IMD searched for a new model whose parameters were both physically well related and statistically stable. IMD has now brought out the following new models:

- 8-Parameter power regression model: This requires data only up to March. This replaces the existing 16-parameter power regression model that required data up to May. The model error is ± 5%.
- 8-Parameter probabilistic model: This requires data only up to March. This replaces the existing 16-parameter parametric model that was used for giving a qualitative forecast.
- 10-Parameter power regression model: This requires data up to June and has been developed for purposes of a long-range forecast update to be issued by 15 July. The model error is ± 4%.
- 8-Parameter power regression model for forecast of July rainfall: This requires data up to June. The model error is ± 9%.
- The existing power regression models for long-range forecasts of monsoon rainfall over three broad homogenous regions of the country have been refined and these forecasts would be issued by 15 July.

The model parameters for both the 8-parameter and 10-parameter power regression models are shown in Table 2. According to IMD, both these new models and the 8-parameter power regression model for July rainfall has used 38 years data (1958–1995) and an independent verification conducted for 7 years (1996–2002). The probabilistic model uses a 'statistical discriminant analysis' for a qualitative forecast. IMD has claimed a better performance for the new 8-parameter and 10-parameter models over the old 16-parameter model during the period of independent evaluation between 1996 and 2002 (see Table 3).

IMD has thus adopted a two-stage forecast process, the first forecast on 16 April and the second, an update to be made available in mid-July. IMD has not got the forecasting models peer-reviewed, although this is strictly not applicable, IMD being a service organization. However, data subjected to a peer-review process is definitely in line with any scientific pursuit. Kelkar said a move was on for ensuring requisite input parameters needed for the statistical models from space satellite data of the Indian Space Research Organization's (ISRO) satellites such as 'Metsat', 'Oceansat' and 'Climatesat' for further improved forecasting of the Indian monsoon now and in the future.

**Table 3.** Comparative chart for the better performance of the new 8- and 10-parameter models as compared to the 16-parameter model

| Year | 16-Parameter | 8-Parameter | 10-Parameter |
|---|---|---|---|
| 1996 | +7 | +3 | +3 |
| 1997 | +10 | −1 | +1 |
| 1998 | +6 | −4 | −2 |
| 1999 | −12 | −5 | −6 |
| 2000 | −7 | +3 | +3 |
| 2001 | −7 | +1 | +3 |
| 2002 | −20 | −17 | −14 |

Source: IMD, New Delhi.
Note: Actual minus forecast (%).

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MEETING REPORTS

# Eco-friendly approaches for sustainable insect pest management*

Agricultural production in India is limited by many factors like soil, water, genetic potential of the crop and the organisms that feed on or compete with food plants. Food crops the world over are damaged by more than 10,000 species of insects and the overall estimated yield losses from different pests are reported to be US$ 500 billion globally and Rs 45,000 crores in India alone. About 42.1% of attainable production is lost due to pest attack; however, if no control measures are adopted, the figure would be 69.8%. To realize the impact of chemical pesticides, sustainable pest management strategies have become vital to systematically review the recent advancements in insect control and to develop better crop protection programmes. Sustainable Insect Pest Management (IPM) was discussed at a national symposium.

Participants from all over India discussed the sustainability of various pest management strategies available for controlling insect pests of different crops. Pest-tolerant cultivars, seed treatment with imidachloprid, *Trichoderma*, etc., judicious use of fertilizers and clean cultivation, okra or marigold as trap crop, monitoring through pheromone traps, *Trichogramma* release, ovicidal insecticides, NSKE 5%, *Ha*NPV, limited use of pyrethroids, hand collection of grown-up larvae, ETL-based application, etc. were the core components of an IPM module which was successful in repeated large-scale trials to give satisfactory control of cotton pests. Growing maize, sunflower, cowpea and green gram leads to more natural enemies.

Prospects of using transgenic crops in India have been looked into and crops like cotton, rice, sugarcane and brinjal containing *Bt* genes have been indicated recently. All these crops are also attacked by several other insect, mite and nematode pests, which are not susceptible to the *Bt* toxins. Hence IPM for transgenic crops becomes important. Insecticides have been found to affect the post-embryonic development, behaviour, haemogram, biochemical, and structural

*Based on the National Symposium on Sustainable Insect Pest Management conducted at Entomology Research Institute, Loyola College, Chennai, 6–7 February 2003.

architecture and the biocontrol potential of assassin bugs. Selective insecticides, which are safer to non-target beneficials should be identified. Possibilities of weeds in biological control, use of introduced parasitoids, *Encarsia haitiensis,* and *E. quadeloupae* for the management of spiralling whitefly *Aleurodicus disperses* on guava were also discussed.

Neem products, viz. Neem Guard, Nimbicidin, NeemGold and Rakshak reduced the pod borers, *Apion ampulum* and *Gydia ptychora* of green gram as comparable to fenvalerate. Two bioagents, namely, *Metarhizium anisopliae* and *Bacillus thuringiensis* were equally effective in reducing the weevil population. Spraying of NeemAzal, *Hyptis suaveolens* leaf extract and the combination of *H. suaveolens* and *Melochia corchorifolia* leaf extract on groundnut reduced the population of *Spodoptera litura*, *Aproaerema modicella* and *Aphis craccivora.* They were found to possess significant ovicidal and larvicidal activity against *Helicoverpa armigera.*

The importance of accurate identification of the pest species was discussed for successful pest management programme and the following are the key criteria: (a) identifying the pests to be managed in the crop production system, (b) defining the management unit, (c) developing pest management strategy, (d) developing reliable monitoring techniques, (e) establishing economic thresholds and (f) evolving descriptive and predictive models. Pheromones (sex pheromones, aggregation pheromones, etc.), NPV, and some of the parasitoids are highly host-specific and proper identification including the biotype is essential. Success of insect-resistant varieties of crops depends entirely on the accurate identification of the pests and their biotypes.

A new synthetic pyrethroid Lambda cyhalothrin applied at 20 ppm effectively controlled shoot and capsule borer, *Canogethes punctiferalis* in cardamom and a new insecticide Profinophos reduced the damage caused by tea mosquito bug, *Helopeltis antonii* on cashew. Imidacloprid and quinalphos were most effective in controlling the mealy bug, *Maconellicoccus hirsutus.*

The IPM package of mulberry leaf webber, *Diaphania pulverulentalis* consists of releasing natural enemies, namely, egg parasitoid, *Trichogramma chilonis* at one lakh/acre and pupal parasitoid *Tetrastichus howardi* at 1 lakh/acre coupled with spray of 0.076% DDVP followed by neem pesticide for effective management.

The symposium discussions centered around identification of newer components of IPM, adoptability, accessibility, economic feasibility and suitability for large-scale implementation. A thrust was given for developing newer IPM models incorporating various components for the management of insect pests in different agro ecosystems.

The panel discussion at the end of the symposium highlighted the following: efforts should enhance studies on biosystematics, biodiversity conservation and enhancement, change in pest scenario in different states, collection of quantitative data on the impact of various agronomical and IPM practices, development of IPM models, field demonstrations and dissemination and working out economics of IPM for different cropping systems. Surveys and collections of native isolates of *Bt* and studies on bioecology of entomophages on *Bt* transgenics are required for insect pest management. Sub-lethal effects of pesticides and botanicals on beneficial fauna are needed to create awareness for the use of pesticidal plants. HRD programmes and networkings are required for extension functionaries, industries personnel, pesticide dealers, NGOs, IPM workers and farmers for better coordination and utilization of IPM modules and exchange of materials for sustainable IPM.

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# Vindhyan vagaries*

Vindhyan ranges in central India are the abode of two revered Hindu deities – Vindhyavasani Devi and Sharda Devi. The Kanderia Mahadev-Khajuraho Temple, a World Heritage Monument made up of Ken Sandstone, which constitutes a part of Vindhyan terrain, is also situated in this chain of hillocks. These hillocks have traditionally attracted and inspired saints, philosophers, poets, and writers. The Ashoka Pillar of Sarnath, the lion cap of which now constitutes the national emblem of the Government of India, was carved out of Vindhyan sandstone. Not only have the Stone Age men left indelible marks in these hills in the form of cave paintings but also some of the impregnable fortresses like those at Rohtas and Kalinjer are in this chain. The region has been explored for precious diamonds and minerals. The same Vindhyan ranges are now being explored by investigating geoscientists to find answers to some of the important questions pertaining to the limit and extension of the basin and steps in the evolution of early life based on reports of advanced (triploblastic) animal traces in Chorhat Sandstone, Small Shelly Fossils in Rohtas Limestone, etc.

The Palaeontological Society of India and Geology Department of the Lucknow University organized an International Field Workshop on Vindhyan Basin from 3 to 11 December 2002. Thirty-four participants from universities, institutions and academia from various parts of the world assembled at Varanasi – the oldest living city of the world. S. Kumar, the organizing secretary, introduced the problems of Vindhyans, aims and objectives of the workshop and the weeklong itinerary (Figure 1).

On the first day, the team covered Kaimur and Semri groups of rocks exposed in Varanasi–Robertsganj–Ghurma, Dala–Chopan Road and Dala–Billi Road sections. Excellent outcrops of Kaimur Group were seen near Adalhat about 24 km from Varanasi and close to south of Arhaura (36 km from Varanasi). Team

*Based on an International Field Workshop on Vindhyan Basins, Central India.