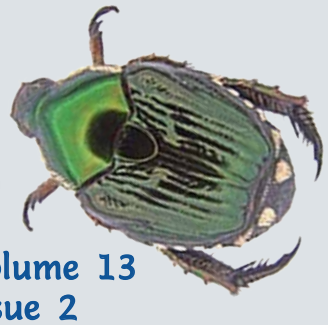
ICAR-NBAIR Newsletter



Volume 13
Issue 2

June 2021

ICAR-National Bureau of Agricultural Insect Resources

Pheromone technology as a component of integrated pest management

The communication between individuals, both intraspecific and interspecific is crucial for the dominance, survival and propagation of the species. While humans and higher animals use visual, oral and auditory communication skills, insects use chemicals (semiochemicals) for their communication. The earliest literature available on pheromone is in 1853 when Fabre demonstrated the attraction of male *Saturnia pyri* moths towards females in the cages. However, the pheromone research was in infancy till the discovery of 'bombykol', the pheromone for the silkworm *Bombyx mori* by Butant in 1959. The past six decades have seen exponential growth in pheromone research, especially on insects due to their prospects for utilization and also on demand from the industries.

In India, the pheromone technology was initially dependent on the expertise from other countries such as UK, Germany and the US, mostly for the synthesis of pheromone chemicals. Thanks to International and National institutions such as NRI, London, Max Planck Institute for Chemical Ecology, Germany and Indian Institute of Chemical Technology, Hyderabad India for the dedicated and systematic work on pheromones. The contributions of Dr. J.S. Yadav, Dr. A.R. Prasad (IICT), Dr. K. Krishnaiah (ICAR–DRR, Hyderabad) and others who have toiled and laid strong foundations need to be appreciated.

The pheromones of several crop pests are available and are also commercially sold along with the traps, primarily for the monitoring of insect pests. Pheromones for *Helicoverpa armigera, Plutella xylostella, Leucinodes orbonalis*, etc. are used to monitor their populations and also for the estimation of insect populations on the crop. Besides, quarantine monitoring using parapheromones of fruit fly such as *Bactrocera dorsalis* and *Bacterocera cucurbitae* have been gaining momentum in several European and Middle East countries where, fruit flies are considered as serious insect pests. Australia uses pheromones to monitor the establishment and spread of weed-killing insects such as *Xubida infusella, Agapeta zoegana* and *Carmenta mimosa.*

Mass trapping is another method of pheromone technology where insects are trapped in abundance and killed thus, reducing the insect damage. The best examples of mass trapping are for trapping red palm weevil and coffee stem borer using their aggregation pheromone and thus managing the pest population below the threshold limit.

Decade long research and field use of pheromones for mating disruption culminated in the development of easy and cost-effective synthetic pathways for pheromone synthesis and also development of cost-effective dispensers for mating disruption where a large quantity of pheromones (usually in grams compared to milligrams in monitoring) was synthesized.

Thanks to advancements in cold-pressed chemical synthesis, the cost of production of pheromone has been considerably brought down from a few lakhs of rupees to a few thousand of rupees. The development of newer dispensers has paved the way for the cost-effective management of insect pests like pink bollworm, brinjal shoot and fruit borer etc. using mating disruption technology.

The dedicated efforts of Dr Abraham Verghese, former Director, ICAR-NBAIR facilitated the development of cheaper wooden dispensers for parapheromone, facilitating the use of male annihilation technology for the management of fruit flies in mango, guava, tomato, Coorg mandarin and cucurbitaceous vegetables.

Slow release, cost-effective and nano delivery materials developed from ICAR-NBAIR have been successfully commercialized for the management of several insect pests including tomato pinworm, fall armyworm, citrus leaf miner etc.

The pheromone technology can easily gel with any other component of integrated pest management (IPM) such as biological control including use of parasitoids and predators, resulting in reduced number of insecticidal sprays ensuring a safer environment.

Promotion of this technology by the Departments of Agriculture/Horticulture, large scale adoption in villages, consistent use for over a longer period of time not only ensures the sustenance of this technology but will also help in reduction of pesticide use especially, on fruits and vegetables. The pheromone formulations, dispensers also have great export potential in other countries. The 'marriage' between the Research institutions and Producers is the need of the hour to take this technology further ahead.

N. Bakthavatsalam
Director (Acting)

Research Highlights

A new fruit fly genus

A new genus of fruit fly, *Gibbifronta pavoniae*, gen et. sp. nov. (Fig. 1), was described from India. Flies were collected on flowers of fragrant swamp mallow, *Pavonia odorata* (Malvaceae) from GKVK Botanical Garden, Bengaluru. Phylogenetic analysis of 141 species of fruit flies using *COI* revealed it to be a distinct genus closely related to *Acidoxantha*, another genus of tribe Acidoxanthini, which are known to breed in flower buds. New genus got its name *Gibbifronta* due to the presence of prominent protuberance on the frontal region of the head.

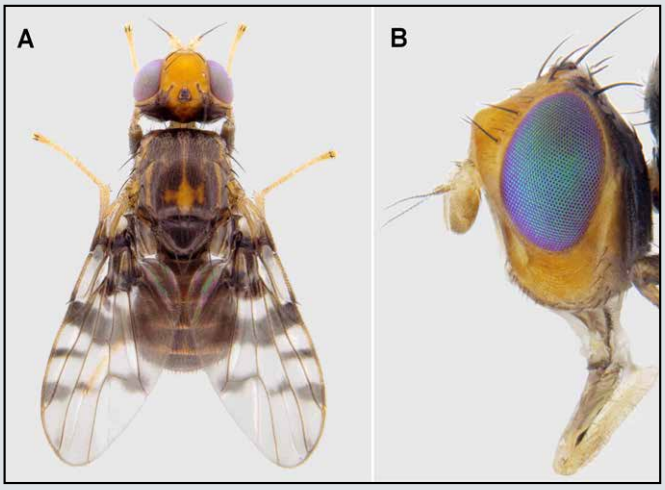


Fig. 1: *Gibbifronta pavoniae*: A, Habitus (dorsal) of male; B, Head (lateral view) showing protuberance on the frons

Taxonomic notes on the pentatomid genus *Sarju* and description of a new species

The genus *Sarju* (Hemiptera: Pentatomidae: Pentatominae: Halyini) and species, *S. farida* and *S. nigricollis* (Fig. 2) were redescribed. A new species, *S. brevirostrata* (Fig. 3) was described from Manipur and a new combination, *S. nodula* was published. A key to species of *Sarju* occurring in India was prepared and published.

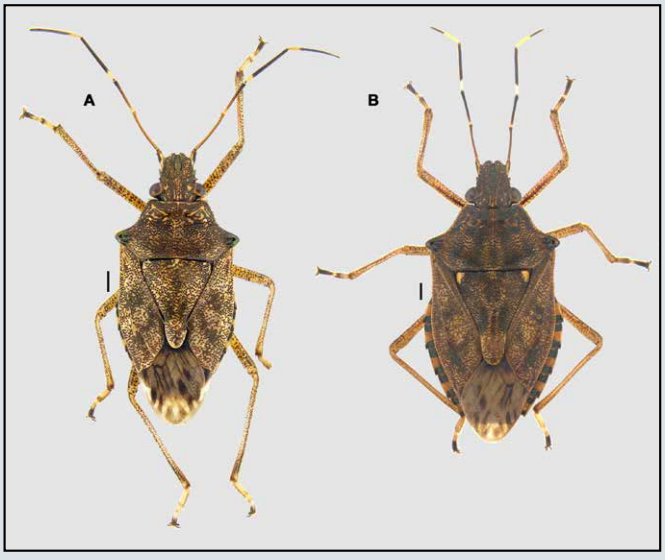


Fig. 2: *Sarju* spp. A, *Sarju farida*; B, *Sarju nigricollis*

Fig. 3: *Sarju brevirostrata*

Two pentatomid genera, *Agathocles* and *Surenus* : tribal reassessment, redescription, new synonyms and description of two new species

Two new species of *Agathocles*, viz. *A. flavipes* (Fig. 4) (India: Andhra Pradesh, Karnataka, Maharashtra, Tamil Nadu) and *A. joceliae* (Fig. 5) (Malaysia) were described. The genus, *Surenus* was synonymised with *Agathocles*. *Agathocles yunnanensis* was synonymised with *A. limbatus*. The genus, *Agathocles* and species, *A. limbatus* were redescribed. A lectotype was designated for *A. normalis*.

Gender agreement and authorship of the name *Riazocoris niger* Ahmad and Afzal in Ahmad *et al.* (1977:161) was corrected and the status of its name-bearing type was clarified as lectotype.

The following new combinations were made: *A. normalis*, *Caystrus dubius*, *Paramecocoris ruficornis* and *Sarju nodula*. Type locality of *Paramecocoris ruficornis* was clarified as Tenasserim (South Myanmar).

Agathocles, which was presently a member of Rolstoniellini was transferred to tribe Caystrini and *Kyrtalus mackiei* from Caystrini was transferred to Myrocheini. A key to species of *Agathocles* was published.

The following new distributional records were published: *A. limbatus* from Cambodia, China (Guangxi, Tibet), Laos and Thailand; *A. normalis*, *Caystrus obscurus*, *Critheus lineatifrons* from Laos; *Amasenus corticalis* from Cambodia, Indonesia, Laos, Myanmar and Thailand; and *Rolstoniellus boutanicus* from Vietnam.

Fig. 4: *Agathocles flavipes*

Fig. 5: *Agathocles joceliae*

Scutellerid bugs as potential pests of star gooseberry

Star gooseberry, *Phyllanthus acidus* was found infested by the scutellerid bugs, *Chrysocoris stockerus* and *Scutellera perplexa* (Fig. 6). Of these, *C. stockerus* was recorded for the first time feeding on this crop. Both the species were morphologically characterized along with the description of male and female genitalia. The nature of damage caused by these bugs was also documented (Figs 7&8).

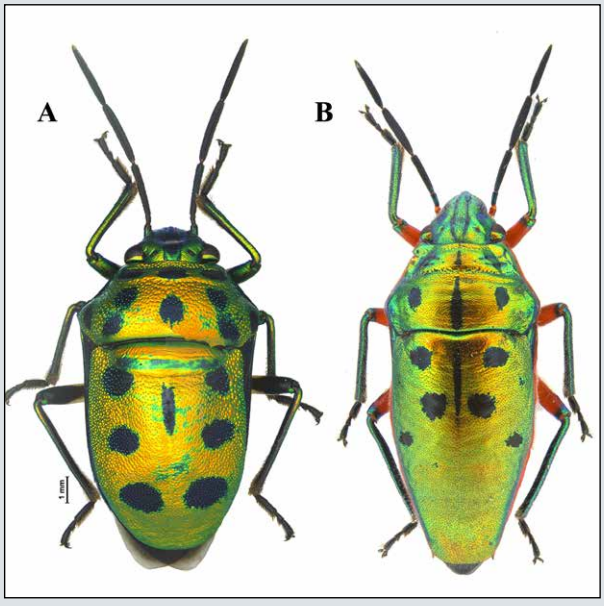


Fig. 6: Scutellerid bugs. A, *Chrysocoris stockerus*; B, *Scutellera perplexa*

Fig. 7: Infested star gooseberries

Fig. 8: Scutellerids feeding on gooseberries

Intrusion pathway of invasive Asian subterranean termite, *Coptotermes gestroi* from the Neotropics into the Indian mainland

Coptotermes is one of the most common subterranean termites of economic importance with a few species considered as truly invasive. *Coptotermes gestroi* (Fig. 9) is also known to be invasive and has taxonomic confusion on its correct identity. Originally described from Myanmar, it is assumed to occur in Northern India and Thailand. However, it is found to cause serious economic losses in a few Asian countries, Brazil, the Caribbean islands and peninsular Florida. Termite specimens were recovered from imported wooden packaging material of a consignment at Goa, received from Harrisonburg, Virginia, USA (Fig. 10). The termite species received was identified as *C. gestroi* through morphological characters (Fig. 11) and DNA barcoding (Fig. 12). The discovery of this unwelcome and serious invasive species in India can be considered as a fortunately failed reintroduction owing to anthropogenic dispersal. As the adults were recorded, there is a high chance of colonization in the area of invasion. It also raises serious concerns about the execution of standard protocol for quarantine measures to be followed during export at the place of packaging (Harrisonburg, Virginia, USA). A serious word of caution was passed on to all the quarantine authorities, exporters, and importers involved.

Fig. 9: Adult *Coptotermes gestroi*

Fig. 10: Dead termites in the consignment

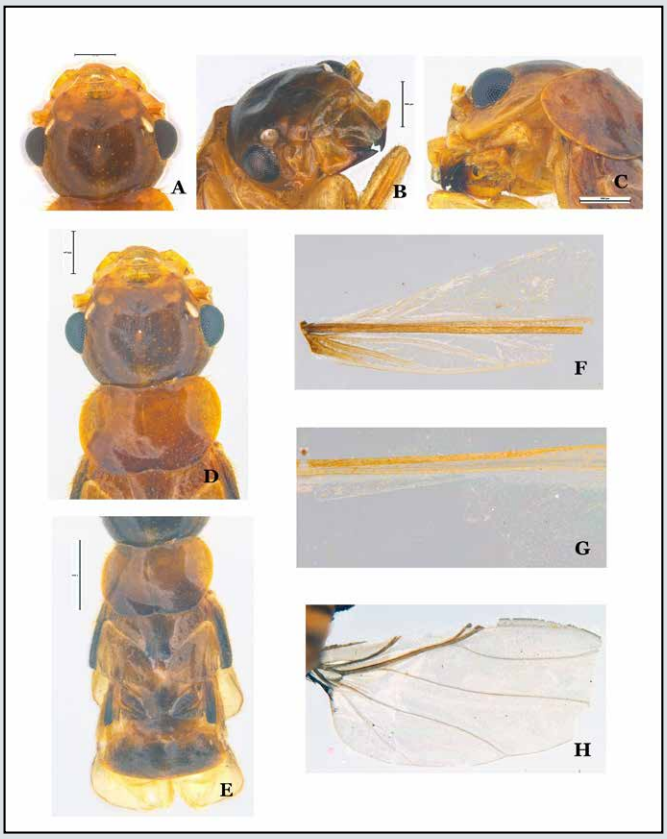


Fig. 11: *Coptotermes gestroi*; A, head (dorsal view); B, head (mandibles in view); C, head (lateral view); D, head with pronotum; E, thorax in part; F, G & H, wing remnants

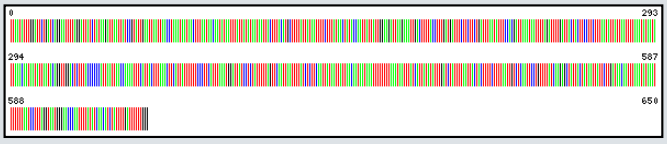


Fig. 12: DNA Barcode of *Coptotermes gestroi* (Accession No: MW575256)

Thrips fauna on horticultural crops in Punjab

Thrips fauna of Punjab was poorly studied despite their significance on fruit and ornamental plants. Hence, surveys were carried out in the six agro-ecological zones of Punjab to study the biodiversity of thrips species on fruit crops and ornamental plants. During these surveys, twelve species of thrips viz. *Frankliniella schultzei*, *Haplothrips ganglbaueri*, *Haplothrips* sp., *Megalurothrips distalis*, *Rhipiphorothrips cruentatus*, *Rhipiphorothrips pulchellus*, *Rhipiphorothrips* sp., *Scirtothrips bispinosus*, *Scirtothrips dorsalis*, *Thrips florum*, *Thrips hawaiiensis* and *Thrips palmi* were recorded in Punjab (Fig. 13). Out of these, *F. schultzei*, *M. distalis, R. pulchellus, S. bispinosus* and *T. hawaiiensis* were recorded for the first time from Punjab. Diagnostic features, distribution and host plant data for all the recorded species were documented. The number of known species of thrips in Punjab was thus increased to fifty one. Damage symptoms caused by thrips species on different host plants were also documented (Fig. 14).

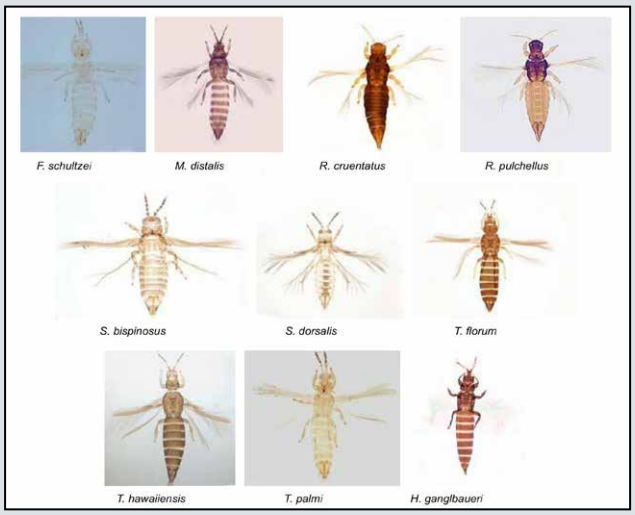


Fig. 13: Different thrips species

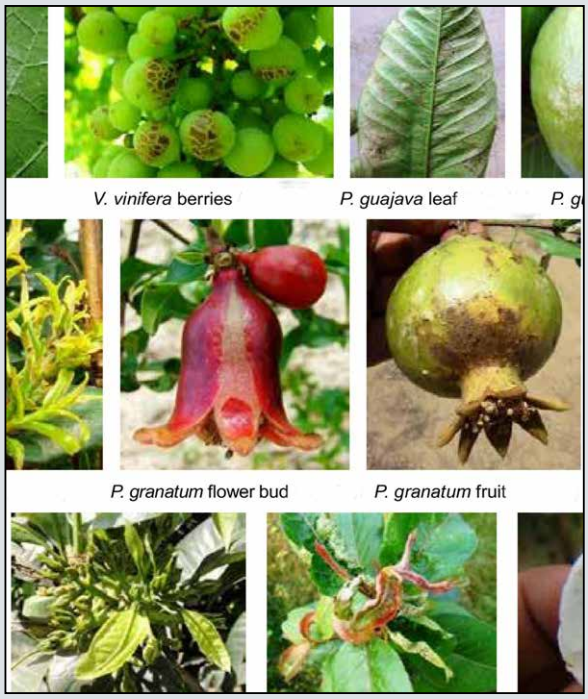


Fig. 14: Damage symptoms of thrips on different horticultural crops

Parasitisation of rice horned caterpillar

Larvae of rice horned caterpillar, *Melanitis leda* (Lepidoptera :Nymphalidae) parasitised by *Cotesia ruficrus* (Fig. 15) (Hymenoptera: Braconidae) from rice ecosystem of Assam was newly reported.

Fig. 15: *Cotesia ruficrus*

Female attractant for Tomato pin worm, *Tuta absoluta*

Tomato pinworm, *Tuta absoluta* is a devastating invasive pest that entered India in 2014 and has spread throughout the country infesting solanaceous crops. It can cause an infestation as high as 80% in tomato and the infested fruits are unmarketable and thus cause serious economic loss. Pheromone produced by the female is known to attract males and are currently used for monitoring and mass trapping. A new pheromone formulation is being developed which showed encouraging results for mating disruption. Based on the electrophysiological, behavioural and analytical studies, a blend of tomato volatiles was tested in tomato fields in sleeve traps. Though the number of adults trapped in the sleeve traps was lesser than those trapped in sex pheromone traps, the proportion of females trapped was found to be very high in the sleeve traps. This blend shows promise to be used as a female attractant for *T. absoluta* (Figs 16–18).

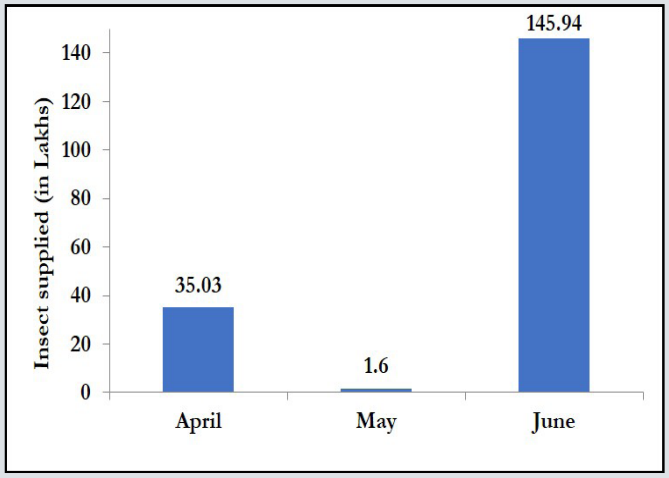
Fig. 16: Trap catch

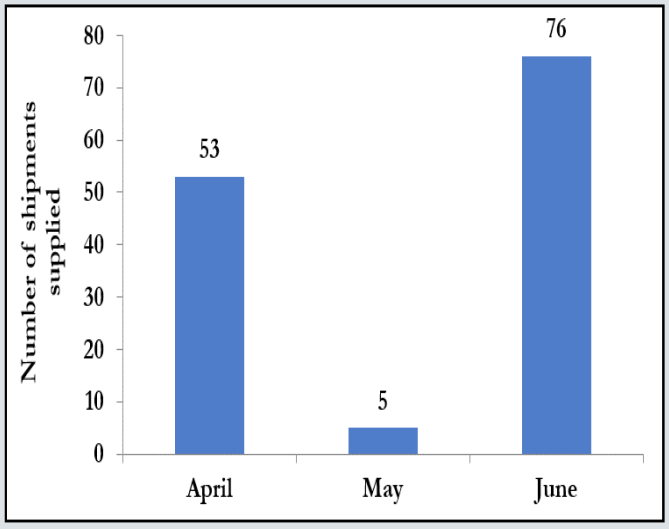
Fig. 17: Trapped adults of *Tuta absoluta*

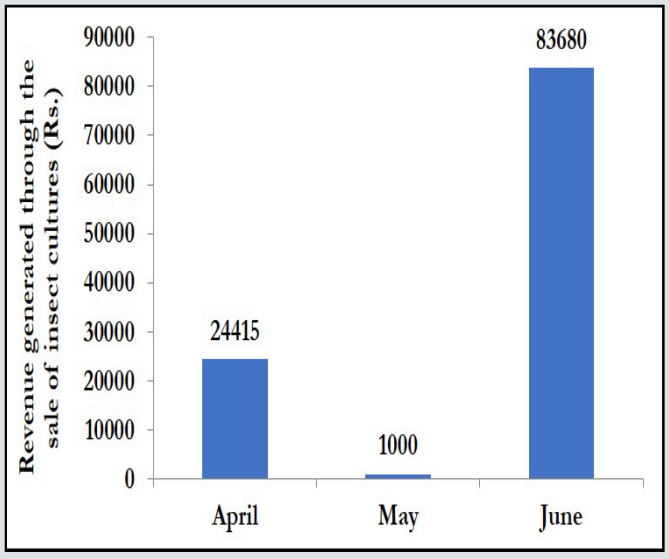
Fig. 18: Moths of *Tuta absoluta* trapped in sleeve trap

Bioagents supplied during COVID period

ICAR–NBAIR has taken strenuous efforts in the maintenance and timely supply of host insects/ parasitoids/predator cultures in the insectary amidst the covid pandemic lockdown period. Rosters for the technical working staffs were prepared tor regular culture maintenance as well as to cater to the demand of the farming community.







Participation of ICAR–NBAIR scientists in International Conference on Biological Control 2 (ICBC 2), Davos, Switzerland

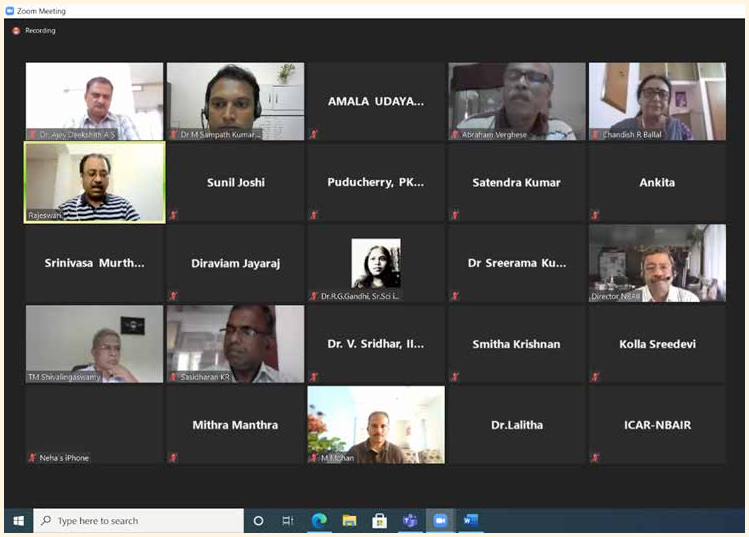
ICAR–NBAIR scientists participated in the virtual International Conference on Biological Control 2 held at Davos, Switzerland during 26–30 April 2021. Dr G. Sivakumar, Principal Scientist (Microbiology) delivered an invited lecture on 'Current research on entomopathogens of recent invasive insect pests in India'. Dr Jagadeesh Patil, Scientist (Nematology) delivered a talk on 'The efficacy of selected indigenous entomopathogenic nematodes against fall armyworm, *Spodoptera frugiperda*, in maize'.

ICAR–NBAIR joined hands with international experts to curb Parthenium menace

ICAR–NBAIR organized a virtual project pre-proposal meeting for parthenium management in India with international experts on 12 May 2021. The purpose of the meeting was to establish a strong international collaboration to work on a project mode among the countries like Australia, South Africa and USA, who are doing exceptionally well in the eradication of parthenium in their countries. The supply of host-specific bioagents to overcome the menace of *Ziziphus mauritiana* in Australia from India was discussed. Dr R. Muniappan, IPM Innovation Lab, Virginia Tech, USA; Dr K. Dhileepan, Department of Agriculture and Fisheries, Brisbane, Australia and Ms Lorraine W. Strathie, Agricultural Research Council–Plant Protection Institute, Hilton, South Africa participated in the meeting. Director, NBAIR; Quarantine team of NBAIR; and Director, ICAR–Directorate of Weed Research, Jabalpur attended the virtual meeting. Dr N. Bakthavatsalam, Director, NBAIR in his opening remarks emphasised the importance of international collaboration especially in line with the mandate of the Bureau to work on the import of insect germplasm for the management of obnoxious parthenium weed in India. He also stressed that having collaborative projects with the international countries will ease the import of insect germplasm and other information-sharing from time to time. The import of additional weed killers for the eradication of parthenium, research collaboration for the management of *Z. mauritiana*, and establishment of a forum for the exchange of information on weed killers were discussed. The need for proposing a concept note on biological control of parthenium in India with the international institutes and national institutes as partners to seek the mandatory permission from ICAR for undertaking the flagship programme in the near future was discussed. The meeting ended with vote of thanks by Dr A. N. Shylesha, Head of Division, Division of Germplasm Conservation and Utilisation, NBAIR, Bengaluru.

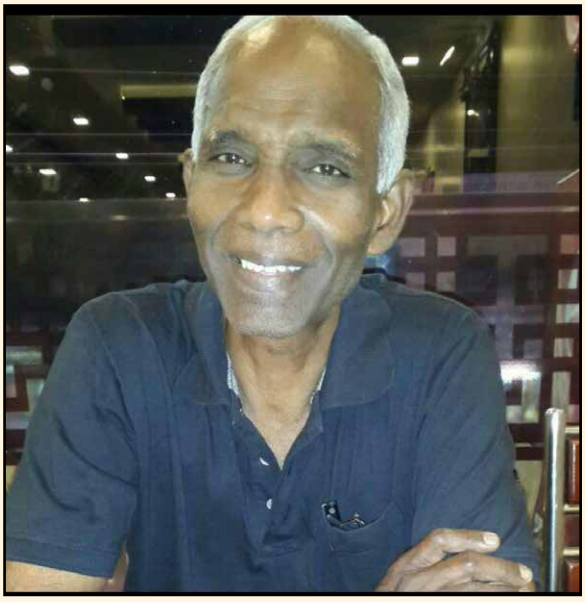
ICAR–NBAIR organised webinar to celebrate 'World Bee Day'

ICAR–NBAIR organized the virtual Town Talk Series 006 to celebrate the 'World Bee Day' under the theme 'Bee engaged–Build Back Better for Bees'. Dr N. Bakthavatsalam, Director, NBAIR briefed the role of bees in agriculture and their untiring role in crop pollination and other services for enhanced crop productivity. Dr A.N. Shylesha, Head, Division of Germplasm Collection and Characterisation gave an insight on the historical aspects of bees in ancient literature like Ramayana. He talked about the services rendered by honey bees in the ecosystem, especially for food security. He also explained about the factors attributed towards bee-population decline like urbanization, monocropping etc. and also listed out the ways to overcome the same. Dr Amala Udayakumar, Scientist (Entomology) delivered a talk on 'Apivectoring', which is a novel technique used in dispensing microbials to target area so as to control plant diseases/insect pests, and also has a coincident benefit of increased crop yield by bee pollination. The webinar was attended by more than 64 participants from NBAIR, other ICAR institutes, AICRP–BC centres, and State Agricultural Universities. Drs K. Subaharan, M. Sampath Kumar, M. Pratheepa and M. Mohan organized the webinar.



Obituary

Dr R. J. Rabindra, former Director (1949 – 2021)



Dr Rajarethinam Jebamani Rabindra was born in Udhagamandalam, Tamil Nadu on 3 June 1949 to Mr. Rajaratnam, a public prosecutor and Mrs Leela. He completed his graduation from TNAU, Madurai and his M.Sc. (Ag.) and Ph.D. in Agricultural Entomology from TNAU, Coimbatore. He had received several recognitions and awards for his academic brilliance. His professional career was initiated in 1970 at TNAU, Coimbatore and he rose up to the level of Professor and Head, Department of Entomology and Director, Centre of Advanced Studies in Entomology. The best evidence for his dedicated years of service to TNAU as a teacher and research guide for four decades are the countless number of students whom he mentored, the excellent manuals on pest management and biocontrol which he authored and the TNAU gold medal which he was awarded for being the best post-graduate teacher 1998-99.

In 2002, Dr Rabindra assumed the position of the Project Director, Project Directorate of Biological Control (now upgraded to ICAR-NBAIR), Bangalore and served for two terms. As a Director, Dr RJR was meticulous in his approach to research management and monitored each and every research project functioning in the Directorate. He was highly critical in his examination of research results as he strongly believed in transmitting promising and relevant basic research results to farmers' fields through strictly monitored research experiments and validation trials. We should be ever grateful to Dr Rabindra for the significant role he played in the establishment of the Yelahanka campus of ICAR-NBAIR. He had an admirable ability at national and international networking, which led to the two notable successes in the field of biological control: the biological control of the notorious Sugarcane Woolly Aphid and that of the Papaya Mealy bug. The above were considered as landmark achievements leading to remarkable savings for the Indian farmers. These successes are quoted as national success stories at the ICAR level even today. He retired from ICAR service on 30 June 2011.

As the Project Coordinator of AICRP on Biological Control, Dr RJR received accolades from the Council, especially for the success story related to the "Adat Panchayat Model" – the stake holder participatory biological control programme covering 5,000 acres in Kerala involving more than 4,000 paddy farmers in Thrissur, Kerala. Besides, he developed new research programmes at the national level for augmentative and classical biological control of indigenous outbreak pests and alien invasive pest species, respectively. He was responsible for the development of some of the clear and sturdy Bio-intensive IPM modules for various crops.

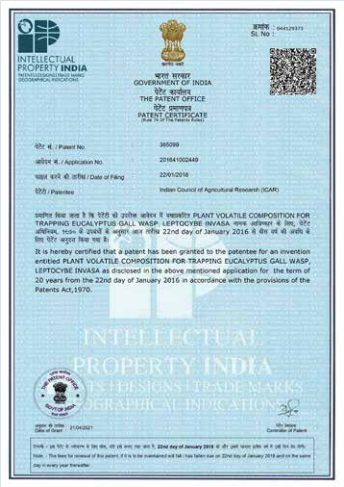
Post retirement, R J Rabindra became the Dean, College of Post Graduate Studies, Central Agricultural University, Umiam, Meghalaya, where he served for almost a year and made exemplary contributions in strengthening the college curriculum and its infrastructure facilities. Considering his extensive expertise and rich experience, he was on several research advisory committees. From June 2020, he worked as a Consultant for TN Government-funded FAW program at TNAU. The AICRP BC team continued to benefit immensely through Dr Rabindra's participation in AICRP Biocontrol workshops as an expert. His keen interest in research and his affection for NBAIR, even post retirement, was evident through his willingness to guide NBAIR scientists in their research programmes and his wholehearted positive responses to all invitations to attend workshops and meetings organised by NBAIR.

Dr R J Rabindra left for his heavenly abode on 30 June 2021 and is survived by his mother Mrs Leela, wife Mrs Alice Rabindra, children, Andrew Rabindra, Joshua Rabindra and Johanna Vikram John. The staff of ICAR–NBAIR (erstwhile PDBC) would always remember Dr RJR as a Director, who was a strict administrator, an accomplished, creative and critical research leader, a meticulous Project Co-ordinator, an excellent communicator and above all, a wonderful human being, who was always warm and compassionate.

Chandish R. Ballal
Former Director, ICAR–NBAIR

Indian patent granted

PLant volatile composition for trapping eucalyptus gall wasp, *Leptocybe invasa* (Primary innovator: Dr N. Bakthavatsalam).



Memorandum of Understanding (MOU)

ICAR–NBAIR signed MOU with Indian Council of Medical Research–National Institute of Malaria Research Field Unit, Bengaluru for work on clean and green management of vectors.

Invited lectures

Dr K. Subaharan, Principal Scientist (Entomology) delivered an invited lecture on 'Recent approaches and prospects of utilizing plant volatiles for plant protection' organised by ICAR–National Institute of Biotic Stress Management, Raipur on 21 June 2021.

Trainings attended

Drs T. Venkatesan, K. Subaharan, M. Mohan and K. Sreedevi attended MDP programme on 'Biodiversity and Environmental laws for agricultural researchers (BELAR 2)' organised by ICAR National Academy of Agricultural Research Management from 07– 09 June 2021.

Dr Deepa Bhagat, Principal Scientist (Organic Chemistry) attended a training titled 'Agilent 5977GC/MS Techniques and Operation with Mass Hunter Data Analysis' at ICAR-NBAIR, Bengaluru, 15–16 April 2021.

Transfer of Technologies

"Controlled release dispenser for delivery of semiochemicals" to M/s Bannari Amman Sugars Ltd., Tamil Nadu.

"Potential entomopathogenic fungus *Isaria fumosorosea* (strain ICAR-NBAIR-pfu-5) for management of rugose spiralling whitefly *Aleurodicus rugioperculatus* in coconut and oil palm" to Regional Agricultural Research Station, Anakapalle, Andhra Pradesh.

"*Metarhizium anisopliae* ICAR-NBAIR Ma 4 for management of white grubs in sugarcane" to AICRP on Biological Control, Anand Agricultural University, Gujarat and M/s Agrarian Agri Biotech, Gujarat.

"Waste to Wealth: Technology on Black Soldier Fly mediated bioconversion of farm and kitchen wastes" to M/s Holocene Ecosolutions Pvt. Ltd., Guntur, Andhra Pradesh.

"Novel insecticidal WP formulations of *Heterorhabditis indica* for the biological control of white grubs & other soil insect pests" to M/s Mitrakida Pvt. Ltd., Pune.

Selected Publications

Das, P., Dey, D., Borah, B. & Gupta, A. 2021. New record of rice horned caterpillar, *Melanitis leda*(L.) larvae (Lepidoptera: Nymphalidae) parasitized by *Cotesia ruficrus* (Haliday) (Hymenoptera: Braconidae) from rice ecosystem of Assam, India. *Insect Environment*, 24 (2): 280-282.

David, K.J., Hancock, D.L., Han, H.Y., Gracy, R.G., Sachin, K. & Swathi, R.S. 2021. A new genus in the tribe Acidoxanthini (Diptera: Tephritidae: Trypetinae) from India, with a discussion of its phylogenetic relationships. *Journal of Asia-Pacific Entomology*, https://doi.org/10.1016/j.aspen.2021.06.010.

Dhanapal, R., Singh, R.N., Raghuraman, M., Mohan, M., Subaharan, K. & Hemavathi, M. 2021. Evaluation of predatory potential and prey stage preference of mirid bug, *Nesidiocoris tenuis* on tomato pinworm, *Tuta absoluta*. *Biologia,* 76 : 2965–2971.

Nishtha, N., Gracy, R., Ashika, T., Mohan, G., Swathi, R.S., Mohan, M., Malvika, C., Bakthavatsalam, N. & Venkatesan, T. 2021. Population structure and genetic diversity of invasive fall armyworm after two years of introduction in India. *Scientific Reports*, 11: 7760.

Ramya, R.S., Ganesh Kumar, M., Ranjith, M. & Bajya, D.R. 2021. Arthropod diversity indices in floricultural ecosystems: which fares better? *Indian Journal of Agricultural Sciences*, 91(3): 340–343.

Salini, S. & Kment, P. 2021. The genera *Agathocles* and *Surenus* (Hemiptera: Heteroptera: Pentatomidae) tribal reassessment, redescription, new synonyms, and description of two new species. *Zootaxa*, 4958(1): 510–559.

Salini, S., Rabbani, M.K., David, K.J. & Sachin, K. 2021. Scutelleridae as potential pests of star gooseberry *(Phyllanthus acidus*) (L.) Skeels. *Insect Environment*, 24(2): 220–228.

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Compiled and edited by: **U. Amala, R.S. Ramya, R.R. Rachana, Kesavan Subaharan & N. Bakthavatsalam**
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Phone: +91 80 2341 4220 ✦ Fax: +91 80 2341 1961 ✦ Website: www.nbair.res.in