nological interventions in honey bees of native species. Dwijendra Singh presented his views on the following issues for biotechnological interventions: (a) Management of diseases and pests with special reference to mite species (*Varroa* and tracheal mite), including development of new superior strains of bees that could develop significant mite resistance besides investigation on phyto-chemicals[4]; (b) Identification of flowering pastures of plant species that may attract maximum number of worker bees for foraging, leading to higher production of honey and associated products[5]; (c) Investigation of granulation problem in mustard honey compared to litchi honey during storage; (d) Developing superior strains of honey bees for other value-added natural products of medicinal importance, namely propolis and royal jelly that may fetch high foreign exchange; (e) Need to identify 'magic bee tree' species similar to *Kampassia alaccensis* that bear about sixty-nine colonies of giant honey bees (*A. dorsata*) on their branches under natural conditions, that could be planted in orchards for maximum cross-pollination in plants, and (f) Identification of novel biotypes through new tools and methods of molecular determination for high productivity of honey and foraging capability of bees.

After the discussion on different subtopics for apiculture in India and need for biotechnological interventions raised by the participants, Gadagkar concluded the session identifying ten important issues, namely Diversity of non-Apis species, Pollination and bee flora studies, Breeding of bees for mass rearing of queens, Honey certification, Development of molecular marker of *A. cerana*, Bioprospecting for royal jelly, etc. Development of database, Documentation of status report, Disease and pest management, behaviour of bee-mite in relation to *A. cerana*, and Bee pheromone science and technology for cross-pollination in agriculture. Based on this brainstorming session, these major areas were classified into 16 sub-priority areas for future studies: genetic diversity (1), pollination studies (3), development of breeding techniques/mass rearing of honey bees (8), honey products (2), molecular markers (2), besides development of database and status report. It is expected that these biotechnological interventions in honey bees will change the present scenario of apiculture in the country leading to nutritional security, natural medicinal source, new genotypes and behaviour, employment and income generation through quantitative and qualitative transformation in national and international trade of honey and its associated products to make India the number one exporter in the world market.

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MEETING REPORT

Insect pest management*

One of the important problems in agriculture is the loss of agricultural produce due to attack by insects. Farmers rely largely on chemical pesticides to save their crops from insect pests. The use of chemical pesticides like DDT, BHC and organophosphate pesticides for insect pest management (IPM) has resulted in the decline of biocontrol agents and other beneficial insects, secondary pest outbreak and emergence of insect strains resistant to pesticides. There is a growing concern among people over the accumulation of pesticides in the food chains. These problems have prompted the scientific community to find non-toxic and environment friendly alternatives to chemicals.

From time to time, researchers have found many ecofriendly alternative methods such as botanical pesticides, attractants and repellents, insect growth inhibitors and biological control. IPM strategies have gained increased attention in recent years as a potential means of reducing commodity losses to pests. Biointensive IPM or 'ecology-based pest management' is gaining grounds. Recently, many farmers have followed non-pesticidal management.

Pest management tactics that minimize environmental impact will contribute to the stability of agricultural systems. With a view to review the latest trends and technologies in IPM, a national symposium on recent trends in IPM was organized.

Deliberations during the symposium covered various aspects of pest management techniques. Totally 62 papers under eight sessions were presented by scientists and scholars from different parts of the country on aspects of host plant resistance and transgenics, microbial technology in IPM, induced resistance in host plants, genetic improvement of entomophages, improved technology for mass rearing of natural enemies, bioefficacy of entomopathogenic fungi and nematodes, insect cell culture technology for production of entomopathogenic viruses, new botanical formulations for ecofriendly pest management, importance of molecular and beha-

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vioural ecology in pest management and pest population monitoring.

In his inaugural address, H. Basker (Central Silk Board, Ministry of Textiles, Govt of India, Bangalore) stated that host plant resistance is basic to IPM, and that several breakthroughs are happening in the field of biotechnology, such as transgenics with pest resistance around the globe. Till recently, cotton production programmes in India were upset by the notorious pest, cotton bollworm. After the advent of *Bt*-cotton, production of the major fibre had gone up in the country. According to the Union Textile Ministry, the nation expects cotton production in the September–October season to go up to 270 lakh bales, each of 170 kg, from last year's production of 244 lakh bales. This is attributed mainly to the management of the bollworm by large-scale introduction of *Bt*-cotton in many States. In Punjab, 70% of the total input was *Bt*-cotton and its use has been increasing.

S. Jayaraj (S. Jayaraj Research Foundation, Chennai) elucidated with case studies that predator longevity feeding on *Bt*-intoxicated prey decreased, creating trade-offs between the mortality caused by the toxin and that due to reduced predation. The use of pesticide for supplementary control of tolerant pests in *Bt*-cotton may further disrupt natural enemies and increase pest levels. He suggested future studies to focus on integrating *Bt*-crops with biological control and other IPM tactics.

S. Ignacimuthu highlighted the work on pest-resistant transgenics in grain legumes and stated that α-amylase inhibitors (α-AI) are attractive candidates to control seed weevils. Legumes like *Phaseolus vulgaris* contain plant defence proteins such as α-AI, phytohaemagglutinin (PHA) and arcelin. α-amylase inhibitors retard insect growth and development by inhibiting larval midgut α-amylases of *Callosobruchus maculatus*. M. K. Dhillon (International Crops Research Institute for the Semi-Arid Tropics, Hyderabad) indicated potentials and limitations of insect-resistant transgenic plants in IPM. He further stated that pollen and *Bt*-genes of transgenic crops do not affect natural enemies, beneficial insects and microbes. Induction of systemic resistance in crop plants against insect pests with bioinoculants was shown in many papers.

Abraham Verghese (Indian Institute of Horticultural Research, Bangalore) explained the recent achievements in fruit fly management in mango and citrus, including aspects related to area-wide management in many States. The perspectives in IPM in mulberry for sustainable sericulture in South India was elaborated by S. M. H. Qadri (Regional Sericultural Research Station, Salem). S. Manisekaran (Horticultural College and Research Institute, Periyakulam) reported that the tomato accession LE 228 is resistant to *Helicoverpa armigera* larva and the resistance is due to morphological adaptations in plants such as low fruit volume index and narrow leaves and biochemical constituents. V. Selvanarayanan (Annamalai University, Annamalainagar) emphasized that host plant resistance can be induced in tomato and sesame by artificial spray of methyl jasmonate and amendment of bioinoculants like arbuscular mycorrhizal fungi.

J. Diraviam (Agriculture, Man, Ecology Foundation, Dharmapuri), mentioned that indiscriminate application of insecticides in rice has resulted in the reduction of biodiversity of natural enemies, development of pesticide-induced resistance and outbreak of secondary pests. A new concept has been proposed called 'Integrated Biodiversity Management' under which IPM and conservation ecology are integrated. N. Somasekhar (Central Potato Research Station, Ooty) stated that the impact of inundative application of entomopathogenic nematodes on soil biodiversity in agroecosystems needs to be assessed before implementing these nematodes in pest management, because entomopathogenic nematodes may sometimes suppress the population of non-target fauna like plant parasitic nematodes. B. Deepa and O. K. Remadevi (Institute of Wood Science and Technology, Bangalore) presented their findings on the insecticidal activity of the leaf extract of *Dodonaea viscosa* on teak defoliator. The efficacy of leaf extracts of plants such as *Aristolochia bracteata*, on feeding, reproduction and mortality of many insects was highlighted by several authors. Several new species of plants were shown to have biopesticide value. Botanical formulations and substances developed by the authors were also presented.

Genetic improvement of entomophages and entomopathogens, as well as improved methodology for mass production of biological control agents, including *in vitro* production of baculoviruses were highlighted by several authors. The impact of insect molecular ecology studies on pest management in crop plants was explained by S. Mohankumar (Tamil Nadu Agricultural University, Coimbatore). Papers in molecular and behavioural ecology, and pest population monitoring were presented.

As a result of the deliberations, scientists proposed to initiate farmer participatory area-wide action research in major crop ecosystems, manipulate crop structure to enable greater natural enemy population, strengthen insect taxonomy and biosystematics research, establish national-level repository for natural enemies, create databases of botanical and microbial pesticides, entomophages, pollinators and other beneficial insects, study the biosafety of *Bt*-toxins and other transgenics under Indian conditions and launch insecticide/*Bt*-toxin resistance management programmes.

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