists, microbiologists, plant pathologists, biochemists and also through strict quality control by government agencies.



Diversity of natural enemies of mite pests infesting agri-horticultural crops in India highlighting their potentiality and prospects in using those in IPM Programme

S.K. Gupta*, Entomology-Wild Life Research Laboratory, Department of Zoology, University of Calcutta, 35 Ballygunge Circular Road, Kolkata-700035.

* Address for correspondence: - 1C/10 Anandam Housing Complex, 7 K.B. Sarani, Kolkata-700080, **E-mail:** salil_zsidumdum@yahoo.com

It is an established fact that mites are becoming very important pests of agri-horticultural crops throughout the world. Due to indiscriminate and injudicious uses of broad spectrum pesticides and adapting improved and intensified agricultural practices during the last two decades, the mite problem has tremendously aggravated and invited threats like resistance, resurgence, residues, etc. and all these contributed adversely in carrying out pest management programme effectively and efficiently. In order to solve this problem, global attention has been focused to explore the various natural enemies both exotic and indigenous ones and utilize those profitably to suppress the pest mite population below economic injury level.

The potential natural enemies which have so far been identified are: -

A. Predators I. Insecta: Coleoptera (Coccinellidae, Staphylinidae), Hemiptera (Myridae, Anthocoridae, Nabidae, Lygaeidae), Diptera (Syrphidae), Neuroptera (Chrysopidae, Hemerobiidae, Coniopterygidae), Thysanoptera (Thripidae), II. Acari: Mesostigmata (Phytoseiidae, Ascidae, Laelapidae), Prostigmata (Anystidae, Bdellidae, Cheyletidae, Cunaxidae, Erythraeidae, Raphignathidae, Stigmaeidae, Tydeidae), III. Araneae (Theridiidae, Salticidae, Lycosidae).

B. Pathogens: IV. Fungi (*Metarhizium*, *Verticillium*, *Hirsutella*, *Beauveria*), V. Viruses (NPV, GV), VI. Bacteria (*Bacillus thuringiensis*), VII. Nematodes, etc.

Among all these, the predatory mites like Phytoseiidae, Stigmaeidae, Cunaxidae and among insects, Coccinellidae, Chrysopidae are of prime importance while the others are of relatively less importance. Since phytoseiid mites are abundantly available, very agile, having high feeding potentiality and shorter life cycle than that of their prey species, they are the most preferred ones and hence, studies on diverse aspects both basic and applied are done in India and elsewhere for incorporation as one of the biological components in IPM.

This paper discusses diversity of natural enemies of phytophagous mites, provides information on their bio-ecological aspects and life strategies they exhibit, emphasizes potentiality and possibility for their use in IPM, focuses the likely constraints in achieving success and stresses upon the need for mass multiplication and augmentive release of the indigenous phytoseiid predators.



Combined use of entomopathogenic nematodes and fungi: a novel approach to control pests of crops

Minshad Ali Ansari, Department of Biological Sciences, Swansea University, SA2 8PP, UK., **E-mail** : M.A.Ansari@swansea.ac.uk

Control of insect pests has often proved to be a considerable challenge. Many chemical pesticides are being withdrawn due to the risks they pose to humans and the environment. Attention had focussed on alternative pest control strategies including the use of entomopathogenic nematodes and insect-pathogenic fungi. When used alone, these agents can give varying degrees of control. Since the grower needs rapid crop protection, a strategy needs to be devised where pesticide inputs can be reduced yet benefit from the control given by these biocontrol agents.

There is growing evidence that pest control can be greatly improved by using combinations of biocontrol agents; their increased efficacy may be due to true synergistic or additive interactions. Recent studies show that excellent control can be achieved by combining entomopathogenic nematodes with insect-pathogenic fungus, *Metarhizium anisopliae*. For example, it has been reported that use of entomopathogenic nematodes with *M. anisopliae* gave excellent control of the white grub, *Hoplia philanthus* (Coleoptera: Scarabaeidae) and black vine weevil, *Otiorhynchus sulcatus* (Coleoptera: Curculionidae), under greenhouse and field conditions. The combined use of entomopathogenic nematodes and *M. anisopliae* provided almost immediate crop protection. The *M. anisopliae* presumably stress the target or alter their behaviour in such a way as to make them more susceptible to entomopathogenic nematodes. The underlying mechanisms for the synergy are unclear but it is postulated that one agent may stress or alter the behaviour (e.g. feeding, movement) of the target insect making it more susceptible to the other agent.

More recently, we showed that neem seed cake enhanced the efficacy of *M. anisopliae* for black vine weevil control through its repellent or antifeedent properties. This was supported by the fact that larvae exposed to neem treatments had more spores adhering to their surface which could only be due to increased movement. Neem seed cake was so effective in enhancing the efficacy of *M. anisopliae* that the application rate of this fungus could be reduced by a 100 fold. This strategy would benefit growers by reducing their costs for controlling media-borne pests like black vine weevil larvae.

These studies clearly show that combined use of *M. anisopliae* with entomopathogenic nematodes offer an integrated approach to increase the efficacy of entomopathogenic nematodes for the control of subterranean pests and perhaps other pests of crops.



Hypovirulence in plant pathogenic fungi

Pratibha Sharma, Principal Scientist, Division of Plant Pathology, IARI, New Delhi-110012. **E-mail:** psharma032003@yahoo.co.in

Hypovirulence in fungal plant pathogens refers to the reduced ability of selected isolates within a population of a pathogen to infect, colonize, kill and (or) reproduce on susceptible host tissues and is often associated with double stranded RNA elements, mitochondrial mutations, nuclear mutations and encapsidated fungal viruses have been (or could be) associated with hypovirulent isolates.

. Hypovirulence is generally reported in sclerotia forming pathogens where the spores are not the causative agents. Rather mycelia and sclerotia are the prominent stages, as in *Sclerotinia sclerotiorum*, *S. minor*, and the disparate species *S. homoeocarpa*. Some workers have attempted to work on *Cryphonectria parasitica*, the causal agent of chestnut blight, *Rhizoctonia solani* Kuhn (teleomorph, Thanatephorus cucumeris (Frank) Donk.), consisting of at least 13 anastomoses groups (AG). Results obtained will be discussed briefly.

Vegetative compatibility refers to the ability of two strains of a fungus to fuse and form a stable heterokaryon. Heterokaryon formed as a result of this process is genetically different from the parent components. The co-existence of two different nuclei (heterokaryon or dikaryon) in the same cell is regulated by the somatic/vegetative/heterokaryon compatibility system. More the incompatibility among the strains of a fungus more is the extent of genetic variation of the fungus.

One hundred and sixteen isolates of *S. homoeocarpa*, the causal agent of dollar spot of turfgrass were assessed for vegetative compatibility in culture and four types of reactions were observed. Results indicated that vegetative incompatibility in *S. homoeocarpa* ranged from fully to partially incompatible. The fully incompatible reaction strongly restricted transmission of hypovirulence-associated dsRNA, whereas the partially incompatible reactions allowed limited spread between vegetative compatibility groups (VCGs), suggesting that vegetative incompatibility is not an absolute barrier to the transmission. Comparison with VCGs reported from elsewhere supported the hypothesis that there is limited diversity among VCGs in *S. homoeocarpa*.

Biological control has been demonstrated through applications of hypovirulent isolates to diseased plant tissues in controlled and field environments. In *S. minor*, disease severity was suppressed by more than 50%, and the number of sclerotia produced on treated diseased tissues was reduced by up to 90%. In *S. homoeocarpa*, biological control efficacies of up to 90 and 80% have been achieved in controlled and field environments, respectively, and were comparable with treatment with a fungicide. Single applications of the hypovirulent isolate Sh12B, containing a strain of the species *Ophiostoma mitovirus 3a* (OMV3a) previously described from *Ophiostoma novo-ulmi* in Europe, were as effective as up to four applications of fungicide, and treatment efficacy persisted into the following year.

SR5-7Hv was isolated from hyphal anastomosis groups of isolates of *S. rolfsii* that showed biological activity against other pathogenic isolates *S. rolfsii*. The cell free culture filtrate and powdered biological formulation of the hypovirulent isolate were

used to study the biocontrol effect in glasshouse against *S. rolfsii* causing disease in different crops viz. tomato, linseed, soybean and wheat and disease suppression upto 80-100% was recorded. The hypovirulent isolate, biologically active against the virulent isolates of *S. rolfsii* was found to possess double stranded RNA, which possibly can be a mycovirus.

Similar interesting results with *Cryphonectria cubensis*, the causal agent of a serious canker disease of *Eucalyptus* spp. in tropical and subtropical parts of the world has been reported and a full-length coding strand of the *C. parasitica* hypovirus (CHV1-EP713) was found to be readily transmitted via hyphal anastomosis to *C. cubensis*. However, vegetative incompatibility was reported to be a barrier for the transfer of dsRNA from one isolate to another in *Cryphonectria parasitica* ...

Biocontrol using hypovirulence depends critically on the use of appropriate vegetative compatibility groups, which closely match the compatibility group(s) of the targeted pathogen. So, random application of vegetative compatibility groups will most often fail. This problem may be addressed (eventually) by application of hypovirulent strains of every possible vegetative compatibility group. The potential in utilizing hypovirulent isolates of fungal pathogens in a biocontrol strategy resides in the ability to transfer hypovirulence from hypovirulent isolates to virulent isolates and thereby, reduce the mean disease severity of the population through overall reductions in virulence, growth, sporulation, and/or survival.



Biological suppression of nematode pests of crops

M. S. Rao, Nematology Laboratory, Indian Institute of Horticultural Research, Hessaraghatta Lake, Bangalore - 89, India,
E-mail : msrao@ihr.ernet.in

Nematodes such as *Meloidogyne* spp., *Heterodera* spp., *Globodera* spp, *Rotylenchulus reniformis*, *Radopholus similis*, *Tylenchulus semipenetrans* and *Pratylenchus* spp. affect economically important crops in the world. They are exposed to a wide range of natural enemies like bacteria, nematophagous fungi and predacious nematodes that are antagonistic to the plant parasitic nematodes. Intensive farming of agricultural crops and excessive chemicalization of agro-ecosystem with various agro-chemicals has affected the soil bio-diversity, adversely tilting the balance towards harmful soil flora and fauna. This deleterious alteration has increased the soil sickness in the absence of natural suppression by antagonistic and useful organisms called bio-control agents. This has led to the development new scenario where in many agricultural crops are affected by higher densities of nematodes and also the disease complex caused by pathogenic bacteria + nematodes and fungi + nematodes.

Various researchers in the world investigated on the biological control of nematodes and documented the bio-efficacy of biocontrol fungi such as *Paecilomyces lilacinus*, *Pochonia chlamydosporia*, *Trichoderma harzianum*, *T. viride*, *Arthrobotrys* spp., *Dactylella oviparasitica*, *Gliocladium virens*, biocontrol bacteria such as *Pasteuria*

penetrans, *Pseudomonas fluorescens* *Bacillus thuringiensis*, *B. subtilis*, *B. pumilis*, *Azotobacter chroococcum* and predacious nematodes such as *Seinura*, *Eudorylaimus*, *Mononchus* and *Odontopharynx* on various nematodes infecting agricultural crops.

At Indian Institute of Horticulture Research, Bangalore, we standardized the methods of use of certain bionematicides for the management of nematodes in horticulture eco-systems. Subsequently standardized formulation technologies of these bionematicides which include liquid fermentation and solid fermentation of the bio-agents using cheaper substrates. The formulation technologies these bionematicides have been transferred to more than 20 private entrepreneurs in India.

However, single bio-agent cannot be very effective in the management of disease complex. Further the bio-pesticide formulation containing single bio-gent cannot be active in different soil types, agro-climatic regions and on all the crops. Hence we are investigating on the combinations of bio-agents for the management of nematodes in papaya, banana, tomato, okra, capsicum, gladiolus and tuberose, through IHR and DBT projects. We are also investing on the bio-efficacy of combinations of bio-agents on the nematode induced wilt disease complex in various horticultural crops. The data on compatibility of bio-agents and suppression of nematode pests and nematode induced disease complex will be deliberated during the national symposium.

Source of primary inoculum of downy mildew of opium poppy and its biological management

D.K.Chakrabarti, Gaur, V.P. and Singh, O.P., AINP on Medicinal and Aromatic Plants, N.D. University of Agriculture and Technology, Faizabad-224229, Uttar Pradesh, India, **E-mail:** dkcnuat@yahoo.com.

Attempts were made to pinpoint the primary source of infection of downy mildew disease of opium poppy (*Papaver somniferum* L) caused by *Peronospora arborescens* (Berk) de Bary and to manage the disease incidence by destroying primary inoculum using the fungal antagonist, *Trichoderma viride*. From dormant mycelia in the crop residue, tufts of hyphae developed, penetrated the cotyledonary leaves and formed blight spots from which first batch of conidia were produced. Germination of 1-year old oospores producing zoospores was also recorded. Zoospores were produced either in a vesicle developed from the oospores or inside the oospore itself by cleavage of its protoplast. In *in vitro* test the oospores were found to be parasitized and destroyed by the fungal antagonist, *Trichoderma viride*. Soil and seed treatment with *T. viride* and drenching of the seedlings with its suspension significantly reduced the disease incidence under field condition and simultaneously increased the yield.

A new process for the production of biopesticides to control plant parasitic fungi and nematodes

M. R. Khan, S. M. Khan, F. A. Mohiddin and N. Khan, Department of Plant Protection, Aligarh Muslim University, Aligarh 202 002, India,
E-mail : mrkhan777in@yahoo.co.in

A novel process to produce biopesticides has been invented. The process involved the mass production of biocontrol fungi and bacteria on sawdust-soil-5% molasses mixture (15:1:1) and immobilization of the microorganisms in the flyash-soil-5% molasses mixture (5:1:1). Using the process, three biopesticides, Biowilt-X (*Trichoderma harzianum*), Bionem-X (*Pochonia chlamydosporia*) and Biocomp-X (*Pseudomonas fluorescens*) were produced to control soil borne fungal and nematode diseases such as wilt (*Fusarium* spp.), root rot (*Pythium*, *Sclerotium*, *Rhizoctonia* species) and root-knot (*Meloidogyne* spp.). Patent for the process and products has been filed (Ref. 1621/DEL/2005).

The three biopesticides so developed are superior than their contemporaries available in the market with regard to CFU load and cost. Shelf life of the three biopesticides was tested at five temperature regimes i.e., 5°, 10°, 15°, 25°C and ambient (March onwards) for 32 wks. The biocontrol agents not only remained viable but also multiplied during the storage. At ambient temperature, the CFU count in the biopesticides was 10^{8-9} of *T. harzianum* and *P. chlamydosporia* and 10^{10-13} CFUs of *P. fluorescens*/g formulation. The formulations were packed in commercial polypacks of 200, 500 and 1000 g. The manufacturing cost of 200 g biopesticide packet hardly comes Rs 10 and can be sold for less than Rs 50.

Effectiveness of the biopesticides @ 2g/kg seed was tested against wilt (*Fusarium* spp.), root-knot (*M. incognita*), and wilt disease complex (*Fusarium* spp. + *M. incognita*) on chickpea and pigeonpea under field conditions and cost benefit ratio was calculated. Application of Biowilt-X and Bionem-X satisfactorily managed fusarial wilt and root-knot diseases of chickpea and pigeonpea and gave a profit of Rs 6220-8140/ha against wilt and Rs 3180-4180/ha against root-knot. Treatment with Biocomp-X effectively managed wilt, root-knot and disease complex of both the legumes with a profit of Rs 3460-11980/ha. The bioagents also established in the soil and can confer a longer management of the target diseases caused by soil borne fungi and nematodes.

Comparative ecological behaviour of some pre- and post-Tsunami isolates of *Trichoderma harzianum* and *T. viride* from Andaman & Nicobar islands

Bhagat¹, Someshwar and Sitansu K. Pan, Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia -741252, West Bengal, India, **E-Mail:** skpan_06@redufmail.com

A comparative ecological study of some pre- and post-Tsunami isolates of *Trichoderma harzianum* and *T. viride* from Andaman and Nicobar Islands, India, was undertaken to assess the effects on some ecological behaviour of these biocontrol agents. The isolates, irrespective of the species, showed better parasitic ability and rhizosphere colonization when the competition of other organisms got withdrawn compared to natural and sun dried soil. Both competitive parasitic behaviour and rhizosphere colonization was low in post-Tsunami isolates of *Trichoderma*. The chlamydo-spore inoculum was found best in percentage colonization of sclerotia of both *R. solani* and *S. rolfsii*, followed by mycelial and conidial inoculum. The isolate Thr AN-5 (*T. harzianum*) was most efficient in parasitizing the sclerotia of *S. rolfsii* and *R. solani*, followed by Tv AN-3, TvAN-5 and ThrAN-7 (Pre-Tsunami isolates) whereas there was significant reduction in the parasitizing ability of post-Tsunami isolates. Similar results were also noted in their rhizosphere colonizing ability in rhizosphere of Bengal gram seedling. All isolates of *Trichoderma* showed insignificantly low competitive parasitic ability and rhizosphere colonization in Mohanpur (BCKV) soil as compared to Port Blair (CARI) soil.

Enhancement of antagonistic potential against *Macrophomina phaseolina* through chitin amendment in formulated biomass of *Trichoderma* spp.

A. Roy, N. Gurung and P.M. Bhattacharya, Department of Plant Pathology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India **E-mail :** pm_ubkv@yahoo.co.in

Species of *Trichoderma* are known to control a wide variety of soil borne plant pathogens including *Macrophomina phaseolina*, the principal incitant of *Macrophomina* disease complex in jute. Mass production technology for such fungi is still being fine tuned as emphasis is now being given to solve the problems of desiccation tolerance, shelf life, field performance and the same during production phase itself. An attempt was made to enhance the biocontrol ability of *Trichoderma* sp. against *M. phaseolina* by changing the nutritional environment with addition of chitin and to study their ability of survival in different formulations while conserving their performance as biocontrol agent. Variation was observed with respect to bio-efficacy of the isolates of *Trichoderma* spp. against *M. phaseolina*. On the basis of the inherent capacity as bio-control agents two isolates, namely, T_{Pun2} and T_{Mnp} were selected for further studies. Two isolates varied in inherent ability to produce chitinase enzyme in medium.

Competitive saprophytic ability of two isolates varied significantly and the same increased with chitin amendment. In both cases increased physiological efficiency to draw and utilize nutrient under limiting resource conditions was recorded. Shelf life was studied in pellet and talc preparations for both the isolates for about five months at room temperature in sealed containers. Although, the trend of population decline was similar for amended and non-amended preparations for respective isolates, the population was higher for the amended ones due probably to higher density of propagules at the initial stage. A sharp decline in viable population was noticed after 100 days in alginate prill preparation for both the isolates, whereas, in talc preparation the decline was significant after 45 days. Alginate prills with 1% chitin amendment was found to inhibit the pathogen more efficiently than other preparations after five months of storage.

Bio-ecology and feeding potential of *Agistemus fleschneri* Summers (Acari:Stigmaeidae) for integrated management of mite pests

Krishna Karmakar, All India Network Project on Agricultural Acarology, Directorate of Research, B. C. Krishi Viswavidyalaya, Kalyani-741235, Nadia, West Bengal, India, **E-mail:** acarikarmakar@rediffmail.com

The Stigmaeid mite, *Agistemus fleschneri* Summers is one of the most important predatory mite species observed as very effective bio-controlling agent in suppressing phytophagous mite species, *Polyphagotarsonemus latus* Banks in chilli, *Tetranychus urticae* Koch in cowpea and *Panonychus citri* (Koch) in mulberry ecosystem. Besides, it was also found to predate upon eggs and nymphs of white flies and mealy bug. Bio-ecology and feeding potential of *A. fleschneri* was studied under laboratory ambient condition at 28-31 °C and 75-80% relative humidity on these mite species. The egg incubation period of the predator was recorded 3.09 days and the larva, protonymph and the deutonymphal stages lasted for 1.2, 0.9 and 0.9 days respectively. The inactive quiescent stages viz., protochrysalis, deutochrysalis and teliochrysalis stages required for 0.8, 0.8 and 1.0 days respectively. Cumulative duration from egg to egg stage was computed 10.7 days. The female found to survive 41.5 days and laid an average of 73 eggs during its oviposition period with a maximum of 7 eggs per day. All the active stages of the predator were found to predate upon egg, larva and quiescent stage of *P. latus*, eggs and immature stages of *T. urticae* and *P. citri*. An adult female of *A. fleschneri* was observed to consume an average of 61.8, 23.4, and 31.5 eggs per day of *P. latus*, *T. urticae* and *P. citri* respectively. Therefore, *A. fleschneri* can be successfully employed as a bio-controlling agent in the integrated management of crops infested with *P. latus*, *T. urticae* or *P. citri*.

Bioinoculants, a vital tool for yield improvement and disease management of MAPs

Mansoor Alam, Abdul Sattar, Abdul Samad and Abdul-Khaliq,
Microbiology and Plant Pathology Division, Central Institute of Medicinal & Aromatic
Plants, Lucknow 2260 15, **E-mail:** email2alam@rediffmail.com

To maintain the productivity in our modern agriculture system, the crops infected by plant diseases are immediately protected through the use of chemical pesticides but the selective and highly effective chemicals pesticides are not a long-term answer to the crops, human beings and animals. Many serious agricultural problems including development of resistant strains of the pathogen, build up of harmful residues in the edible plants, non-target side effect of beneficial micro flora and environmental pollution etc. are being posed by their intensive and indiscriminate use. To avoid such problems attentions have been redirected towards the use of bioinoculants for improving yield and the management of pests and diseases.

It is well accepted and widely recognized fact that bioinoculants have a distinct possibility for the future and can be successfully exploited in modern agriculture system without affecting our precious ecosystem. In this paper, work on the use of bioinoculants to enhance productivity and disease management of some medicinal and aromatic plants is presented. They are effective only when they are applied under suitable and optimum conditions.

The bioinoculant used in the present investigations were all isolated from indigenous sources and were found to be highly antagonistic against the plant pathogens of medicinal and aromatic plants (MAPS) *in vitro* test. Some of them showed growth promotion activity. They were identified as strains of *Bacillus* sp., *Pseudomonas*, *Streptomyces* and *Trichoderma harzianum*. They have been used either alone or in different combinations along with different arbuscular mycorrhizae (*Glomus aggregatum*, *G. fasciculatum* *G. intraradices* *G. mosseae*) as potential bioinoculant for the yield improvement of geranium, pyrethrum and safed musli and protection from the attack of the diseases caused by fungal pathogens. The results would be presented and discussed.

***Beauveria bassiana* – a potential biocontrol agent for Rice Hispa (*Dicladispa armigera*) in Assam**

K. C. Puzari¹, *L.K Hazarika², Pranab Dutta³ and H. K. Deva Nath⁴,
Mycology Research Section, Department of Plant Pathology, *Department of Entomology, Assam Agricultural University, Jorhat 785013, Assam, India,
E-Mail: ¹kcpuzari@indiatimes.com, ²lkhazarika@yahoo.com

Rice is the most dominant staple food crop of India with an average yield 3034 kg/ha. More than 100 species of insects recorded as pests of rice are major constraints not only in increasing the productivity but also for sustaining it because of their repeated outbreak in different parts of the country. It is estimated that crop losses due to the pest attack range from 15-25% out of which rice hispa, *Dicladispa armigera* alone can cause 35-65% loss in yield, regarded as one of the major limiting factors in rice production in Assam causing 10% loss in post flooded conditions. Under outbreak situation failure of insecticides to control the pest led to an attempt for identification of mycoinsecticides against this pest and found *Beauveria bassiana* (Bals.) Vuill. a potential bio-agent out of several entomogenous fungi prevalent in the rice ecosystem. All the embryonic and post embryonic stages of the pest were observed to be infected by the fungus. Adults with frosty mycelial growth covered the entire body surfaces and hyphae emerged through the intersegmental sutures of lateral as well as ventral sides of thorax and abdomen, ultimately covering the whole body and appendages (antennae, mouth parts and legs). Infected eggs, larvae and pupae were covered by white fluffy mycelial growth. As the fungus enters into the laid eggs it ramifies inside by utilizing its contents. Study on laboratory and field level pathogenicity tests revealed that the infection percentage by the fungus was more than 90% on different postembryonic stages. The percentage of infection was comparatively lower under field conditions than in the laboratory. Larvae and pupae of *D. armigera* showed 98.98% and 94.33% mortality under laboratory inoculation. The fungus is virulent on adults in the range of 78-87% with LC 50 value 90.16 conidia/ml solution. It is also found to be compatible with several insecticides at their recommended and half of the recommended doses and with certain other chemicals viz., Sandovit, Triton-AE, Teepol 80 and toilet soap at a concentration of 10⁷ conidia/ml causing 74% 81%, 96% and 92% mortality, respectively. Mass production on rice hull: sawdust: rice bran (RH: SD: RB) medium + 2% dextrose can yield 39.33 x 10⁷ spores/ml. Increased virulence and faster multiplication of the fungus was obtained by addition of chitin obtained from various sources. Addition of 2% crustacean chitin on RH: SD: RB medium enhanced the growth rate and the time required to attain maximum growth (39.33 x 10⁷ conidia/gm of medium) of *B. bassiana* was 9.90 ± 1.12 days. An attempt was made to study the shelf life and possible loss of virulence in transportation and storage results, the virulence of the fungus have varied shelf life on three different shelved conditions, where temperature plays a major role. Chloropyrifos at half of the recommended dose along with *B. bassiana* can be recommended in controlling the pest. Compatible combination of *B. bassiana* (10⁶ spore/ml) was obtained in half of the recommended dose of chloropyrifos. This study proved the superiority of combined application of the entomopathogen and chloropyrifos to the commonly applied insecticides in decreasing the pest population with an increased yield of rice.

Regulatory mechanism for biopesticides : A key input for organic/sustainable agriculture

V. K. Dhingra, (Scientific Director), Biotox/Bio-organics International, New Delhi 29 (INDIA). **E-mail:** drvkd@hotmail.com

To meet the dual objective of safeguarding the interest of farming community at large for making available quality (safe, efficacious) input and promotion of the use of biopesticides as key input for organic/sustainable (safe, inexpensive, profitable and sensible) agriculture, Govt. of India, Dept. of Agriculture through Central Insecticide Board (CIB) has an effective regulatory mechanism for regulating the quality, production and sale of some biopesticides including botanicals such as Neem, BTK, *Trichoderma*, NPV Granulosis Virus (GV), *Beauveria bassiana*, *Verticillium lecanii*, *Metarrhizium anisopliae*, *Nomuraea rileyi*, *Pseudomonas fluorescens*, *Bacillus subtilis*, *Gliocladium* spp., *Hirsutella* spp.

The present communication discusses the various requirements for economical development and registration of biopesticides and addresses appropriate suggestions for rational regulatory requirements for biopesticide and other organic inputs.



From epidemiology to site-specific appropriate precision agriculture

Mrinal Kanti Dasgupta, Oikos, Simanta Palli, Santiniketan 731 235, WB, India, **E-mail:** oikos_santiniketan@rediffmail.com.

Epidemiology: Epidemiology is a conceptual extension and application of ecology. The term “pest” has been used comprehensively (*sensu* Dasgupta). The concept of disease triangle has been comprehensively expanded to an inverse truncated pyramid for an epidemic. Plant disease epidemiology has advanced as extension or critique of Vanderplank’s analytical epidemiology.

To argue against the dictum that “IPM was a tool without theory,” the author earlier proposed a unified analytical epidemiological theory of IPM.

Loss modelling and other epidemiological projections: We used both critical point and multiple point crop loss models for prediction, ranking, relations, components, partitioning, field application, etc Multiple regression analysis (MRA) is now a routine feature of epidemiological research. We innovatively used AUDPCs to determine component-wise loss due to *Aeginetia pedunculata* in sugarcane. Any mathematical and statistical assumptions and functions are biologically unreal and are accommodated them by courtesy. Mathematics and statistics should fit into biology and not vice versa. We may paraphrase Vanderplank: “Who’s afraid of biology?”

Synoptic analysis of complex field problems, and protocol to distinguish interaction from association between pests have been worked out. Ten types of ecological associations from postharvest pathogens have been identified.

Forecasting: It is linked to management for direct benefit to farmers. Botanical and synoptic predictions merely chronicle a given epidemic. Decision support system (DSS) has been done for LBP and apple scab. Decision rules for insect pests in dry and wet rice in Sriniketan by the Author and his team. Forecasting service in India has to be biologically well-founded, simple, agroecosystem-specific, realistic, and flexible, leaving room for supervisory judgement.

Appropriate diagnostics and advisory integrated nematode management system (ADAINMS): ADAINMS in West Bengal and Tripura is the first such attempt known to be done anywhere. Community analysis is the current trend in Indian nematology, but its purpose has been missed.

IPM to AIPM and beyond: The threshold-based IPM had its birth in ecological entomology and as synthetic epidemiology. The ETL, a concept based on damage coefficient applicable to individual injurious pests, is basic to IPM but limited in application. Absolute (but actually dynamic) or notional ETLs are utility notions. We comprehensively developed appropriate IPM (AIPM) across all circumstances AIPM selects out cropping sequence by varied efficiency analyses.

“IPM is no longer threshold-based,... but crop specific and location-specific” and “more of sociological research than technological.” So said Zadoks abck in 1993. We emphasized these even earlier in 1975). The technological research content is less because it addresses the management gap in productivity and popularity. The AIPM has thus come to stay, which is the “IPM” as conceived and practised now, using identical experimental designs, but sea-changed from the sophisticated technological IPM. Misconceptions and wrong methodologies do prevail.

Limit to integration: We sought to maximise integration of management options with six different components (also combinations, doses and methods) against the sunnhemp wilt (c.o. – *Fusarium udum* f. sp. *crotonariae*). Not more than 60% wilt reduction and avoidable loss of 15% fibre yield protection could be registered only when up to three tactics were combined. We examined our premise on the limit to integration, constructed a hypothesis on holistic health management for the biosphere. and defined its domain.

Precision Agriculture ~ for Whose Cause? – Precision Agriculture (PA) is as complicated as an IT-strengthened geo-informatics-referenced, agricultural management system, using molecular plant epidemiology, and pattern analyses of r-DNAs and population genetics). PA may be suitable for capital-intensive, high turnover economy under controlled management in a few hundred to a few thousand ha of technological monoculture. India is far behind PA thus conceived. Misconcepts about the PA are growing though!

Site-Specific Appropriate Precision Agriculture (SSAPA): From site-specific appropriate cropping systems management (SSACSM, SSAPA is proposed to infuse as much realisable precision into the unaided agriculture, including RS-generated data, thematic maps, and other determinations. NAINS and Agricultural Technology Management Association (ATMA) may operate with = one KVK per sub-agroecosystem and = one agrotechnologist to serve every Anchal Panchayet in every possible way.

An exploratory experiment on comparative nine rice- and vegetable-based cropping sequences, simultaneously analysed on six parameters, together with SSAPA, geo-informatics and agri-informatics, is in progress perhaps being the first venture of its kind in India to be reported in this Symposium.



Current biopesticidal strategies in modern crop production systems

O.M. Bambawale, National Centre for Integrated Pest Management, New Delhi, India, **E-Mail:** bambawale1@rediffmail.com

Integrated management strategies are designed to tackle some of the key pests which are not readily amenable to chemical pesticide way of management and here microbes offer a large array of alternatives/supplements and hope to our efforts in IPM.

We have been engrossed for a long time with 'bollworms' of cotton and now that we have got a breather through the Bt transgenics, can we now shift our focus on other major pressing pest problems? A large number of pests, be it insects, diseases or nematodes, are continuing to devastate some major cropping systems - a long list can be drawn, and all these urgently require solutions.

Even when we find that some microbial biocontrol options are working effectively, we can not promote them like insecticides to be routinely sold from a sales counter. We need to follow their proper use, ensure their proper quality and shelf life, and there are several other major issues to be resolved.

Since early nineties of the last century, a good number of entrepreneurs have entered into producing microbials and now the number stands at around 200. Since 2001, the microbials have come under the CIB pesticide registration act and we now have a little more than 100 registered products of *Trichoderma*, around 50 of *Pseudomonas fluorescens*, a few of NPVs and other insect pathogens. It can be said that only around 10% of these production units have good facility with regard to fermentation equipment, trained staff including qualified microbiologists, sufficient space for each operation, rolling capital and enough buffering capacity. They are providing high standard quality products, though there is a good scope for further improvement. The rest of the 90% of the biopesticide enterprises are mostly 'one-man-shows' which look mostly at short term gains. They lack proper infrastructure and often end up with contamination of their nucleus culture obtained from public institutes.

These two types of set ups have some major problems :— In general, these lack R & D facility. A strain or culture is obtained from some public sector institute/ foreign laboratory and the production starts. Even without evaluation against the target pest (pathogens, insects, nematodes) the label claim says that it can manage several different insects/diseases, etc. It can be easily proven that their exists a high level of specificity and examples are given in this presentation with respect to *Beauveria bassiana*, *P. fluorescens*, *Trichoderma* spp. etc. It has been found that even a pathogen like *Fusarium ciceri* on chick pea is antagonistic to several isolates of *Trichoderma*. Another problem facing this industry is marketing. Several issues are involved, but primarily the industry does not know where to focus their efforts, in which crop and in which geographical location. They also lack the aggressiveness of the chemical pesticide industry, because they are not confident about the performance of their product. In subsistence farming of pigeon pea/chickpea, even though the industry is product-confident, the resource poor farmers can ill-afford

the cost.

To make this crucial biopesticide sector viable in the long run, urgent obvious steps are required :

- We have a very weak pest monitoring system, almost nonexistent for various crops. The epidemics appear and pass by but we hardly have any history of authentic records; the endemic pests continue to devastate crops and enlarge their areas year after year often crossing geographical state boundaries. Survey and surveillance needs to be strengthened to identify hot spots.
- One issue where some efforts are being made is the review of registration requirements of biopesticides and upward revision of quality standards. For example, the quality standard of *Trichoderma* are very low, 2×10^6 cfus/g of product, which needs to be at least 100 times higher. Similar upward revision is necessary for *P. fluorescens*.
- We need to develop tailor made strains of microbes for specific pest problems. CIB registration is a cumbersome process, which is costly for each product registered, including the generation of toxicological data shelf life, bio-efficacy etc. and further obstacle of human interference by way of middle men involved. The need is to relax registration requirements for different isolates of the same microbe so that suitable label claims can be generated.
- A good infrastructure for quality check by public institutes and supply chain for nucleus cultures and sale needs to be established.
- Stable ecosystems like that those of orchards/plantation crops and subsistence farming such as pulses and chick pea need to be supported on war-footing through developing the missions on project mode.
- Secrecy of production protocols is common to both the large and small scale / cottage industries. But they need to make their procedures amenable to the public sector scientists' scrutiny so that any serious lapses can be rectified or simple improvements suggested in the protocols can substantially improve the output.
- Contract farming would offer the right opportunity in implementing the IPM of several crops/fruits where biopesticides would be the most crucial and efficient input.
- The synergies between Ministry of Agri., CIPMCs, State Agri. Deptts., SAUs and ICAR Institutes, private biopesticide industries, KVKs, NGOs etc. need to be developed to attain the overall goal of promotion of use of biopesticide in the country.



Role of All India Coordinated Research Project (Nematodes) for developing nematode management technologies

R.K. Jain & R.V. Singh, AICRP (Nematodes), Division of Nematology IARI, New Delhi -110012, India. **E-mail:** rameshjain1952@yahoo.co.in

The awareness about nematodes as one of the constraints in successful crop cultivation has been felt in the recent past. The All India Coordinated Research Project (AICRP) on Nematodes was started in 1977 with objectives to carry out studies on nematode problems of different crops in different agro-climatic zones of the country and to work out the cost effective eco-friendly integrated nematode management technologies against economically important nematode pests. The studies carried out by different cooperating centres under aegis of AICRP (Nematodes) for generated information on effect of these noxious nematode pests on crop yield from identified host spots during 2001-04. The national loss due to plant parasitic nematodes in 24 different crops in monetary terms has been estimated to the extent of Rs.21,068.73 millions which needs due attention for working out the cost effective nematode management technologies for reducing the yield losses caused by them.

In order to minimize the adverse affects of increasing nematode populations on crop plants and also to work out various nematode management strategies viz. physical, mechanical, cultural, judicious use of chemicals, bioagents and integrated nematode management technologies for enhancing crop production were evaluated and recommended. Once the nematode population are established in the field, eradication is neither practical nor desired. So, strategies have to be developed to live with the nematodes and manage their populations below threshold levels by using practically feasible economically viable and eco-friendly approaches. The selection of nematode management options largely depends on nematode biology, host crop, initial nematode population in the field, their means of dissemination, survival and economical relationships.

Under the aegis of AICRP (Nematodes) low cost eco-friendly and practically feasible integrated nematode management technologies have been developed and demonstrated by different cooperating centres of AICRP (Nematodes) against economically important nematode populations at farmers' field. A number of such technologies have been included in the package of practices of different State Agricultural Universities for adoption by the farmers in the nematode affected areas. The rice root nematode, *Meloidogyne graminicola* and rice root nematode (*Hirschmanniella* spp.) can be managed by treatment of nursery beds with carbofuran @ 0.1 g a.i./m² and field application of carbofuran @ 1 kg a.i./ha 40 days after transplanting. Soil solarization of nursery beds area using a thin transparent polyethylene sheets 50-100 um thickness for 2-4 weeks in summer and application of carbofuran @ 0.3 g a.i./m² before sowing could provide nematode free seedlings of transplanted crop like vegetables, fruits, ornamental etc. which could perform better in field and reduced the spread of nematodes. Deep summer ploughings in States having hot and dry summers has helped in reducing the infestation of root-knot nematodes, cereal cyst nematodes and other plant parasitic nematodes.

Management of cereal cyst nematodes infecting wheat and barley by practising crop rotations with mustard, coriander, garlic etc. led to reductions in the populations of cereal cyst nematodes. Methods have been developed for reducing the cost and dose of nematicides. Nursery bed treatment with carbofuran @ 0.3 g a.i./m² + bare root dip treatment of seedlings at transplanting with emulsifiable carbosulfan (25 EC) @ 500 ppm, protected transplanted vegetables like tomato, brinjal, chilli and pointedgourd etc. against root knot nematodes. Seed dressing of direct seeded crop with carbosulfan (25 SD) @ 3% a.i. w/w in mungbean, cowpea, black gram, okra and cucurbits etc. reduced the attack of root knot, reniform and lesion nematodes. Use of organic amendments including neem and castor cakes @ 1 t/ha and their combinations with seed treatment with carbosulfan (25 DS) @ 3% w/w has been found to reduce root-knot nematode damage in vegetables and groundnut. Paring and hot water treatment of banana suckers at 55°C for 20 minutes combined with application of neem cake or carbofuran in the pit @ 16.6 g before planting was effective against root knot and burrowing nematodes. Use of neem cake @ 100 kg/ha + neem oil @ 500 litre/ha and carbofuran @ 1 kg. a.i. /ha has been found to effectively control root-knot nematode infecting groundnut. Among various bio-agents tested, seed treatment with *Pseudomonas flourescens* + *Trichoderma viride* each @ 5 g/kg seed was found most effective for the management of reniform nematode, *Rotylenchulus reniformis* infecting cowpea. For effective management of *M. graminicola* infecting rice under organic farming system, neem cake @ 100 g/m² or *Trichoderma viride* @ 20 g/m² or neem seed kernel powder (10% w/w) or *Pseudomonas flourescens* @ 20 g/m² were effective. In future emphasis will be laid on to further develop cost-effective integrated nematode management technologies for different cropping systems under different agro-climatic zones of the country and also for organic farming systems.



Exploitation of slow disease development traits for Integrated Disease Management

Ramesh Chand, Department of Mycology and Plant Pathology, Institute of Agricultural Sciences, Banars Hindu University Varanasi 221005, India, **E-mail:** rc_vns@yahoo.co.in/rchandbhu@gmail.com

Although most crop plants lack major gene resistance, certain genotypes are known to retard growth and reproduction of plant pathogens for a substantial period and display lower disease severity. Existing knowledge related to slow disease development is inadequate and therefore this trait is least exploited in many crop plants. Traits responsible for slow disease development are known to be component based and highly heritable with the genes regulating the slow disease development being limited to two, three or four in most cases. Knowledge of these major components contributing to slow disease development would help plant breeders select for yield traits with slow disease components from a segregating population. These additive genes are generally scattered in different genotypic back grounds and if pyramided together are known to increase host resistance by many folds. The protection conferred upon the crop plants by slow disease development traits are equivalent

to that of two/ three chemical sprays. It is also known to increase plant height, total biomass and test weight of grain in wheat and pea. Recently, in wheat, many such components have been brought together to fight rust and the effect was similar to that of major genes. A simple strategy has been developed to enhance the frequency of slow disease components in the plant population. These components have been tested over time and space and found to be durable. Monitoring of the pathogen population and selection for aggressiveness has revealed that selection in the pathogen population is very slow and newly resistant cultivars would be effective for at least the next 10 years. However, this process can be accelerated manifold by marker added selection as in the case of wheat using Ltn markers. Molecular markers provide an added advantage for the pyramiding slow disease components under one common head.



Forecasting models for major diseases and aphid of oilseed *Brassic*as in India for ecofriendly crop health management

C. Chattopadhyay¹*, R. Agrawal², A. Kumar², B.K. Bhattacharya³, P.D. Meena¹, V. Kumar¹, S.A. Khan⁴, I.

Bhattacharya⁴ and S. Jha⁴, ¹National Research Centre on Rapeseed-Mustard (ICAR), Sewar, Bharatpur 321303; ²IASRI, New Delhi 110012, ³SAC, ISRO, Ahmedabad 380015, ⁴BCKV, Mohanpur- 741252, India, **E-mail:** chirantan_cha@hotmail.com.

Rapeseed-Mustard are among the major oilseed crops cultivated in India and around the world. Out of 48.6 mt of rapeseed-mustard seed produced over 27.3 mha in the world, India produces 6.7 mt from 6.3 mha. *Alternaria* blight (*Alternaria brassicae*), white rust (*Albugo candida*) and powdery mildew (*Erysiphe cruciferarum*) diseases infecting all above-ground parts of the plant are considered important constraints in husbandry of oilseed brassicas in India. Though total destruction of the crop due to the diseases is rare, they can reach up to 47%. *Sclerotinia* rot (*Sclerotinia sclerotiorum*) has become important on the crop in recent times causing up to 40% losses in mustard (*Brassica juncea*). Aphid (*Lipaphis erysimi*) is also known to cause up to 83% yield losses in mustard. Severity of the diseases and aphid on oilseed Brassicas differs among seasons and regions as also between individual crops within a region in India. In the absence of stable, desirable and diverse source of resistance to the mustard diseases and aphid, chemical pesticides have so long been the only effective means to manage the diseases or aphid; timing application of the pesticides has not been optimal while crops requiring treatment have been left unsprayed at appropriate time and others sprayed unnecessarily. Hence, the present study was undertaken to attempt forecasting crop age at time of first appearance of the diseases or aphid or pinpoint the combination of weather and crop growth stage that trigger initial infection when inoculum or aphid is not limiting, peak severity of the diseases or aphid on the crop in the season and crop-age at peak severity of the diseases or aphid.

In recent years, an increasing consciousness about environmental pollution due to

pesticides and development of pesticide resistant strains in pests has challenged plant protectionists to search for ecofriendly tools for disease management. Earlier workers reported management of oilseed brassica diseases by chemical pesticides. However, no effort was made to use plant extracts as 'ecofriendly' components for effective management of such diseases. We report identification of an effective plant extract for biomanagement of major diseases and aphid of mustard in India.

Experiments were laid out at Bharatpur, Mohanpur, Pantnagar, Kangra, S.K. Nagar, Berhampur, Dholi, New Delhi and Faizabad with oilseed *Brassica cvs* 'Varuna' and an important one in the locality sown on 10 dates at weekly intervals during 1999-2006. First appearance of the major diseases on leaves and pods of respective crops apart from aphid on 10 cm main shoot were recorded, their highest frequencies identified. Severity of different diseases on leaves and pods of different crops as also of aphid were correlated with different weather parameters. Published data on aphid infestation in mustard for Hisar, Ludhiana, Berhampore and Pantnagar was also used for devising the models. Regional and cultivar specific models devised through step-wise regression could forecast, at a few weeks after sowing, the crop age at which different diseases first appeared on the leaves, pods, the highest disease severity on leaves, pods and the crop age at peak disease severity on leaves, pods at least one week ahead of first appearance of the disease or aphid on the crop. Models were made user-friendly by PC-based software on visual basic. This allows growers to undertake timely need-based pesticidal sprays. Only those models that were found effective on validation are reported.

Predicting aphid growth in oilseed *Brassica* using near-surface meteorological data from Advanced Very High Resolution Radiometer TIROS (Television and InfraRed Operational Satellites) Operational Vertical Sounder at National Oceanic and Atmospheric Administration Satellite was also attempted. Characterizing mustard Sclerotinia rot infestation using Moderate Resolution Imaging Spectroradiometer geophysical products and spectral discrimination through hyperion hyperspectral data was done.

Garlic (*Allium sativum*) bulb aqueous extract (1% w/v) application based on forecast of the aforesaid parameters of the diseases or aphid location-wise and possible yield losses provides holistic eco-friendly protection technology for oilseed *Brassica* crop management.

New horizons in weed management

S.K. Mukhopadhyay, Retd. Professor Agronomy, Arko, Passin Pall;, Santiniketan-731235.

Weed control became following the age-old traditional hand weeding so commonly practiced by Indian Farmers. The use of chemical toxophores called herbicides engulfed. The market and weed management scenario. The antecedent problems of excessive herbicide use became apparcut from eashy to and alternative safe approaches and integrated approaches became the order of the—.

The first of this appeared in the horizon as a zero tillage approach to weed management came the zero till drill for rice and zero till approach was extensively adopted in the new millennium. Variations of techniques came in vogue in China and Indonesia.

This approach was followed by the biotechnological approach to weed management through incorporatory herbicide resistance gene in host crops so that they tolerated more herbicides. Manson tom Dupont and Americans Cynamide were pioneer to this approach. Bioherbicides were being tested but were not very efficient. Genetically engineered microbes were also very attractive.

Finally came the procaine farming, remote sensing, GIS and GPS systems of nanosenors for tracking and managing weeds in a large form. Some these tools will be discussed in this precaution.

Beyond IPM and farmer field schools (ffs): a journey from pest management to sustainable livelihoods

Goswami¹ R., S. N. Das², M. Ghosh³, N. Ali¹, ¹Lecturer, IRDM Faculty Centre, Ramakrishna Mission Vivekananda University, **E-mail:** goswamirupak@rediffmail.com, nasimali2004@rediffmail.com. ²Senior Lecturer, State Agricultural Management & Extension Training Institute (SAMETI) and Agricultural Training Centre (ATC), Ramakrishna Mission, Narendrapur, ³Principal, Agricultural Training Centre, Ramakrishna Mission, Narendrapur. **E-mail:** atcrkmnd@vsnl.net, atcrkmnd@gmail.com

To many scientists and researchers, IPM is just about pests, which ruefully overlooks the important role IPM can play in human resource development, where pest management is used as naturally important entry points to an overall developmental intervention. That is why meaningful selection of menu of IPM options is largely defined by a gamut of agro ecological, socioeconomic, and institutional factors. The most significant and archetypal response by the large-scale organized extension to IPM has been Farmer Field Schools, which address the challenge of ecological heterogeneity and location specificity in pest management by supporting ecologically informed decision-making by farmers. FFSS have spread rapidly to many continents since their first introduction in 1989 in Indonesia to combat brown plant hoppers in

irrigated rice. As the concept has spread, it has been adapted for a wide range of crops; its curricula and learning processes also have been developed for the livestock sector, for land productivity issues, for a range of social and health issues, and environmental issues. But now, the lessons emerging from IPM Farmers Field School implementation over the past decade - with view of the scaling up problem - argues for a sustained effort combining elements of technological development, adult education, local organisation, alliance building, and advocacy. The long-term development of a sustainable small-scale agriculture also requires strong farmer groups with linkages among these groups and with the wider community. This longer-term process has been identified as Community IPM, which is a strategic approach the goal of which is to institutionalise IPM at the community level. Like the "sustainable livelihoods" approaches that have been gaining attention, Community IPM has started assuming that all rural people have assets, even the poor. In this analysis assets can be described in terms of five categories of "capital": natural, human, social, physical and financial. Within a Community IPM programme participatory approaches are now being used to transform a range of assets into a number of livelihood outcomes. With this backdrop, the present paper starts off with the history of changing response of extension to IPM with special reference to the FFS. The changing trend and present status of FFS functioning are then described at length with experiences drawn from all over the world. The paper then introduces the concept of sustainable livelihoods framework and tries to incorporate the FFS functioning within it. The concluding part suggests lessons for extension agencies – both private and public – within the Indian context.



Integrated management of diseases and pests in mulberry sericulture – present scenario and future strategies

A. K. Bajpai, Central Sericultural Research & Training Institute,
Berhampore – 742 101, W.B., India, **E-mail:** akbjp@redifmail.com

Sericulture is an agro-based cottage industry, employing millions of rural people in India. Mulberry cultivation and silkworm rearing are two important components of the industry. Mulberry (*Morus* spp.) the sole food plant of silkworm (*Bombyx mori* L) is affected by several diseases and pests throughout the year. Disease and pest infestation impairs mulberry leaf yield and greatly reduce nutritive value. Feeding of infested leaves to silkworm reduces cocoon yield and quality. Silkworm is also vulnerable to various diseases and pest. Leaf and cocoon yield loss due to diseases and pests in general ranges between 10 and 24% in mulberry and 5 and 10% in silkworm occasionally complete crop loss. To minimize disease and pest induced crop loss of mulberry and silkworm, effective management practices involving cultural/mechanical, chemical, botanical, biological measures have been developed. To forewarn farmers community well in advance to take up timely control measures and to minimize crop loss, weather based forecasting models have also been developed. Farmer's dependence on chemical pesticides to get quick management of diseases and pests leads to threat on sustainability of the industry. As the management of

diseases and pests is not possible through only one approach, in recent years efforts were taken to reduce the effect of chemical pesticides on environment, rationalize the use and simultaneously manage diseases more effectively through integration of variety of control measures to give stable and long term disease control without any adverse effect on the environment. This paper discusses mulberry and silkworm diseases and pests especially of Eastern and Northeastern India and their management practices, future strategies for development of effective, affordable, eco-friendly approaches of integrated disease and pest management of mulberry and silkworm as well.



Area-wide management for greater efficacy in fruit fly control in fruit orchards (mango & guava)

Abraham Verghese, John M Stonehouse* and John Mumford*, Indian Institute of Horticultural Research (IIHR), Hesserghatta Lake PO., Bangalore 560089, Karnataka, India,

*Imperial College London, Silwood Park, Ascot, Berkshire SL5 7PY, UK,

E-mail: avergis@ihr.ernet.in.

Fruit flies (Diptera: Tephritidae) are serious pests of horticultural crops all over the world. Fruit fly research in some parts of the world focuses on the quarantine risk that the alien species may pose and the means of eradicating outbreaks if they occur. However, in South Asia, a major concern is the optimum control of fruit fly pest species [mainly *Bactrocera dorsalis* Hendel and *B. cucurbitae* Coq. using integrated pest management (IPM)]. The control of fruit flies is particularly difficult on small orchard and vegetable plots because of the constant immigration of flies from nearby areas. Fruit fly IPM in India, as in most parts of the world, requires an area-wide approach; organizing groups of growers to reduce the overall fly population in the respective area. Well-organized fruit and vegetable growers can achieve high levels of control with practices that are safe to them and the consumers of their produce, and thus good yields of healthy commodity and consequently high prices. The principle of area-wide control raises innumerable practical issues that must be resolved through research, along with these techniques being demonstrated to grower groups, who will take up appropriate measures with a commitment towards working together to reduce pestilence in their crops.

Studies were carried out under the Integrated Management of Fruit Flies in India [IMFFI], a project conducted by ICAR- DFID (UK) during 2002-2005. IMFFI research was directed at two main goals. The first was the optimization of on-farm management for a variety of crops and climatic and economic conditions. The second was the quantification of the added returns which may be possible when flies are managed cooperatively at village level. Broadly the studies have shown that low-cost fruit fly controls are possible using lures [methyl eugenol and cue lure] as male annihilation technique [MAT], with or without bait application technique [BAT], together with cultural methods. It has also been found that area wide control as opposed to small field controls give greater efficiency of control. This

paper deals with the latter aspect especially with respect to *B. dorsalis*. The overall study helped in arriving at the following IPM for mango.

A. "Bait Application Technique (BAT)"

- Spray liquid of 0.1% insecticide + 10% jaggery or 10% pulped ripe banana in water

- Applied in spots of 40ml at a rate of 200spots/Ha (approximately 8L/Ha)

- Applied to the undersides of leaves

- Applied with sprayers or with a fine brush to coat leaf surfaces smoothly

B. "Male Annihilation Technique (MAT)"

- 5x5cm squares of plywood of approximately 1.2cm thickness

- *Soaked for 48 hr in a solution of 6: 4: 1 V:V:V ethanol:methyl eugenol: malathion

- Nailed or hung in traps, at a density of 10/Ha, within 2m from ground

[* At IIHR it was found that soaking can be dispensed with by application of one ml of methyl eugenol on ply wood 1.5 x 1x 3 blocks with an ink filler, if kept in bottle traps

C. "Cultural control" comprises of fallen fruit collection and destruction

All fallen fruit collected weekly, starting when fruit start maturing (45 days prior to harvest)

1 Fruit removed from the orchard should be buried or destroyed, and not left exposed.

At IIHR a pre-harvest IPM consisting of the following has been standardized:

Sanitation (weekly removal of fallen fruits, starting 45 days prior to harvest);

Under-tree raking, at least once or twice, towards harvest;

Male annihilation technique @ 4 methyl eugenol traps/acre If infestation is serious, a cover spray of Deltamethrin 0.0014% + Azadirachtin 0.03% 2ml/l – 21 days prior to harvest (if needed) gives excellent control of *B. dorsalis* in mango.

In guava, sanitation + MAT are sufficient.

Area-wide: Area-wide implies a cooperative act of the above pre-harvest IPM application over larger tracts (contiguous) as opposed to single farm applications.

Merits of area-wide management:

i) Area-wide is better suited for flying insects like fruit flies.

ii) It is a cheaper substitute for area-wide sterile insect release, e.g. Control of *Ceratitis* sp.

Factors affecting area-wide control:

i) Perception of seriousness by farmers; loss due to fruit fly, value of crop

Social cohesion caste/class etc.,

ii) Role of unifying social codes (an influential politician)

iii) Formation of cooperative cultivation shared economy.

In conclusion, area-wide control has been found to be very cost effective and useful in fruit fly management especially in mango as against management at only farm levels. In India it should be developed on the same lines as sterile insect release methods elsewhere abroad.

Effect of biopesticides in the suppression of major insect pests and yield of oilseed crops under different climatic conditions in Bangladesh

Nesar Ahmed Khandker, BCSIR Laboratories, Dhaka, Qudrat-E- Khuda Road, Dhanmondi, Dhaka-1205, Bangladesh, **E-mail:** khandkerahmed@yahoo.com

Plant protection through biopesticide (plant based potential extracts, introduction of beneficial insect parasites and predators etc.) has explored a new horizon of insect pest management due to health hazards and environmental pollution resulting from use of chemical pesticides. The oilseed crops under study period were sunflower, sesame, soybean, rapeseed, groundnut and linseed. The oilseeds cultivation centers were located in western zone, BCSIR Lab Oilseeds Cultivation Centre and northern zone, Patgram Oilseeds Cultivation Centre, Lalmonirhat district, Bangladesh. To get rid of the insect pest attack on oilseed crops, 10 % of ten different kinds of insecticidal plant extracts were sprayed on test oilseed crops i.e., Barabishkatali (*Polygonum orientale*), Bishkatali (*P. hydropiper*), custard apple (*Annona squamosa*), tobacco (*Nicotiana tabacum*) leaf extracts, Neem (*Melia azadirachta*) seed oil, a mixture of Neem seed oil and sesame oil, sesame (*Sesamum indicum*) oil, castor (*Ricinus communis*), wheat (*Triticum aestivum*) and spices preparation (dry pepper, garlic and ginger).

The insect pests that severely attacked sunflower (variety- Kirani) foliage and the capitulum (inflorescence) were *Epilachna* sp., *Micraspis discolor* (F.), *Spilosoma obliqua* (Walker), *Heliothis armigera* (Hb.) and *E. septima* Dike. The treatment of the mixture of Neem seed oil and sesame oil exhibited the most effective result in controlling the pests of sunflower and its maximum yield was 480 kg per acre in BCSIR Lab Centre, Rajshahi. The major insect pests on soybean crop were the leaf roller (*Sylepta derogata*), white spotted beetle (*Monolepta signata*), pentatomid bug (*Nezara viridula*) and blue butterfly (*Euchrysops cnejas*). Least pest attack was observed in the spray of tobacco leaf extract. The maximum yield was 1470 kg per acre in BCSIR Lab Centre. The insect pests on sesame (variety- Jamalpur) were *Nezara viridula*, *S. obliqua*, *Dolycoris indicus*, *Dysdercus koenigii* and some unidentified coleopteran beetles and hemipteran bugs. Custard apple leaf extract spray showed the best result and the maximum yield was 858 kg per acre in Patgram Oilseed Centre. In rapeseed (variety-Tori-7), three spray materials e.g., Bishkatali leaf extract, spices preparation and wheat flour preparation were applied. Spices preparation produced good control. The major pests observed were *Lipaphis erysimi*, *H. armigera* and an unidentified black noctuid caterpillar. The aphid population and the noctuid caterpillar caused enormous damage to brassica crop and yield was greatly reduced. During the crop season, some beneficial coccinellid predators i.e., *Coccinella septempunctata* and *C. transversalis* were found in plenty which suppressed the aphid population considerably. The maximum yield was 660 kg per acre in BCSIR Oilseed Centre. In the groundnut (variety- Dhaka 1) field, spray of a mixture of Neem seed oil and sesame oil produced the best result. In fact, no need of botanical spray had arisen because of the major pest of groundnut, *Aphis craccivora* Koch. was effectively controlled by existing coccinellid predators viz., *C. septempunctata*, *C. transversalis* and *Brumoides suturalis* and *Scymnus fuscatus*

Boheman. The maximum yield of groundnut was 1020 kg in BCSIR Lab Centre. In pre-harvest condition, linseed was not damaged by serious insect pests. The minor pests encountered were *M. signata* which damaged the foliage. The aforesaid coccinellid beetles were observed in enormous numbers and perhaps helped in successful pollination. Sesame oil extract showed maximum yield and it was 164 kg per acre in BCSIR Lab Centre, Rajshahi.

Weather based forewarning of gram pod borer, *Helicoverpa armigera* (Hub.) in pulse crop based agro-ecosystems of India

D. K. Das and A. Dhandapani, National Centre for Integrated Pest Management, LBS Building, IARI Campus, New Delhi – 110012, **E-mail** : debkumar_das@yahoo.com

Monitoring and forewarning of the pests are pre-requisites for any Integrated Pest Management (IPM) programme. These reduce the amount of pest management inputs and the cost of plant protection by giving the prior intimation regarding whether certain pest will come or not; if it comes, time of initiation, peak value of population, time of reaching peak value and estimated loss of yield. Weather and climate play important roles in outbreak, establishment and spread of most of the insect pests and diseases.

Gram Pod Borer, *Helicoverpa armigera* (Hub.) is one of the most dangerous insect pest in the world which attacks and devastates around 180 plant species including many cultivated ones. Bengal gram/ chickpea (*Cicer arietinum* L.) and red gram/ pigeon pea (*Cajanus Cajan* Millsp.) are two most important pulse crops cultivated in India and get infested by *Helicoverpa armigera* every year. But the level of infestation varies from place to place and year to year. In the present study, data on the pest infestation/ damage along with weather parameters have been collected from different locations of the country. Simple thumb rules/ predictions and statistical models have been developed and validated.

A thumb rule has been developed using the pest population (male moth catch by pheromone traps) and monthly rainfall data collected during 1983-1995 at ICRISAT, Hyderabad . Deficit rainfall during monsoon and excess rainfall during November are found to be congenial for outbreak of *H. armigera* during winter months on pigeon pea and chickpea in any year. The same thumb rule has been fine tuned to validate the damage on pigeon pea at Gulbarga district of Karnataka. Out of 13 years, it has predicted the damage correctly for 11 years. Zilla Parishad, Gulbarga has adopted it and is giving *Helicoverpa* forewarning on pigeon pea using this rule from 2004 onwards.

In North India, studies have been conducted at Punjab (Ludhiana) in cotton-chickpea based system using similar type of pheromone trap catch data and weather parameters of 1991-1996. Regression models have been developed. It has been found that the peak population on chickpea during March- April is depended on base population of previous months, minimum temperature and afternoon relative humidity of February. Similarly, *Helicoverpa* population of Central (Kanpur) to western (Modipuram) Uttar

pradesh during chickpea season (March-April) from 2000-2006 has been found to be depended on base population, temperature and rainfall during previous January and February.

Efficacy of some disease management practices against bacterial wilt of potato in red and lateritic region of West Bengal

Partha Pratim Ghosh and Mandal N C, Department of Plant Protection, Visva-Bharati Sriniketan – 731236. **E-mail:** ppghosh_santiniketan@rediffmail.com

Bacterial wilt (c.o. *Ralstonia solanacearum* (Smith) Yabuuchi *et al.*) is one of the threatening diseases of potato (*Solanum tuberosum* L.). To study the Integrated Disease Management practices in potato and their impact, an investigation was conducted in a loamy sand in texture with medium fertility status and slightly acidic soil (pH 5.62) in a RBD with three replication and seven treatments including whole tuber planting, (i), minimum routine practice (ii), supervised management, (iii) maximum routine practice, (iv) govt. package of practice, (v) farmers' practice. Seed treatment with organomercurials, streptomycin and carbendazim failed to eradicate bacterial infection and protect the plants up to 40 DAP suggests infection may have originated from soil through partially suberized tubers. In treatments of minimum routine practice and maximum routine practice the pathogen invades easily perhaps due to application of BIOVITA during seed piece tuber treatments which might predisposed the host, or scavenging effect of streptomycin or induced bacterial multiplication. It is interesting to note in supervised management, banding with cow dung manure : oil cake : SSP : MOP (20:5:3:1) at 41 DAP and 1% bleaching powder drenching with out removal of affected plant(s) were found to be effective to contain the disease. These investigations revealed that among different disease management modules, whole tuber planting and supervised management with well decomposed cow dung at land preparation, seed piece treatment with carbendazim + streptomycin and eradicated bleaching powder drenching along with eradicated banding with cow dung manure, oil cake, SSP and MOP (20:5:3:1) were the best treatment in terms of their responses to yield, disease management and higher return per rupee investment. Thus farmers may be recommended either whole tuber planting or supervised management. Since, IDM is dynamic in nature, obviously it offers scope for future modification.

Incidence pattern of pulse aphid (*Aphis craccivora* Koch) and its natural enemies on greengram in lower gangetic plains of West Bengal

Amitava Banerjee and B. Bandyopadhyay, Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur – 741252, Nadia, West Bengal, **E-mail:** amitava_ecoento@rediffmail.com

Keeping in view the role played by natural enemies in suppression of insect pest population, an experiment was conducted to study the incidence pattern of both aphid (*Aphis craccivora* Koch) and its natural enemies as well as the prey predator function on five varieties of greengram in two different seasons during 2003-04 and 2004-05. The results revealed that aphid is cohabited with three of its predators – two coccinellids, *Coccinella septempunctata* Linn. and *Cheilomenes sexmaculata* (Fabr.), and an unidentified syrphid species. During *prekharif* season, aphid, which appeared on the crop by about middle of April in both the years showed increase in population generally upto about middle of May. Among the predators, syrphid appeared simultaneously with aphid but its population declined rapidly much earlier attaining peak during first week of May in first year and fourth week of June in second year of the investigation. *Cheilomenes* occurred during first three weeks and *Coccinella* for last two weeks of the occurrence of aphid on the crop. However, during *kharif* seasons the association pattern of predatory groups/ species varied during the two years of investigations. In the first year, *Cheilomenes* appeared earlier than aphid, followed the incidence pattern of aphid reaching peak population during fourth week of October and gradually declined to disappear during the first week of November. However, *Coccinella* and syrphid appeared simultaneously with the appearance of aphid. In second year, aphid made its appearance in early third week of October and peak population was attained in the next week with an exception in case of variety K-851 where the peak was observed a week later, followed by gradual decline during next two weeks. Highest incidence of the syrphid and *Cheilomenes* coincided with peak of population occurrence of aphid. But, syrphid appeared a week earlier than that of aphid, while the two coccinellids appeared simultaneously with aphid.

Serological changes associated with induction of resistance in soybean plants following treatment with phytoalexin inducers

A.K.Chowdhury, P.Mitra and B.N.Chakraborty*, Department of Plant Pathology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbeahar, West Bengal, PIN: 736165, *Dean, Faculty of Sciences, University of North Bengal, Rajarammohanpur, Darjeeling, West Bengal, India, **E-mail:** apurba1996@yahoo.co.in

Sclerotium rolfsii Sacc., a soil borne pathogen of very aggressive nature, causes considerable damage to soybean as Sclerotium blight or southern blight of soybean. The disease is very difficult to control by conventional fungicides and no soybean variety resistant to *Sclerotium rolfsii* is known. An attempt was made to induce resistance against the pathogen by non-conventional phytoalexin inducer chemicals.

For this purpose, eight metal salts, three growth regulators and one biological compound were used in non-toxic concentrations. Of these, cupric chloride and ferric chloride effectively reduced disease intensity. The induced resistance was correlated with accumulation of phytoalexin, glyceollin in treated plants. Results revealed that treatment with cupric chloride and ferric chloride induced a high level of glyceollin (485 µg/g and 332 µg/g fresh weight) production following challenge inoculation with the pathogen in comparison to untreated inoculated plants (190 µg/g fresh weight). Alteration in antigenic patterns after chemical induction of resistance in susceptible plants was detected using immunodiffusion and immunoelectrophoretic tests. It was observed that strong precipitin reactions occurred when antiserum of *S. rolfii* reacted against its own antigens as well as root antigens of untreated susceptible plants but antigens of treated plants showed no precipitin reaction. Reciprocal cross reaction between antiserum of treated roots and the pathogen antigens also failed to develop even weak precipitin bands. The cellular location of cross reactive antigens (CRA) shared by soybean and *S. rolfii* using fluorescein isothiocyanate (FITC) was also determined.

Tospoviruses and their vectors in India

N. K. Krishna Kumar, R. Asokan*, H. R. Ranganath and Vikas Kumar,
Division of Entomology & Nematology, *Division of Biotechnology, Indian Institute of Horticultural Research (IIHR), Hessaraghatta Lake (PO), Bangalore – 560 089, India
E-mail: nkkumar@iihr.ernet.in

One group of viruses that have emerged as important in the recent past in limiting the crop production is the tospoviruses (Tomato Spotted Wilt virus). These viruses are single stranded, tripartite RNA viruses (3 segmented genome) and are exclusively transmitted by several species of thrips globally. An approximate estimate on annual yield loss of US\$ 1 billion implies the severity of the tospoviruses in world wide. Tospoviruses are known to be transmitted by at least 12 species of thrips. The western flower thrips, *Frankliniella occidentalis* Pergande is the most important vector, but this species does not occur in India. *Thrips palmi*, *T. tabaci*, *Scirtothrips dorsalis* and *Frankliniella schultzei* that occur in India, are important vectors of different tospoviruses such as watermelon bud necrosis, groundnut bud necrosis, tomato leaf blight, capsicum chlorosis etc. Recently another important tospovirus called the Iris yellow spot virus has been found has been observed causing extensive damage on onion in Maharashtra vectored by *T. tabaci*.

Earliest reports of diseases caused by tospoviruses were from Australia and South Africa in 1910s. So far, three distinct tospoviruses, namely groundnut bud necrosis virus (GBNV) and groundnut yellow spot virus (GYSV) from groundnut and watermelon bud necrosis virus (GBNV) have been identified from India on the basis of nucleocapsid protein (NP) sequence divergence. While GBNV and GYSV are endemic to India and other Asian countries, WBNV has emerged recently as a serious pathogen of watermelon in parts of India such as Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu and Uttar Pradesh. WBNV is becoming increasingly important on other vegetables including cucumber, muskmelon and tomato. Besides these crops, tospovirus infection has been reported on a number of other crops such as potato in North- Western/ Central plains.

The thrips-tospovirus relationship is complex and a thorough understanding of vector and virus association is a vital prerequisite in tospoviruses management.



Biotechnological tools for disease management

V. A. Parthasarathy, Director, Indian Institute of Spices Research,
Marikunnu P.O., Calicut, Kerala, India – 673012, India

E-mail: parthasarathy@iisr.org

The management of crop diseases has become important throughout the world. Various methods have been advocated to manage viral, bacterial and fungal diseases of various crops. The emphasis and prime importance is given on the development of resistant varieties and now it has been possible to manage the various diseases in integrated manner. Biotechnology has made it possible to engineer transgenic plants that are transformed with genes for resistance against specific diseases, or with genes coding for enzymes such as chitinases and glucanases directed against certain groups of pathogens such as oomycetous fungi, viruses and bacteria or with nucleic acid sequences that lead to gene silencing of pathogens. There are many crops in which plants genes for specific pathogens have been isolated from resistant plants, transferred into susceptible plants and expressed in these plants thus making formerly susceptible plants now behave as resistant ones. Such resistant plants are subsequently cloned and multiplied and distributed as resistant variety. Examples for such cases include hybrid rice transformed with the rice gene *Xa 21* coding resistance of rice to bacterial blight caused by *Xanthomonas oryzae* pv *oryzae*. Transgenic plants expressing that gene display high, broad spectrum resistance to *Xanthomonas oryzae* pv *oryzae* races while they maintained high quality agronomic characteristics. When the resistance gene DRR206 from pea was transferred into canola, the transgenic canola exhibited resistance to black leg disease caused by the fungus, *Leptosphaeria maculans*. Similarly in creeping bent grass plant transformed with the *Arabidopsis thaliana* gene *PR5K*, which codes for a protein kinase receptor, showed resistance to the fungus, *Sclerotinia homeocarpa* causing the dollar spot disease, with resistance appearing as a delay in disease symptoms. Plants transformed with antipathogen compounds such as pathogenesis related proteins (chitinase and glucanase) showed reduced disease incidence against several pathogens in different crops. Peanut plants transformed with antifungal genes that reduced the incidence of Sclerotinia blight caused by *Sclerotinia minor* by 36%. Transgenic broccoli plants expressing an endochitinase gene showed less severe symptoms. Viral resistant transgenic plants are obtained by inserting segments of viral nucleic acid into plant genomes that leads to silencing of genes of the virus that have homologous sequences, thereby making plants resistant. There are several cases of successful transformation of a susceptible into a resistant crop through genetic engineering with parts of the genome of the virus such as coat protein, movement protein, replicase protein and non-coding regions. The first such case was tobacco transformed with coat protein gene of *Tobacco mosaic virus*. This was followed by reports transformation of several crops with sequences from different viruses. The resultant transgenic crop in majority of the cases showed resistance against the virus whose sequence was used in the transformation. Virus resistant transgenic varieties of squash, papaya and others are already under commercial cultivation in USA, Canada and China. Some of the nonviral genes also have resulted in virus resistance include the gene for ds RNase fro *Schizosaccharomyces pombe*, tobacco resistant gene 'N', mouse protein kinase, systemic acquired resistance gene etc.

Combining a host gene for resistance with pathogen derived genes or with genes coding for antimicrobial compounds provide for a broad and effective resistance in many host –pathogen combinations. This has been shown with the combination of a tobacco host gene and a *Tobacco vein mottle virus* coat protein gene, which showed broad and effective resistance to potyviruses in tobacco. Similarly, combination of *Sw 5* tomato gene for resistance and *Tomato spotted wilt virus* (TSWV) nucleocapsid (N) protein gene for resistance to TSWV in transgenic plants showed high levels of resistance to several strains of TSWV. Though plants lack an antibody making machinery, through Biotechnological interventions, it is now possible to transform plants with genes that make possible the production of functional recombinant antibodies. Such plant produced antibodies are called as plantibodies. Production of virus specific plantibody molecule in plants showed resistance reaction in the transgenic plants against viruses. Such viruses include *Tobacco mosaic virus*, *Potato virus X*, *Potato virus Y* and *Clover yellow vein virus* and TSWV.



Transgenic approaches to broad-spectrum disease resistance: novel pathways and gene silencing

Amitava Mitra, Center for Biotechnology and Department of Plant Pathology, University of Nebraska, Lincoln, NE 68583-0722, USA,

Email: amitra@unlnotes.unl.edu

The annual revenues from the global production of agricultural commodities exceed five trillion US dollars. Plant diseases cause significant economic crop losses; more than 25% of all crop plants worldwide are lost to nematodes, fungal, bacterial, and viral diseases every year. Protection of crops against pathogens is one of the most significant unmet needs in agriculture. Preventing crop loss due to diseases has historically been achieved through conventional breeding efforts and use of pesticide chemicals. However, it has become increasingly difficult to obtain resistant genotypes for the purpose of breeding disease resistant varieties and many agricultural chemicals have environmental and safety concerns, so the focus has shifted towards utilization of genetic engineering tools. Genetic engineering provides a method for isolating, selectively amplifying, and expressing genes encoding desirable traits. Genes can be obtained from one organism and transferred into another organism to introduce new traits. Since transformation of many previously recalcitrant crops has recently become simple and routine, success seems limited only by our ability to identify appropriate resistance genes or pathways.

Our approach towards genetic engineering for disease resistance has focused on broad-spectrum resistance against multiple pathogens as crop plants usually succumb to more than one pathogen in a growing cycle. Several antimicrobial pathways or genes are known in animal systems where they are part of an early defense innate immune system. Innate immunity, the rapidly responsive and phylogenetically ancient system of host defense, is generating increasing interest in part due to the growing appreciation for its remarkable broad spectrum effectiveness. In model plant systems

and in wheat and soybean we demonstrated that expression of an animal antiviral pathway results in high levels of virus resistance in transgenic plants. The introduction of this antiviral pathway in essence mimics "hypersensitivity" which is one of the best examples of natural resistance against plant diseases. The system is effective against single stranded RNA viruses that include most of the economically important plant viruses. We also have data suggesting that it is also effective against multipartite and double stranded RNA viruses. A few members of this group cause significant crop damage in U.S. and Asia. Similarly, we used an antimicrobial lactoferrin gene to obtain high levels of resistance against several fungal and bacterial diseases. These strategies, which are natural defense systems, have the potential to minimize pandemics of many plant diseases having an immediate and sustained impact on the productivity and consumer acceptance of transgenic crops. Considering tremendous losses inflicted by diseases, it is conceivable that the potential economic impact could be in millions of dollars. This approach has the potential to provide "generic" resistance to a wide variety of plant diseases.

In the process of optimizing expression of two antiviral pathway genes in transgenic plants, we serendipitously discovered a powerful gene silencing method (DRIGS – Direct Repeat-Induced-Gene-Silencing)) that is extremely efficient in obtaining plant 'gene knock downs'. Post-transcriptional gene silencing is a sequence-specific RNA down-regulation mechanism that targets the trigger RNA molecules as well as the RNA molecules that share a certain sequence homology with the trigger. A striking feature of DRIGS is its high frequency of silencing and exceptional genetic stability. Almost 100% silencing frequency in plants containing four or more repeats and stable inheritance of silenced phenotypes in progenies clearly establish the importance of effectiveness of DRIGS for functional genomic studies. Furthermore, a DRIGS based gene-tag approach can be used to determine function and clone the gene simultaneously. The DRIGS is also capable of inactivating homologous genes in trans. The discovery of DRIGS has significance for dissecting the gene silencing mechanism and for efficient generation of silenced phenotypes useful for research and agricultural biotechnology products. Exploitation of this simple approach can achieve efficient and consistent gene inactivation, allow expeditious gene function analysis, and development of novel strategies for plant genetic engineering. We have used DRIGS to obtain simultaneous resistance against 8 – 10 viruses by linking small virus sequences to a silencing locus.

Engineering resistance against Rice Tungro Virus in rice using RNA-interference

Himani Tyagi, Vidhu Verma, S. Rajasubramaniam, Shweta Sharma and Indranil Dasgupta, Department of Plant Molecular

Biology, University of Delhi South Campus, New Delhi-11002, India.

E-mail: indranil57@hotmail.com

Rice tungro disease, caused by the joint infection of a DNA virus, *Rice tungro bacilliform virus* (RTBV) and an RNA virus *Rice tungro spherical virus* (RTSV) is a severe devastating disease of rice in South and Southeast Asia. The viral complex is jointly transmitted by the specific insect vector Green Leafhopper (GLH). Even though RTSV is efficiently transmitted by GLH, RTBV cannot be transmitted on its own and is dependent upon RTSV for transmission.

RNA-interference (RNAi) is a newly-discovered inherent RNA-mediated phenomenon found in diverse organisms, believed to be involved in defence against viral pathogens, transposable elements and related phenomena. RNAi has been shown to be initiated by double-stranded RNA and hairpin RNA which are recognized by nucleases known as Dicer and cleaved into 22-26 bp fragments known as Small-interfering (si)-RNA. The siRNAs are then incorporated within a multiprotein complex known as the RNA-induced Silencing Complex (RISC), which degrades homologous RNA using siRNA as a guide.

To develop transgenic RNA-i-mediated resistance against RTBV, one of the four Open Reading Frames encoded by the viral DNA, ORF IV was cloned in both sense as well as anti-sense orientation under constitutive promoter in a binary vector. Using a similar approach against RTSV, a cDNA encoding RTSV replicase was cloned in a binary vector to give rise to a transcript potentially capable of forming a hairpin loop. Transgenic rice plants were obtained using the above constructs using *Agrobacterium*-mediated transformation, which were confirmed by Southern hybridization to be integrated in the plant genome. Expression levels of the transgene in the above plants were investigated by northern hybridization but were undetectable. This indicated the operation of RNAi phenomenon, which is characterized by specific degradation of the target transcript. As expected, plants harboring the RTBV transgene accumulated siRNAs complementary to the transgene used. Taken together, the above observations indicated operational RNAi in the above plants, targeting the transcripts homologous to the introduced transgene.

To assess the resistance of the transgenic plants, they were challenged with viruliferous GLH and the accumulation of RTBV and RTSV were monitored over time for a period of about 50 days using DNA and RNA dot-blot. Different transgenic lines showed differing patterns of viral accumulation as compared to control non-transgenic lines; some showing delayed viral buildup and some showing overall low titers. This was true for both RTBV and RTSV. Some of the lines showing delayed accumulation of RTBV showed mild tungro symptoms, as compared with non-transgenic control lines, which were severely symptomatic. RTSV transgenic lines were also checked as to their capability of acting as further source of transmission of the tungro viral complex by GLH. Most RTSV transgenic lines were seen to act very poorly as transmission source. Taken together, we conclude that the above transgenic rice plants accumulate low levels of RTBV and RTSV, show mild tungro symptoms and can also reduce the GLH-mediated spread of the viral complex.



Resistance against soft-rotting disease conferred by inactivation of quorum sensing signal required for the expression of bacterial virulence

Arun K. Chatterjee, Yaya Cui and Asita Chatterjee, Division of Plant Sciences, University of Missouri at Columbia, Columbia, Missouri 65211 U. S. A., **E-mail:** chatterjeea@missouri.edu

Erwinia carotovora ssp. *carotovora* (Ecc), a member of the family of Enterobacteriaceae, causes soft-rotting disease on a wide variety of plants or plant organs worldwide. A consortium of plant cell wall degrading extracellular enzymes comprising pectate lyase (Pel), polygalacturonase (Peh), protease (Prt) and cellulase (Cel) contribute to its plant virulence. Among those, extracellular pectinases including Pel and Peh play a crucial role in tissue maceration and cell death. An assortment of secondary factors including motility and some effectors secreted through the type III secretion system augments virulence of Ecc. The regulation of the extracellular enzymes and proteins including harpin, the elicitor of the HR (hypersensitive response) in Ecc has been extensively studied and many regulatory genes and factors have been identified. These extracellular proteins are co-regulated by plant signals, quorum sensing (QS) signal as well as by an assortment of transcriptional factors and post-transcriptional factors including the RsmA-*rsmB* system (Rsm= regulator of secondary metabolite production). Of these regulators, the post-transcriptional regulators, RsmA and non-coding *rsmB*sRNA are absolutely critical in the expression of exoprotein genes. RsmA, a small RNA binding protein, promotes RNA decay and thus behaves as a negative regulator. *rsmB* specifies a regulatory sRNA that binds RsmA and neutralizes its negative regulatory effect. The expression of *rsmA* and *rsmB* in Ecc is subject to multi-factorial regulation. The transcription of *rsmA* is controlled by an alternate sigma factor (RpoS) and QS signal receptors (ExpR1 and ExpR2). The levels of *rsmB* RNA are determined by cumulative actions of a two component system (the response regulator, GacA and the sensor kinase, GacS), a LysR homolog (HexA), a putative transcriptional adapter (RsmC) and a pectinase repressor (KdgR). While GacSA positively regulate *rsmB* transcription, HexA, RsmC and KdgR function as negative regulators. The KdgR action is novel in that it prevents transcription by a road-block mechanism.

N-acyl homoserine lactone (AHL) and its analogs are diffusible metabolites of bacterial origin that function as cell density (quorum) sensing signals. These molecules control diverse phenotypes including bacteria-microbe and bacteria-plant/animal interactions, bioluminescence, production of secreted proteins, extracellular polysaccharides, antibiotics, pigments and other secondary metabolites. The QS system of *E. carotovora* is required for its virulence as well as for the production of extracellular proteins and the antibiotic, carbapenem (Car). The signaling system is unusual in many respects. (1) These bacteria possess several species of AHL-receptors: ExpR1, ExpR2 and CarR. (2) ExpR1 and ExpR2 activate *rsmA* transcription, whereas CarR regulates the Car biosynthetic genes. (3) The ExpR proteins differ in their ligand (AHL)-binding specificity. (4) The activator function of ExpR species is ameliorated upon AHL-binding. By contrast, CarR-AHL complex, but not CarR, activates expression of the *car* genes. (5) The AHL receptors do not regulate transcription of AHL

synthase gene, *ahII*, and thus differ from the classical auto-inducer (LUX) paradigm. The current model of AHL-mediated regulation of extracellular proteins postulates that AHL production is constitutive and AHL molecules accumulate as the cell density increases. In the absence of AHL or when AHL levels are relatively low as during early growth stage, the AHL receptors (ExpR proteins) activate *rsmA* transcription. Under these conditions free RsmA accumulates promoting decay of RNA species, including those of exoprotein genes and some of their regulators. As the cell density increases AHL levels rise and produce ExpR-ligand complex. These complexes do not activate *rsmA* transcription. Moreover, activation of *rsmB* RNA production at this juncture results in quenching of free RsmA by the formation of RsmA-*rsmB* RNA complex. The consequent reduction in the pool of free RsmA stimulates extracellular protein production resulting in tissue maceration and cell death.

As described above, a primary function of AHL in Ecc in the context of extracellular protein production and virulence is to modulate the levels of RsmA. It then follows that in the absence of AHL, RsmA levels will remain high inhibiting enzyme production and consequently rendering the pathogen avirulent. Several laboratories have discovered enzymes (AHL-lactonase and AHL-acylase) that degrade AHL analogs. The cognate genes are widespread in many bacterial species including several plant pathogens. The AHL-lactonase gene *aiiA* from a *Bacillus* species has been cloned and transgenic plants expressing the gene have been developed. These plants or their organs are resistant to soft rotting disease as little or no bacterial maceration occurs. Thus, this system illustrates the merits of exploiting fundamental knowledge of virulence factors and their regulation in plant disease management.



Development of insect resistant rice: A genetic engineering approach towards crop management

Sampa Das, Plant Molecular & Cellular Genetics, Bose Institute, P1/12 C. I. T. Scheme VII (M) , Kolkata-700054, India

E-mail: sampa@bic.boseinst.ernet.in/sampa_d@rediffmail.com

Rice is the staple food of over half of the world's population. It is estimated that to feed the ever increasing global population, by the year 2012, the rice production needs to be increased over 60% of that of now.

One of the major constraints in increasing rice production in Asia and some other parts of the world is the attack of homopteran group of sucking insect pests, the brown plant hopper (BPH) and green leafhopper (GLH). These insect pests not only cause "hopperburn" and other physiological damages of the crop, extracting the plant phloem sap by stylet probing but also transmit disease causing rice tungro viruses by acting as vectors. The sap sucking homopteran insects are affected by none of the so far known control agents except few mannose binding plant lectins. In this backdrop, a chimeric construct of 25 kDa *Allium sativum* leaf lectin coding gene (*ASAL*) was transformed into IR 64, a well known rice cultivar. The selected T₁/T₂ transgenics exhibited detrimental effect on development and multiplicity of the target insects. The selected leafhopper resistant lines were evaluated through PCR analysis and RNA dot blot assay for detection of rice tungro bacilliform (RTBV) and Rice tungro spherical viruses(RTSV), respectively, the results of which will be presented.



Resistance gene analogue and its application in plant protection strategy

Amita Pal, Plant Molecular & Cellular Genetics, Bose Institute, Kolkata-700054, India, **E-mail:** amita@bic.boseinst.ernet.in

In the post-genomic era, plant scientists have the opportunity to identify consensus domains present within the plant disease resistance (R) proteins employing tools of bioinformatics. These proteins encoded by *R* genes that confer resistance against number of diseases and protect crop plants from various biotic stresses. The consensus domains of R proteins are often referred as Resistance Gene Analogues (RGA). RGAs are usually present in many copies and most of these are non-functional part of the genome. However, functional NB-ARC domains are present as polymorphic allele in several disease resistant plants, while, absent in the susceptible ones. The polymorphic nature of these functional RGAs has been exploited in marker development for the marker assisted selection (MAS) in crop plants.

The strategy of RGA-mediated plant protection against biotic stresses is an eco-friendly approach and has the following advantages over other markers developed so far for MAS of disease resistance: i). RGA markers are part of the functional gene, that developed from a cross could also efficiently employed across other crosses, genotypes, populations etc. Otherwise, when the linked marker is at a distance away from the target (R) gene, it produces a high percentage of false data during the screening process. ii). Sometimes, a marker developed for a gene of interest in a segregating progeny may not be useful for screening progeny plants of another cross, even though the same gene would segregate, unless the marker is from the gene itself .

A total of eight different types of R proteins were identified, of which, most common one is one of the members of an ancient gene family that encode nucleotide-binding proteins. Because of their distinctive features, these proteins are termed as nucleotide binding site-leucine rich repeats (NBS-LRRs). The NBS-LRR protein contain a unique nucleotide binding domain which has few conserved signature motifs and also has high homology with the animal innate immunity proteins, e.g. Apaf-1 of mammals and Ced-4 of nematodes, referred to as NB-ARC family that has been split into two subfamilies, based on the presence or absence of a region homologous to the Toll and Interleukin-1-receptor (TIR) domain at the N-terminus. In contrast to the TIR, the amino acid residues at the N-terminal of NB-ARC domain of the non-TIR subfamily are organized into a putative coiled-coil or a leucine zipper structure. The TIR and non-TIR bearing R-proteins are also distinct at the functional level due to their putative involvement in different signal transduction pathways.

Eight conserved motifs within the NB-ARC domain were reported, which are almost universally present across different plant taxa. In a recent analysis of the sequences under TIR and non-TIR subfamilies of NB-ARC domains in the members of family Fabaceae, we have identified eight additional conserved motifs. RGA primers were designed from the sequences of these conserved motifs.

RGA primer based polymorphisms were identified between mungbean yellow mosaic India virus (MYMIV) resistant and susceptible germplasms of *Vigna mungo* and *V. radiata*. Two such polymorphic domains were analyzed at the molecular level and

the transcript analysis revealed these are from coding regions and probably part of the targeted *R* gene/s. Through this RGA-based approach we were able to develop a reliable and efficient screening method for MYMIV-resistance of both mungbean and urdbean germplasms. This germplasm screening method is eco-friendly and bio-safe. These markers could also be efficiently deployed in molecular breeding to raise MYMIV-resistant *Vigna* and protect these crops from the subsequent attack by this Begomovirus.

The RGA-based molecular strategy generally exhibits perfect marker-trait association and can be used directly for MAS and map based cloning. Through marker-trait association, large variety of agronomically useful traits has been screened in several crop plants. Thus, through the use of RGA based approach interests of plant breeders could be protected in a biosafe manner.



Biotechnological approaches for plant disease management in potato

S.K. Chakrabarti, Principal Scientist (Biotechnology), Division of Crop Improvement, Central Potato Research Institute, Shimla 171 001, Himachal Pradesh, India, **E-mail:** skc_cpri@yahoo.co.in

Potato originated in the high lands of Andes and was introduced to this ancient agrarian land around 400 years ago by Portuguese colonizers. Since then, it established as the fourth most important food crop in India. As a recent introduction, the crop faces unique threats from scores of viral, fungal, and bacterial pathogens. The vegetative nature of its propagation further aggravates the disease problem of this crop. Potato is perhaps the best example of a crop plant to which biotechnology has been most extensively applied in all aspects of disease management. Use of disease-free planting material constitutes the most effective component of integrated disease management in potato. Meristem tip culture and micropropagation have been perfected by the Central Potato Research Institute (CPRI) that are being used routinely for production of virus free planting materials. CPRI is the first institute, among plant science research institutes of India, to introduce ELISA in 1984 and ISEM in 1987 for plant virus diagnosis. The virus diagnosis laboratory is now equipped with automated ELISA system, PCR and NASH facilities. Initially, immunodiagnostic protocols were standardized for detection of important viruses like PVY, PLRV, PVX that contributed largely in production of disease free seed stock. ELISA is still being used as the primary protocol for potato virus detection in seed production. Nucleic acid spot hybridization (NASH) protocol has been standardized for PSTVd that does not have a coat protein. NASH technique is now routinely being used for detection of potato spindle tuber viroid (PSTVd) in exotic germplasm for quarantine clearance. The institute is also developing molecular diagnostic protocols for PVX, PVS, PVM, PVA, and the bacterial wilt pathogen *Ralstonia solanacearum*.

Resistant cultivars constitute the second most important component of potato IDM. Deployment of several *R* genes of *Solanum demissum* by classical breeding for

late blight management is perhaps a good example of resistant breeding. The classical breeding is now being supplemented with genetic transformation techniques for conferring disease resistance in potato cultivars. Three priority traits namely late blight durable resistance, bacterial wilt resistance and resistance to viral diseases have been identified for improvement by genetic engineering. The *RB* gene cloned from the wild potato species *Solanum bulbocastanum* is being transferred to Indian potato cultivars for conferring durable resistance to late blight. Besides, a pathogenesis related protein (PR 5) was cloned from the wild potato species *Solanum chacoense* and transferred to cultivated potato varieties by *Agrobacterium*-mediated genetic transformation. The bovine enteric b-defensin gene was transferred to the potato cultivar Kufri Badshah for conferring bacterial wilt resistance. The transgenic plants showed remarkable level of tolerance to *Ralstonia solanacearum* under green house screening. Virus resistant transgenics are being developed against potato virus Y (PVY), potato leaf roll virus (PLRV) and the newly emerging potato apical leaf curl virus caused by ToLCNDV. Pathogen-derived resistance genes are being used for conferring resistance to viral diseases. The CP gene of an Indian PVYO strain has been amplified by RT-PCR, cloned and sequenced. Sense, antisense and hairpin constructs have been designed and are being used for plant transformation. The CP gene of the Indian potato leaf roll virus (PLRV) has been cloned and used for transgenic development. Similarly, the *rep* gene of potato apical leaf curl virus has been cloned and sequenced. Sense, antisense and hairpin constructs of the *rep* gene has been designed and cloned. The antisense and the hairpin constructs are being used for transgenic development.

Molecular markers also played a key role in diversity analysis of plant pathogens as well as mapping and introgression of resistant genes. RAPD markers have been used extensively for analysis of population structure of the late blight pathogen *Phytophthora infestans* and the bacterial wilt pathogen *Ralstonia solanacearum*. Wide range of genetic variability was revealed within the population of these pathogens by marker analysis. Marker assisted selection (MAS) is particularly useful in case of introgression breeding where one or a few useful genes from an otherwise undesirable wild background have to be transferred to a commercial cultivar. Tightly linked markers for many qualitative and quantitative traits of potato have been published and are available for MAS. A published SCAR marker tightly linked to extreme resistance to PVY has been validated at CPRI and is now being used for development of triplex/quadruplex parental line and for breeding potato varieties with combined resistance to PVY and late blight. AFLP markers are also being used for molecular mapping and identification of major QRL (quantitative resistance loci) from the late blight resistant wild species *Solanum chacoense*. Besides, an ambitious project on structural and functional genomics of potato has been initiated recently for identification of novel late blight resistant genes. Achievements made in the area of potato biotechnology for disease management in India will be presented and future strategies will be discussed.

Predicting mustard aphid incidence in the gangetic plains of West Bengal from temperature variation

Bannerjee¹, Saon, Asis Mukherjee², M. K. Nanda³ and C. Halder³,

¹AICRP on Agrometeorology and ²Agromet Advisory Services, Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia-741235. West Bengal.

³Department of Agril. Meteorology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia-741252. West Benga,

E-mail: sbaner2000@yahoo.com

As the mustard aphid (*Lipaphis erysimi* Kaltentbach) incidence is closely linked with prevailing weather situation, its infection can be predicted to forewarn the farmers to take necessary plant protection measures. Considering this fact, an experiment was conducted to evaluate the relationship between temperature and aphid population in the farmers' field of some selected sites (Chandamari, Muratipur, Nagardanga, Shimurali, Birohi and Chakdah) around Kalyani during 2006-07. In all sites, aphid population from top 10 cm shoot of selected plants was counted in weekly interval. The average value of the pest population is compared with the temperature situation prevailing over the region.

It was observed that the aphid population was highest (about 200 per top 10 cm shoot) during last week of January. Generally during this period, maximum temperature increased and there was no change of minimum temperature. Hence the temperature range during this period was high. Between aphid population and maximum temperature, no definite trend was observed and the correlation between two parameters was also very poor but for an increasing trend between aphid population and temperature range. Hence, higher temperature range (more than 13°C) causes higher aphid population. The aphid population is also positively correlated with heat unit (accumulated growing degree days). When the accumulated growing degree days is more than 1100 °C Day, the aphid count crosses the limit of 30 per top 10 cm. The study can form the basis of a aphid forewarning system in the New Alluvial Zone of West Bengal.

Investigations on role of bioagents in IPM of mango malformation disease

Chand, Girish, Mukesh Kumar Pandey and D. K.Chakrabarti, N.D.

University of Agriculture and Technology, Faizabad 224229, U.P., India

E-mail: dkcnuat@yahoo.com

Malformation disease of mango (*Mangifera indica* L) induced by a physiological race of *Fusarium moniliforme* Sheldon var *subglutinans* Wollenewb and Renking is considered as a plant disease of international importance. Attempts were made to find out natural antagonist(s) of the *Fusarium* and to use it as biocontrol agent.

Aspergillus niger van Tiegh was found to grow profusely over dead necrotic malformed panicles which was also the site of multiplication of the pathogen. In *in vitro* tests, *A. niger* restricted the development of colonies of the *Fusarium* by its over growth and finally by parasitizing over the *Fusarium*. When conidial suspension of *A. niger* was sprayed over the *Fusarium* growing on necrotic panicles on plants, the population of the pathogen (initial inoculum level) was reduced drastically. In a separate experiment the efficacy of two other broad spectrum bioagents viz. *Trichoderma harzianum* and *T. viride* were also tested. In *in vitro* tests both the antagonists were highly effective against the pathogen but *in vivo* their performance was not as good as *A. niger*. The results of these experiments are presented.

Management of damping off of chilli (*Capsicum frutescens*) through integration with bio-antagonists and botanicals under green house conditions

Chakraborty, Ayana, Sunita Mahapatra, Srikanta Das, P. S. Nath, S. K. Ray, D. C. Khatua and B. Dasgupta, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, PIN – 741 252, Nadia, West Bengal, India,
E-mail: sridas_bckv@rediffmail.com.

Efforts were made to manage the damping off of chilli (*Capsicum frutescens*) caused by *Pythium aphanidermatum* by using seed coating with biocontrol agents viz. *Trichoderma viride*, *T. harzianum*, *Aspergillus niger*, *Bacillus subtilis*, *Pseudomonas fluorescens* as well as soil drenching with botanicals viz. hydro-distilled leaf extract of palmarosa (0.025%), lemon grass (0.02%), citronella (0.02%) and methanolic leaf extract of *Acacia nilotica* (3.5%), *Tamarindus indica* (1.3%) in different combinations under green house condition for two consecutive years (2003 and 2004). All the treatment combinations increased germination percentage, and reduced the pre and post emergence damping off as compared to sick soil treated as control. Similar results were noted in both the two years. Two years pooled mean showed that among the treatments, seed coating with *T. viride* (2×10^8 spores/ml) + soil drenching with all the botanicals in their respective concentration increased germination percentage and reduced the pre- and post emergence damping off of chilli. Among the soil drenching botanicals palmarosa leaf extract (0.02%) gave maximum germination percentage (89.9%) and minimum pre and post emergence damping off (9.3% and 33.6% respectively) followed by lemon grass (0.02%) in the same *T. viride* coated seeds. So seed coating with bio-antagonists in combination of soil drenching with botanicals in the compatible doses enhance the seed germination and reduce the most destructive disease like damping off of chilli seedlings in the present day organic farming agriculture.

Incidence of saw fly (*Athalia lugens proxima* Klug.) as influenced by level of irrigation and fertilizers on mustard

Chowdhury, Manidipa, Research Scholar, Department of Agricultural Entomology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar-736165.

With an objective to study the incidence of saw fly (*Athalia lugens proxima* Klug.) as influenced by level of irrigation and fertilizers on mustard c.v. NC-1 (Jhumka) of *Brassica campestris* var. yellow sarson, experiments were conducted in the Instructional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal in two successive Rabi seasons of 2005-06 and 2006-07. Highest saw fly population (0.26 larvae/plant) was recorded on the crop grown without irrigation and medium level of fertilizers (60:30:30 Kg NPK/ha) while lowest population level (0.10 larvae/plant) was observed at highest level of irrigation (three) coupled with medium level of fertilizers (60:30:30 kg NPK/ha) and two irrigation coupled with lowest level of fertilizers (40:20:20 Kg NPK/ha).

Population dynamics of mustard aphid on different *brassica* cultivars under terai agro ecological conditions of West Bengal

Choudhury, S. and S. Pal, Regional Research Station, Uttar Banga Krishi Viswavidyalaya, Kalimpong, Darjeeling, West Bengal-734301,
E-mail: palsento@gmail.com

The experiments were conducted at the Instructional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar during *rabi* seasons of 2002-03 and 2003-04 to study the population dynamics of mustard aphid on seven popular rapeseed-mustard cultivars. The incidence of aphid commenced from 5th to 2nd standard week with a very low population levels on all the cultivars. The aphid population attained the peak level from 7th to 9th standard week. The correlation coefficients between aphid population and different abiotic factors revealed contradictory results. Except for a few instances the weather parameters were found to register low order of associations with aphid population. So, the ecological factors exhibited little impact on the population build up of mustard aphid. The degree of infestation and the rates of population change of the aphids on different *Brassica* cultivars seem to be governed by varietal characteristics of different germplasms. *Brassica campestris* varieties as a group harboured relatively higher populations of aphid than *Brassica juncea* varieties.

Use of meteorological information in Integrated Pest Management

Das, D. K., National Centre for Integrated Pest Management, LBS Building, IARI Campus, New Delhi -110012, **E-mail:** debkumar_das@yahoo.com

The present day crop protection is heavily relying on chemical control of pests. The dependence on chemicals cause some serious problems to the human and its ecosystems. The problems are emergence of pest(s) resistant to insecticides, resurgence of pests, persistence of pesticide residues and their biomagnification in the food chain, pollution to surface and ground water and rejection of exported agricultural products in the foreign market. The adoption of Integrated Pest Management (IPM) strategies has received the most attention to minimize the above problems. The IPM strategy suggests use of safe pesticides and botanical pesticides in appropriate time, biological control agents, resistant crop cultivars, cultural methods and development of transgenic plants resistant to insect pest and disease.

Meteorology is the science of atmosphere which deals with weather and climate with a wide range of branches. The information that are useful for IPM can be classified into two broad categories: weather forecasting and agrometeorological information. Weather forecasting is of three types - short range, medium range and long range. Short range weather forecasting is used to provide very short time gap (1-2 days) to prepare for pest management practices. Medium range weather forecasting (3-10 days) provide good scope for planning, preparation, purchasing of pest management inputs, provide adequate time for pest management as well as farm management practices. Medium range forecasting of different weather parameters can be utilized for different pest management measures. Long range forecasting (>10 days) is also useful in IPM particularly pest forecasting as several workers have noticed the post-monsoon pest population depends on amount and distribution of monsoon rainfall.

Apart from weather forecasting, another branch of meteorology, i.e. agrometeorology has significant role to play in IPM. Agrometeorology is an interdisciplinary science in which the main scientific disciplines involved are atmospheric sciences, soil sciences, plant and animal sciences including their pathology, entomology and parasitology. Different branches of agrometeorology which are contributing in IPM are- forewarning of pest and disease outbreak, pest phenological information based on temperature based degree day concept, scheduling insecticidal, fungicidal spray to minimize the use of chemicals, selection of biocontrol agents and appropriate timing their release, determination of crop stress due to insect pest and diseases by remote sensing techniques and assessment of yield loss, modification of microclimate for pest suppression, soil environment and relation with soil borne pathogens and nematodes, pest risk analysis.

In the present days, climate change and global warming are the major burning topics to the environmentalists and policy makers. Future pest scenario, i.e., spatio-temporal pest distribution pattern in the context of global warming and future requirement of pest management inputs can be a major area of scientific investigation.

Occurrence of groundnut stripe virus in West Bengal

Das, Raju and A. K. Chowdhury, Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, West Bengal,
E-Mail : chowdhuryanil@yahoo.co.in

Groundnut (*Arachis hypogaea* L.) is now sincerely accepted by the farmers in a few districts of West Bengal particularly in rainfed regions where growing of cereals, vegetables and other crops are becoming expensive, sometimes less profitable in terms of cost benefit ratio. Under this situation cultivation of groundnut will be more profitable during pre-*kharif* and *Rabi* seasons in some areas of West Midnapore, Bankura, Birbhum and in some other districts of West Bengal where there is a limited availability of surface and under ground water. The major advantage for growing this crop is that it could be cultivated in all the seasons with minimum input requirements including irrigation water.

Two years intensive survey in three cropping seasons recorded that incidence of virus diseases like Groundnut Stripe Virus (GStV) is gradually increasing in groundnut fields. GStV is very important virus, has wide host range and in groundnut plants it causes discontinuous chlorotic lesions along the lateral veins of young quadrifoliate leaves. In groundnut fields *Aphis craccivora*, *Aphis gossypii* and *Myzus persicae* were very dominant vectors to spread the virus disease. In laboratory transmissions like sap, seed and aphid, results differed with the method of transmission.

Standardization of index based screening technique for *Trichoderma*

Debnath, A., Roy, A. and P. M. Bhattacharya, Department of Plant Pathology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, PIN-736165,
E-mail: pmb_ubkv@yahoo.co.in

Trichoderma may well be the most versatile, multifaceted beneficial fungus, which is abundant in the soil. This microorganism is not generally pathogenic to plants and often display plant growth promoting properties; however it can parasitize, control and destroy many fungi, nematodes and other phytopathogens that attack and destroy many crops. To harvest maximum benefit out of this microorganism, agro-climatic region based screening may prove to be significant. An attempt was made to standardize an index based procedure to test the bio-efficacy of different isolates against some selected soil borne plant pathogens. The index was calculated for all the isolates against test pathogens based on certain properties of the antagonist, such as competitive saprophytic ability, colonization behaviour, percent inhibition, speed of overgrowth on pathogen, inhibition zone, vigour index of the test plant and chitinase activity. This method may be utilized for rapid *in vitro* screening of isolates of *Trichoderma* against different pathogens on regional basis. Index based screening of the organism is at a very early stage and it requires further refinement.

A set of 21 isolates of *Trichoderma* were screened against *Sclerotium rolfsii*, *Rhizoctonia solani*, *Macrophomina phaseolina* and *Fusarium solani* using the above procedure. Isolate UBT-18 was found highly effective against *S. rolfsii*, *M. phaseolina* and *R. solani* and moderately effective against *F. solani*, whereas UBT-5 was found most effective against *F. solani*. UBT-8 was also highly effective against *R. solani*. The results were then validated through pot trials with cowpea as the plant system.

Infestation of coconut eriophyid mite *Aceria guerreronis* Keifer in Konkan region of Maharashtra

Desai, V.S., S.D. Desai, A.J. Mayekar and M.S. Karmarkar, Department of Agril. Entomology, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli Dist. Ratnagiri, Maharashtra, **E-mail:** sddesai_ento@rediffmail.com

Eriophyid mite (*Aceria guerreronis* Keifer) of coconut, was first observed to be causing serious damage from Kerala in 1998 in India. It was first noticed in Maharashtra from Vasai tahasil of Thane district in 2002. Now it has spread throughout Maharashtra and causing serious damage to the coconut plantations. To know the intensity of infestation of coconut eriophyid mite, a survey was undertaken from coconut growing tahasils of four districts of Konkan region. Out of five districts of Konkan, four districts were selected for recording observations on eriophyid mite infestation because; the coconut cultivation is confined to these four districts only. Out of these four districts, the coconut growing tahasils were selected. From each tahasil, two villages from the coconut growing tahasils of these districts were selected for the survey. Orchards of six farmers from each village were surveyed to evaluate the number of infested Palms and intensity index was derived. The intensity of infestation of coconut eriophyid mite of each selected tahasil from four districts of Konkan region revealed that the eriophyid mite infestation was highest in Thane district followed by Sindhudurg district in all three seasons of survey. Among the tahasils, it was highest in Vasai i.e. 78.35, 82.23 and 77.66 per cent in April 2004, October 2004 and March 2005, respectively. The level of infestation increased in October 2004 but it was somewhat decreased in March 2005. On the contrary the scale of infestation was increased from II to IV in Vasai tahasil. Moreover, the level of infestation and scale index was more in Palghar tahasil of Thane district followed by Dodamarg tahasil of Sindhudurg district. While the intensity of infestation and scale index was low in Raigadh and Ratnagiri district. The preliminary survey thus, conducted shows that there is a severe infestation of eriophyid mite which is day by day going increasing therefore, the proper control measures were required for further spread.

Evaluation of biocontrol potentiality of native plant growth promoting bacteria against *Rhizoctonia solani* mediated damping off disease of tomato

Dutta, S., N. Chackraborty and D. Dutta, AICRP on Vegetable Crops, Directorate of Research, BCKV, Kalyani, Nadia-741235, India, **E-mail:** subrata_mithu@yahoo.co.in

Tomato occupies second position amongst the vegetable crops in India in terms of production. In tomato, with the increasing intensity of production, diseases become one of the major constraints to the stability of production. Among all the diseases, *Rhizoctonia solani* induced damping off is most important soil borne pathogen on tomato causing severe losses under favourable conditions in nursery bed. Native rhizobacterial isolates of tomato, banana, chilli, rice and bacterial isolates of vermicompost were evaluated *in vitro* by dual culture method for their antagonistic activities against four important soil borne plant pathogens viz. *R. solani*, *Macrophomina phaseolina*, *Sclerotium rolfsii* and *Sclerotinia sclerotiorum*. Bacterial isolates from vermicompost (VPf-1) and banana rhizobacterial isolate (BPf-1) were found to be effective in suppressing the growth of all the four soil-borne plant pathogens. Based on cultural, morphological and biochemical characteristics, seven rhizobacterial isolates (BPf-1, VPf-1, Rpf-1, Trb-2, Trb-7, Acpsm-1 and Acpf-1) were identified as *Pseudomonas* sp. belonging to fluorescent group and two isolates (Azo-2 and Azo-5) as *Azotobacter* sp. Seed treatment with native biocontrol consortium exhibited enhanced level of protection as compared to native individual antagonistic rhizobacteria against both pre- and post-emergence damping off of tomato.

Effect of different organic and inorganic nutrient management on late blight disease of potato

Dwary A., M. Pramanick and S. Debnath, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, 741252, Nadia, West Bengal, India.

An experiment was conducted at the University Farm, Gayeshpur, BCKV during the year 2005 and 2006 with an objective to study the effect of different sources of organic and inorganic based nutrients on late blight disease [*Phytophthora infestans* (Mont) de Barry] of potato. The different combination of various sources of nutrients showed different magnitude of disease reaction. Maximum (16.14%) disease was noticed when N, P and K were used as inorganic sources where maximum percentage of N was recorded in the plant. Minimum (10.10 %) was recorded when plant nutrients were applied through exclusive organic sources coupled with black polythene mulching. Nutrition from organic sources exhibited lower percentage of nitrogen in plant. Intercropping of potato with coriander leaf crop (1: 1) also showed comparatively low disease infestation over exclusive inorganic sources.

Diversity of the pathogens inciting rhizome rot disease of ginger in Assam and Arunachal Pradesh

Gogoi¹, Robin, H.K. Devanath, T.R. Borah and Gunjan Gogoi, Department of Plant Pathology, Assam Agricultural University, Jorhat-785 013. ¹ Division of Plant Pathology, Indian Agricultural Research Institute, New Delhi-110 012, India,
E-mail: r.gogoi@rediffmail.com

Three major ginger growing areas of Assam viz., Sadiya of Tinsukia district, Borpathar of Golaghat district and Jorhat and also Roying of Arunachal Pradesh were surveyed for rhizome rot disease of ginger. Isolation of the pathogens from infected plants and rhizosphere soil followed by the pathogenicity tests on the healthy plants confirmed the association of *Ralstonia solanacearum* and *Fusarium oxysporum* in Sadiya, *R. solanacearum* and *Pythium myriotylum* in Borpathar and Jorhat while only *F. oxysporum* was observed in the Roying regions. In all the regions, prominent symptoms of the disease developed as yellow to golden yellow colour on the older leaves starting from the leaf margins, wilting and toppling of the plants apart from rotting of the rhizomes. Plant parasitic nematodes viz., *Helicotylenchus dihystera*, *Hoplolaimus indicus* and *Tylenchus* sp. were isolated from the rhizosphere soil of the infected plants.

Bioefficacy of some indigenous products in the management of okra fruit borers

Hegde, K. K. and Nandihalli, B. S. Department of Agricultural entomology, College of Agriculture, University of Agricultural Sciences, Dharwad- 580 005.
E-mail: b_nandihalli@rediffmail.com

A field experiment was conducted in kharif, 2003 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad to evaluate the bioefficacy of some indigenous products against okra fruit borers, *Earias vittella* (Fabricius) and *Helicoverpa armigera* (Hubner). Different indigenous products like NSKE (5%), GCKE, sweet flag extract (5%), garlic extract (5%), cow dung (10%) and cow urine (10%) were tried individually and in combinations along with endosulfan (0.07%) and untreated control. Repeated sprays of GCKE recorded least number of eggs (1.40 eggs/plant) followed by NSKE (5%) alternated with cow dung 10 per cent (1.71 eggs/plant). Repeated sprays of cow dung and cow urine used individually were not effective against the borers and recorded higher fruit damage of 55.70 and 52.10 per cent, respectively. GCKE was significantly superior in reducing the fruit borer damage to the tune of 64.83 per cent with higher fruit yield of 35.87 q/ha. The highest incremental benefit: cost ratio was noticed in endosulfan treatment (15.00) followed by treatment involving NSKE alternated with cow urine 10% (13.00), repeated sprays of GCKE (10) and NSKE alternated with cow dung 10% (7.90).

Synergistic effect of arbuscular mycorrhizal fungi and Bacillus subtilis on the biomass and essential oil yield of rose scented geranium (Pelargonium graveolens)

Khaliq, Abdul, Abdul Sattar and Mansoor Alam, Microbiology and Plant Pathology Division, Central Institute of Medicinal & Aromatic Plants, Lucknow-226015, INDIA, **E-Mail:** akhaliq1@rediffmail.com

Four different AM fungi viz. *Glomus aggregatum*, *G. fasciculatum*, *G. intraradices*, and *G. mosseae*, were used alone and in combinations with *Bacillus subtilis* to evaluate their effectiveness for root colonization and capability to increase the productivity of geranium over non mycorrhizal control plants. The mycorrhizal treatment increased the growth and total biomass invariably over non mycorrhizal control plants. In single treatments, best result was obtained in *G. mosseae* treatment where 371.3g fresh herb yield per pot was recorded (estimated increase of 70.9% over control). The plants inoculated with *Bacillus subtilis* alone also yielded 287.8g fresh herb which was 32.4% more over uninoculated controls. Similarly, *B. subtilis* in combination with *G. mosseae* produced 390.8g-herbs/pot yields with an increase of 79.8% over controls. The essential oil yield was not significantly affected due to the treatments of above bio-inoculants but the total oil yield was increased due to the increase in herb yield in treated pots. The data on AM root colonization were found inconsistent with the yield.

Forewarning of mustard aphid with agrometeorological parameters

Khan, S. A., S. Choudhuri and S. Jha, Department of Agricultural Meteorology and Physics and Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur-741252, India, **E-mail:** sakhn_bckv@sify.com

In view of strong dependence of incidence of pest on weather, research work have been intensified for development of forecasting of pest based on agrometeorological parameters. For the present study, which was aimed at to develop weather based forewarning models for mustard aphid, field experiment was conducted during the winter seasons of 2001-02, 2002-03 and 2003-04 in the 'C' Block Farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani (22°57'N; 88°20'E; 9.75 m a.m.s.l.). The 'Varuna' variety of mustard was sown on ten dates at seven days interval, starting from first October, at 30 cm apart rows, and at 10 days after emergence, crop was thinned out to maintain population at 10 cm apart in a line. For counting of aphid population, ten plants were randomly selected from each plot. Number of aphids was counted twice a week from 10 cm top main shoot of each plant and average aphid population for each sampling date was determined. Results revealed that first incidence of aphid varied from third week of November to first week of December, whereas the peak aphid population was observed during second week of January to third week of February during the period under investigation. Correlation coefficient

between aphid population recorded on different dates and accumulated values of weather parameters prevailing prior to the observation date revealed that temperatures, growing degree day, wind speed and sunshine hours showed negative association with the aphid population. As the magnitudes of these parameters increased, the population build-up of aphid decreased. The following regression models, involving days to attain first, ETL and peak incidences and predisposing weather factors accumulated over different periods, have been developed for prediction first incidence, ETL and peak dates. For prediction of initiation date: $Y=374.5462-0.3596*X_1+3.3009*X_2$ ($R^2=0.984$; X_1 and X_2 =minimum temperature and wind speed, respectively accumulated over one week, ending one week before the date of aphid initiation; for prediction of ETL date: $Y=515.6305-0.7972*X_1+0.0363*X_2$ ($R^2=0.916$; X_1 and X_2 =maximum temperature and growing degree day, respectively accumulated over one week, ending three wks before the date of ETL aphid); for prediction of peak date: $Y=389.2339+0.6149*X_1-0.4709*X_2$ ($R^2=0.788$; X_1 and X_2 =minimum temperature and temperature range, respectively accumulated over one week, ending two weeks before the date of peak aphid incidence).

Aphid-weather diagram, as an aid to farmers' advisory for forewarning of pest, have also been prepared for early, normal and late sown crops. It is concluded that these regression equations could be useful tools for issuing forewarnings to the farmers against aphid incidence in mustard crop grown in the New Alluvial Zone of West Bengal.

Disease dynamics, severity prediction and loss assessment of fungal diseases of some commercial ornamentals

Laha S, Mandal D, Ghosh P P and Dasgupta M K, Department of Plant Protection, Visva-Bharati, Sriniketan - 731236, West Bengal, India,
E-mail : oikos_santiniketan@rediffmail.com

A survey was undertaken during 1996-1997 in different flower gardens and nurseries at Bolpur, Santiniketan and Sriniketan of Birbhum District, West Bengal, India, to study the fungal diseases of ornamentals viz. *Polianthes tuberosa*, *Pothos* sp., *Chrysanthemum indicum*, *Gerbera jamesonii*, *Dracaena marginata*, *Hibiscus rosa-sinensis*, *Calathea ornata*, *Ficus elastica*, *Bougainvillea glabra*, *Jasminum sambac* and *Rosa multiflora*. Fifteen fungal diseases have been formally described from West Bengal for the first time on these twelve ornamentals, of which the leaf spot of *Ficus religiosa* (c.o. *Alternaria* sp.) is the first report from India. Monthly dynamics were determined for occurrence, intensity and severity of these diseases. The values of these variables were highest during rainy months in *Alternaria alternata* on *Polianthes tuberosa*; *Alternaria alternata* and *Septoria chrysanthemella* on *Chrysanthemum indicum*; *Colletotrichum gloeosporioides* and *Alternaria* sp. on *Dracaena deremensis*; *Alternaria* sp. and *Cercospora hibisci-manihotis* on *Hibiscus rosa-sinensis*; *Colletotrichum gloeosporioides* on *Calathea ornata*; *Alternaria* sp. on *Ficus religiosa*; *Cercospora jasminicola* on *Jasminum sambac*; *Lasodiopodia theobromae* (= *Diplodia rosarum*) and *Diplocarpon rosae* on *Rosa multiflora*, and during summer to pre-rainy months in *Cercospora* sp. on *Pothos* sp.; *Alternaria*

alternata and *Cercospora gerberae* on *Gerbera jamesonii*; *Glomerella cingulata* on *Ficus elastica*; *Alternaria tenuissima* on *Bougainvillea glabra*. Strongly predictive equations for severity in terms of occurrence or intensity of diseases helped to assess losses. The 0-9 point scale was used for estimation of severity. Thus, new methodology has been developed for indirect loss assessment in terms of severity, as a direct function of yield loss in terms of occurrence or intensity together with a generalized key and corresponding disease scores. These findings may help in building of simple decision rules for management of these diseases.

Evaluation of botanicals for eco-friendly management of mulberry diseases

Maji, M. D., S. Chattopadhyay, R. Banerjee, A. B. Saha¹, P. K. Ghosh, S. Chakrabarti and A K. Bajpai, Central Sericultural Research and Training Institute, Berhampore-742101, India, ¹ Research Extension Centre, Nabagram – 742 184, India. **E-mail:** csrtiber@rediffmail.com

Mulberry (*Morus* sp.), the sole food plant of silkworm (*Bombyx mori*) is prone to several foliar diseases. Bacterial leaf spot [C.O - *Xanthomonas campestris* pv. *mori* Maji et al.], Myrothecium leaf spot [C.O- *Myrothecium roridum* Tode ex. Fr] and Powdery mildew [C.O-*Phyllactinia coryle* (Pers)Kraus] are major foliar diseases of mulberry in the Eastern and North Eastern region. These diseases reduced 10-15% leaf yield as well nutritive quality. The farmers are mainly depends on chemical pesticides for management of these diseases. Use of chemicals pesticides for disease management having several limitations i.e. residual toxicity on silkworm, costly and hazardous to environment. Moreover repeated use of fungicide/antibiotics leads to evolve of resistant pathogen strains. Therefore switch over from chemical to botanicals pesticides is urgently needed for sustainability of the sericulture industry. In order to develop eco friendly control measures of these diseases, two botanical products viz. Biosafe-X and CT-40 have been developed by the institute. The products were evaluated at farmers' field in Murshidabad and Malda for two years in paired plot technique. It was observed that foliar spray of Biosafe-X at 0.75% concentration reduced bacterial leaf spot disease severity 35.41% and increased leaf yield 16.29%. It also reduced Myrothecium leaf spot disease severity 34.07% and enhanced leaf yield 12.83%. Foliar spray of CT-40 at 2.5% concentration reduced powdery mildew disease severity 67.97% and increased leaf yield 15.41%. Biochemical analysis revealed that foliar spray of botanicals increased Chlorophyll-a, b, total chlorophyll, total soluble sugar, total soluble protein and total soluble phenol content. Benefit cost analysis revealed that, Benefit cost ratio of Biosafe-X and CT-40 is 1.78: 1 and 4.65: 1 respectively. The findings indicate that foliar spray of botanical pesticides not only reduced foliar disease severity but also increased leaf yield as well as leaf quality. Benefit cost ratio indicates that use of botanical pesticides for mulberry diseases management is cost effective and environment friendly.

Eco-friendly management of mealybug, *Dysmicoccus brevipes* (Cockerell) in pineapple

Mandal Dhananjoy, Subject Matter Specialist (Plant Protection), (Uttar Banga Krishi Viswavidyalaya), Uttar Dinajpur Krishi Vigyan Kendra . Chopra, Uttar Dinajpur 733 216, **E-mail:** dhananjoy1@redifmail.com

An on-farm experiment was conducted during the year of 2006-07 at Chopra, Islampur, Uttar Dinajpur, West Bengal, for eco-friendly pest management of mealy bug, *Dysmicoccus brevipes* (Cockerell) in pineapple. In RBD, the treatments were: T₃ (Treating planting materials (basal portion of the planting material) with monocrotophos (0.02%) + phorate 10 G (15 kg ha⁻¹) (100 days after planting: DAP) + neem cake (1.5 t ha⁻¹) (180 days after planting; and three times manual weeding); T₁ (Farmers' practice: phorate 10G (20 kg ha⁻¹ during planting, monocrotophos (0.03%) at 100 DAP + endosulfan (0.02%) (150-180 DAP); T₂ (Treating planting materials with monocrotophos (0.02%) + phorate 10 G (15 kg ha⁻¹) (100 DAP) + Neem oil spray (2.5 ml/l) (150 DAP). On the basis of yield performance and reduction of percentage of wilted plants and mealy bug population, the treatment T₃ was the best and T₂ ranked second. Percent of wilted plants in T₁, T₂ and T₃ were 11.88, 4.19, 2.62, mean mealy bug population/plant were 9.33, 5.29, 4.20, and yield were, 38.7 t/ha, 32.5 t/ha 41.6 t/ha, respectively. Benefit: Cost ratio was highest in T₃ (1.30) followed by T₂ (1.24) and T₁ (1.09).

Site-Specific Appropriate Precision Agriculture

Dhananjoy Mandal¹, K. Baral² and M. K. Dasgupta³ ¹ Subject Matter Specialist (Plant Protection), Uttar Dinajpur KVK (Uttar Banga Krishi Viswavidyalaya), Chopra, Uttar Dinajpur,

^{2&3} Professor of Plant Protection, Department of Plant Protection, Palli-Siksha Bhavana, Visva-Bharati, Sriniketan 731236, Birbhum Honorary Professor of Plant Pathology, respectively; *Oikos*, Simantapalli, Santiniketan 731235, Birbhum, **E-mail:** dhananjoy1@redifmail.com

Precision Agriculture" (PA) applies geoinformatics and agriinformatics to manage spatial and temporal variability associated with all aspects of crop and pest management. So conceived, PA may be suitable for capital-intensive, turnover economy, technological monoculture and controlled management but not for peasant farming.

To seek site-specific appropriate precision agriculture (SSAPA) (size of site dependent on the scale of available data), in Senkapur-on-Ajay, 6 km SW of Sriniketan

(23°39'2" N, 87°42'2" E, 58.9 m AMSL), in a strip plot experiment, we are comparing nine rice- and vegetable-based cropping sequences between improved and farmers practices in terms of five parameters, viz. crop growth and productivity, soil nutrient

management, pest and BCA balance, energy balance, economics ~ each with several variables.

By return per Rupee investment Rice-Potato-Pumpkin¹, Cucumber- Cabbage-*Basella alba*, and Groundnut–Brinjal+Brinjal sequences were suitable for resource-rich growers, whereas Okra-Chilli+Chilli, and Black gram–Parwal+Parwal sequences were suitable for resource-poor growers. Overall, Groundnut–Brinjal+Brinjal, Okra-Chilli+Chilli, Cucumber-Cabbage-*Basella alba* cropping sequences, over three years in a row, were the best.

Information on the detailed soil survey, RS-generated geo-informatics including geo-referenced thematic maps, soil and physiography, meteorological data, farmers' socio-economic status, market arrival and price, crop and pest management provided, farmers' decision-making may become easier and more precise than without.

Antagonistic effect of neem and other plant products as seed coating against root-knot nematode, *Meloidogyne incognita*, infecting chickpea

Mishra, S. D. and Parul Agarwal, Division of Nematology, Indian Agricultural Research Institute, New Delhi-110 012. **E-mail:** sdm_nema@yahoo.com

Chickpea (cv. *Cicer arietinum*), the most important pulse crop of India, used both for livestock as well as human consumption, was found to be heavily infested with root-knot nematode, *Meloidogyne incognita*, the most widespread and polyphagous among nematode pests of plants in the world. An experiment was carried out to test the eco-friendly nematicidal efficacy of various plant products viz. neem seed powder, neem seed cake, fresh and dried leaves of *Calotropis procera*, fresh and dried leaves of *Datura metel*, and latex of *Calotropis procera*. The experiment was conducted in earthen pots containing highly root-knot infested soil having the level of nematode infestation as 10 J²/g of soil. All the treatments were applied as seed coating with two alternate doses of 5 % and 10 % w/w of seeds and replicated three times along with check. Seeds of chickpea cv. PUSA 1103 were sown per pot after applying the desired treatments. Observations on plant growth parameters viz. shoot-length and shoot-weight, root-length, root-weight and number of root-knot galls were recorded after two months of germination. A drastic increase in shoot-length and shoot-weight, root-length and root-weight was observed with the seed coating of latex of *Calotropis procera* @ 10 % w/w which was followed by fresh leaves of *Calotropis procera*, whereas in check, it was much lower. Root-knot gall index was found to be lowest i.e. 0 (on the basis of 0-5 scale) in case of latex of *Calotropis procera* and fresh leaves of *Datura metel* at 10% w/w concentration and highest in check. Dried leaves of both the plants and neem products also provided significant results. Higher concentrations of all the treatments (i.e. 10% w/w) were observed better than lower (i.e. 5% w/w) of the treatments. Such treatments may be incorporated in Integrated Nematode Management options against nematodes infesting pulse crops.

Bioefficacy of some indigenous plant extracts against epilachna beetle [*Henosepilachna vigintioctopunctata*, Fabr.] infesting cucumber

Mondal, Sujoy and S. S. Ghatak, Department of Agril. Entomology Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, Pin-741252.
E-mail:mondla_bckv@yahoo.co.in

A field trail was conducted on "Barapata" variety of cucumber in a Replicated Randomized Block Design at Viswavidyalaya Instructional Farm during 2004-2005 to find out the impact of plant derived pesticides viz; Neem Azal, Rhizome extracts of *Acorus calamus* with petroleum ether as solvent and Seed extracts of *Annona squamosa* with methanol as solvent in controlling Epilachna beetle, *Henosepilachna vigintioctopunctata*, Fabr. Both of Neem Azal and Seed extracts of *Annona squamosa* were used at 4ml, 5ml and 6ml (per lt of water) while this was 1ml, 2ml, and 3ml (per lt of water) in case of petroleum ether extract of Rhizome of *Acorus calamus*. Endosulfan 35 EC was used at 1ml, 1.5ml and 2ml (per lt of water) to compare the efficacy of plant products. Results of the experiment revealed that Endosulfan 35 EC at 1.5ml/lt of water performed very well in reducing population build up of *Henosepilachna vigintioctopunctata*, Fabr to the extent of 62.54%, while among the botanical pesticides, this was highest (53.24%) in Seed extracts of *Annona squamosa* at 5ml/lt of water followed by 41.67% in Neem Azal at 6ml/lt of water and 33.16% in petroleum ether extracts of Rhizome of *Acorus calamus* at 2ml/lt of water.

Insecticide resistance management (IRM) in diamond back moth (*Plutella xylostella* L.) – A success story

Mukherjee, U., Ranendra Agricultural University, Pusa, (Samastipur) – 848 125, Bihar, **E-mail:** umukherjeerau@gmail.com.

Diamondback moth (*Plutella xylostella* L.) is a serious insect pest of cabbage and cauliflower crops. It has attained a high level of resistance to almost all types of insecticides used against it. However, the following IRM strategies adopted against DBM has caused revolutionary impact on its efficient management: crop rotation, insecticide rotation, use of bio-pesticides and use of synergists. This paper elaborates the success achieved due to implementation of various IRM strategies against DBM.

Studies on the bio-safety of botanical insecticides to native natural enemies in mulberry ecosystem

Mukhopadhyay, S. K., M. V. Santha Kumar, P. Mitra and A. K. Bajpai,
Entomology Laboratory, Central Sericultural Research & Training Institute, Berhampore
– 742 101, W.B. **E-mail:** csrtiber@rediffmail.com/swapan_man@yahoo.co.in

Mulberry (*Morus alba*) is damaged by three major pests viz., thrips (*Pseudodendrothrips mori*), mealy bug (*Maconellicoccus hirsutus*) and whitefly (*Dialeuropora decempuncta*) causing a leaf yield loss ranging from 11 – 24 %. Chemical control measures are costly and cause residual toxicity to silkworm if applied without observing the safe period.. Therefore this Institute has identified various concentrations and combinations of pongamia oil, neem oil, and nicotine extract for effective control of pest incidence. In the present study, different effective concentrations and combinations viz. 1.5% pongamia oil, 2% pongamia oil, 1% neem oil, 2% neem oil, 1% nicotine extract, 2% nicotine extract, 1% pongamia and neem oil, 1% neem oil and nicotine extract, 1% nicotine and pongamia oil were evaluated for the impact on the native natural enemies of the major mulberry pests. The observations have revealed that all the concentrations were found safer to the predators, viz., *Micraspis crocea*, *Micraspis discolor* and *Scymnus bourdilloni* when exposed to leaves after four hours of spray. Hundred percent mortality was observed when the predators were exposed to the leaves treated with 0.1% dimethoate. Thus botanicals can conveniently be used as being safer for natural enemies.

Utilization of botanicals in the management of the coconut perianth mite, *Aceria guerreronis* Keifer

Nandihalli, B. S. Department of Agricultural Entomology, University of Agricultural Sciences, Dharwad, Karnataka, India. **E-mail:** b_nandihalli@rediffmail.com

The experiment on utilization of botanicals in the management of the coconut perianth mite, *Aceria guerreronis* Keifer was conducted at Main Agricultural Research Station, Dharwad, Karnataka during 2003-04 with nine treatments. The results of the present study indicated that among different botanicals, NSKE 5 per cent was found significantly superior in reducing the mite population with higher healthy nuts (81 nuts/4 bunches), least per cent of damaged nut (65 per cent) and highest benefit (12.2) which was on par with wettable sulphur (10.5). The next best treatment was neem oil 2 per cent.

Pests infesting ornamental plants in hilly region of West Bengal

Pal, S. and I. Sarkar, Regional Research Station, Uttar Banga Krishi Viswavidyalaya, Kalimpong, Darjeeling, West Bengal-734301, India,
E-Mail: palsento@gmail.com

A survey was conducted during 2005-06 at the farms of R.R.S Kalimpong; UBKV, Pedong and other adjoining areas. The crops surveyed included gladioli, carnations, *Anthurium*, gerbera, china rose, chrysanthemums, Bird of Paradise and straw flower. A number of aphid species were found infesting different ornamental plants viz. *Myzus persicae* on carnations, gerbera and *Anthurium*; *Macrosiphoniella sanborni* on chrysanthemum; *Aphis gossypii* on China rose. Other sucking pests infesting ornamentals included *Bemisia tabaci* on gerbera, leafhopper on gladiolus and scale insects (unspecified) on *Anthurium*. Amongst the thysanopteran pests *Taeniothrips simplex* was very much serious on gladiolus and another species of thrips (unspecified) was found infesting carnations. Amongst the lepidopteron pests gram pod borer, *Helicoverpa armigera* was most important inflicting serious damage to carnations, gerbera, gladiolus, chrysanthemum and Straw flower. The green semilooper, *Plusia orichalcea* caused damage to gerbera and gladiolus by feeding on the leaves. The tobacco caterpillar, *Spodoptera litura* was serious on gladiolus and *Anthurium*. Cutworm, *Agrotis segetum* damaged the seedlings of gladiolus. Among the Coleopteran pests the Blister beetle, *Mylabris* sp. was most important feeding on the flowers of gladiolus and China rose. The steel blue beetle, *Altica* Sp. and white spotted flea beetle, *Monolepta signata* was found infesting gladiolus and chrysanthemum respectively. The serpentine leaf miner, *Liriomyza trifolii* was recorded on gerbera. Among non-insect pests the red spider mite, *Tetranychus urticae* was very important causing havoc to carnations, gerbera and chrysanthemums during dry summer months.

Eco friendly approach for guava wilt disease management in West Bengal

Ray, S.K. and I. Bhattacharya, AICRP on Subtropical Fruits and Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, 741235, **E-mail:** indrabratabhattacharya@gmail.com

Continuous decline of guava orchards caused primarily due to wilt and several other minor parasitic and non parasitic diseases is a common and serious disease complex posing as a major problem for commercial production of guava in several parts of India including West Bengal. Annual loss from this disease accounts for 10-80% of production depending on disease severity in different agro-ecological situations. In West Bengal guava is commercially cultivated mainly in Baruipur subdivision in the district of south 24 Parganas with an average yield of 80-90 MT/ha per year. Besides Baruipur commercial cultivation is also made in isolated areas

of new alluvial zone and red and lateritic region. Thorough investigation on aetiology of guava wilt disease established the role of *Fusarium oxysporium f.sp.psidi* and *Macrophomina phaseolina* depending upon season and agro-ecological situation. In new alluvial region including Baruipur, *M.phaseolina* is predominant causal agent in rainy season and *Fusarium oxysporium* in red and lateritic regions in winter season. In light and acidic soil (pH-5.-5-6) of lateritic region only *Fusarium oxysporium* was responsible whereas in gangetic alluvial soil of Baruipur both *Fusarium* and *Macrophomina* caused wilt. Nutrient depletion and poor management of guava orchard are also aggravating factors for wilt disease development. Sustainable management strategy can be developed through genetic resistance lines, cultural practices and nutrient management of guava orchard. Flood irrigation and water stagnation for 3-4 days and integrated nutrient management by application of different oil cakes like neem, karanja and ground have been found effective management practice in Baruipur orchards. Genetic resistance has been found in some local germplasms and some degree of tolerance was observed on L-49 variety. But Allahabad Safeda which is the most popular commercial cultivar is highly susceptible. Neem cake, organic amendments and slow releasing inorganic fertilizers delayed the wilting process and some degree of recovery has been found with their application in red and lateritic regions of Birbhum district orchards. Basic strategy of wilt disease management has been developed by regular disease monitoring, cultural practices, integrated nutrient management and proper selection of guava cultivars for different agro-climatic regions of West Bengal.

Development of weather based forecasting models for major mulberry pests in murshidabad district of West Bengal

Santha Kumar, M.V., S. K. Mukhopadhyay, U.K. Bandyopadhyay, N. Chakraborty, P. Mitra & A. K. Bajpa, Entomology Laboratory, Central Sericultural Research & Training Institute, Berhampore – 742 101, W.B.

E-mail : csrtiber@rediffmail.com

Mulberry (*Morus* Spp.) the sole food plant of silkworm *Bombyx mori* is prone to two major pests viz. thrips, *Pseudodendrothrips mori* (Niwa) (Thysanoptera: Thripidae), and whitefly, *Dialeuropora decempuncta* (Quaintance & Baker) (Homoptera: Aleyrodidae) causing leaf yield loss from 11 to 25%. These also cause deterioration in the quality of mulberry leaves. Several chemical control measures have been recommended from time to time but due to clear-cut schedule for silkworm rearing, chemical control measures are often a problem especially when pest incidence occurs during the safe period during which chemicals cannot be applied for controlling the pest because the treated leaves may cause mortality in silkworm.

Considering this, an alternative approach was initiated to inform the farmers about possible incidence of the pest in advance to remain in preparedness. Pest incidence and damage response was surveyed vis-à-vis abiotic factors viz., max. & min. temp., max. & min. R.H. and rainfall conditions for three years and were correlated. Multiple regression equations were constructed for each pest. In case of thrips maximum temperature showed a positive significance (at 5% level) on population

build up. On the other hand, maximum relative humidity and rainfall had a positive correlation with the incidence of whitefly. It has been observed that the effect of abiotic factors could explain the variations in the population of pests. Based on this, a forecasting model was developed for Murshidabad district of West Bengal. By this model an extension functionary will be able to inform the farmers to remain in preparedness for taking appropriate control measures, leaving chemical pesticide application as last option. An alternative approach was initiated and forewarning system has been developed for managing the pest.

Histochemical localization of reactive oxygen species activity in the vascular bundle of rice leaves affected by *Xanthomonas oryzae* pv. *oryzae* and its relation with the activity of scavenging enzymes

Satya, P. Department of Genetics and Plant Breeding, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal, India, PIN : 736165,
E-mail: satyapratik123@rediffmail.com

Bacterial blight of rice caused by *Xanthomonas oryzae* pv. *oryzae* is a vascular disease that progresses from leaf tip downwards to leaf sheath. The bacteria colonise the vascular bundles, block cellular activity and the symptoms are expressed as yellowing followed by browning of affected tissues. Vital staining was applied to identify spatial distribution of living and dead tissues in infected rice leaves. Linear restriction of the progress of disease was observed with xylem tissues being more affected than phloem tissues. The pathogen infestation was found to be associated with ROS scavenging enzyme activity. Histochemical localization of hydrogen peroxide activity using diaminobenzidine revealed increased accumulation of H₂O₂ activity along disease progress and enzymatic activity gradient.

Temporal variability in disease progress of *Xanthomonas oryzae* pv. *oryzae* isolates from eastern India

Satya¹, P. S. Debnath¹, N. K. Biswas² and A. Debnath², ¹Department of Genetics and Plant Breeding, ²Department of Plant Pathology, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar-736165, West Bengal, India,
E-mail: satyapratik123@rediffmail.com

Xanthomonas oryzae pv. *oryzae* (*Xoo*) causing bacterial blight of rice seriously affects rice productivity all over India. The disease attacks both Aman and Boro rice in northern districts of West Bengal and Bihar. Variable progress of disease was noted in Aman as well as Boro rice in different crop growth stages. Active tillering and reproductive phases were found to be more susceptible than early kresak phase. Genotype by isolate interaction and isolate by crop growth stage interaction were significant indicating genetic variability of collected *Xoo* isolates. Traditional aromatic rice lines were found to be more susceptible to isolates collected from terai region. Three resistant lines were identified from a pool of thirty two germplasm.

Biological Control of *Sclerotinia* blight of cabbage using *Trichoderma* spp.

Selvakumar, R. Assistant Professor (Plant Pathology), Department of Plant Protection, Central Agricultural University, College of Horticulture & Forestry, Pasighat – 791 102, Arunachal Pradesh, **E-mail:** selvakumar2000@gmail.com

Sclerotinia blight (*Sclerotinia sclerotiorum* (Lib.) de Bary) is one of the most widespread and destructive diseases occurring on cabbage. The present research was conducted to identify possible biocontrol agents affecting severity of infection by *S. sclerotiorum*. *Sclerotinia* usually produces dark brown to black stem lesions near the soil level and causes leaves to wilt, then die and roots to become rotted. Severely diseased plants show a droopy symptom in which all leaves wilt completely and characteristic brown lesions and white mycelia appear at the base of the stems. A total of 12 strains of *Trichoderma* sp. were evaluated for antagonism against *S. sclerotiorum* *in vitro*. This antagonism was confirmed for selected strains in greenhouse evaluations. These results suggest that certain *Trichoderma* strains have an excellent potential for use in managing *Sclerotinia* blight of cabbage.

Development of management strategy for production of transgenic citrus resistant to citrus tristeza closterovirus

Tarafdar, A., Sumita Kumari and K. K. Biswas, Unit of Plant Virology, Division of Plant Pathology, Indian Agricultural Research Institute, New Delhi 110012, **E-mail:** kkbiswas@lycosasia.com

Genetic engineering approach to modify crop plants using viral genome has been proven to be an effective alternative method to develop virus resistant cultivars. However, virus resistant/tolerant transgenic citrus plants developed by the transformation techniques have been relatively slow. Still, use of coat protein (CP) gene for transformation of citrus plants now is on offing.

Citrus tristeza virus (CTV), a member of genus *Closterovirus*, is one of the largest known aphid transmitted plant virus causing destructive disease causing decline of several millions of citrus including more than 1.5 million trees in India till date. Since the CTV is a complex in nature with biological and genetic variants of CTV existing under natural conditions, efforts have been made to identify severe and mild CTV isolates from diversified CTV population and isolation of CP gene from mild and severe CTV isolates for production of CP gene construct in sense and antisense direction in binary vector for transformation of kagzi lime (*Citrus aurantifolia*) plant mediated through *Agrobacterium* cells.

Based on biological indexing, two mild CTV isolates, CTK5 and CTK13, and two severe isolates CTK9 & CTK10 were identified from Darjeeling hill region of North eastern Himalayan region of India. Entire CP gene of 672 bp length was amplified from all the selected isolates using specific primers K543F and K544R, cloned into

pDrive vector and sequenced. CP gene was re-cloned in *pBinAR* binary vector in *Bam HI* and *Sal I* site. Regeneration protocol of kagzi lime and Darjeeling mandarin (*C. reticulata*) was standardized using 1-2 cm ex-plant from 1-2 months old epicotyls from *in vitro* produced seedlings using MSo medium supplemented with different concentration of BAP. After two months upto 60% plants were regenerated inducing maximum multiple shoot @ 3-5/explant using 2-3 mg BAP litre⁻¹. Regenerated shoots were harvested from the explant segments after 3-4 months and placed into MSo medium supplemented with NAA @ 0.5 mg litre⁻¹. Explants from epicotyls segments from *in vitro* produced seedlings were co-cultivated with *Agrobacterium tumefaciens* strain EHA105 harbouring CP gene construct in binary vector *pBinAR* (*pBinARCK-5*, -9, 10 and -13) for transformation of kagzi lime plants.

Effect of *Meloidogyne incognita* on biochemical changes in leaves of *Mentha arvensis*

Thakur^{*}, S. K. and P. P. S. Baghel, ^{*}Department of Nematology, R A U, Bihar Pusa (Samastipur) 848125 and Department of Nematology, CCS HAU, Hisar, Haryana, India, **E-mail:** baghel_pps2000@yahoo.co.in.

Meloidogyne incognita inoculated @ 0, 10, 100, 1000, 10000 J²/plant/ pot to study the impact on biochemical changes in *Mentha arvensis* leaves under screen house conditions. Decrease of reducing sugar, carbohydrate, starch, and phenol in mentha leaves was observed at all inoculum levels over check (0 inoculum). The decrease was progressive with increase in nematode inoculum levels. Significant decrease in above parameters was observed on 1000 and 1000 J²/pot/plant inoculum levels. *M. incognita* inoculum @ 1000 J²/pot/ plant and above significantly affected the quality of mint oil. It significantly reduced the menthol per cent in mint oil, which is the basis of price fixation in market. Other constituents viz., menthone, isomenthol, methyl acetate and neo-menthol of mint oil were also affected. Significant reduction in all constituents of mint oil was observed on highest nematode inoculum level.

Effect of *Meloidogyne incognita* and *Glomus fasciculatum* on plant growth and oil content of *Mentha arvensis*

Thakur¹, S. K. and P. P. S. Baghel, ¹Department of Nematology, R A U, Bihar Pusa (Samastipur) 848125 and Department of Nematology, CCS HAU, Hisar, Haryana, India, **E-mail:** baghel_pps2000@yahoo.co.in.

The experiment was conducted in pots by applying endomycorrhizal fungus *Glomus fasciculatum* inoculum (450-500 chlamydospore/100cc soil)/plant (*Mentha arvensis*) in 5 kg capacity pot, *Meloidogyne incognita* 5000 J²/plant/pot and various combination of both. For comparing the effect of each organism individually and in combination two check, no nematode no fungus and nematode with carbofuran @ 4Kg a.i./ha, were also maintained. *G. fasciculatum* suppressed population and enhanced

mentha plants growth (length and fresh weight of shoot and root) and significantly enhanced plant nutrients (N,P and K) for better growth . *M. incognita* reduced plant growth parameters, herbage yield and oil content. Alone, mycorrhizal fungus inoculated plants showed significant increase in oil content and herbage yield. The fungus in presence of nematode suppressd the adverse effect of nematode. Mycorrhizal fungus alone treated plants showed superiority over different combination of mycorrhiza with nematodes. Mycorrhizal fungus inoculated 15 days prior to nematode performed better in respect of plant. growth.

Evidence of bioinsecticidal properties in aquous phyto extract of datura (*Datura stramonium* L.) against *Helicoverpa armigera* Hub. on chickpea

Yadav, R.P. and R.P. Sharma, Department of Entomology and Agril. Zoology, Tirhut College of Agriculture, Dholi, Muzaffarpur (Bihar)- 843 121, India.

In order to explore the possibility of bioinsecticidal activities in *Datura* (*Datura stramonium* L.), its aquous phytoextracts at five different concentrations viz; 0.5, 1.0, 1.5, 2.0 and 2.5 per cent, were tested against *Helicoverpa armigera* Hub. on Chickpea (*Cicer arietinum* L.) under laboratory conditions and comparisons were made with untreated control. Differential effect of the phytoextract was assessed in respect of six growth and developmental indices viz. survival index, larval weight index, ovipositional preference index and success index. Each of these indices recorded a value less than 1.0 at all the test concentrations of the phytoextract, indicating the adverse effect of treated chickpea plant material on different life processes of *H. armigera*. Intensity of deleterious effect of the test phytoextracts was found to increase with increase in its concentration from 0.5 to 2.5 per cent as indicated by decreasing value of growth and developmental indices. Correlation and regression analysis revealed that larval survival, larval weight, pupal weight, pupal period, pupal survival and longevity as well as fecundity of female adult had a highly significant but negative correlation with the concentration of the test phytoextract. Reduced larval, pupal and adult survival, poorer larval and pupal growth and ultimately reduced fecundity of female developed on chickpea plant treated with the aquous extract of *D. stramonium* would lead to poor population growth of *H. armigera* through successive generation.