NBAIR Newsletter

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ICAR-National Bureau of Agricultural Insect Resources

Fruit flies as emerging pests and their management using attractants

Although the term 'fruit flies' often connotes *Drosophila* and related taxa due to their extensive use in various facets of scientific research, the fact is that 'true fruit flies' are 'picture-winged flies' belonging to the family Tephritidae, but not to Drosophilidae. With more than 5,000 described species in nearly 500 genera distributed across various zoogeographic regions in the world, they represent a highly diverse group with a wide array of feeding habits, occupying a range of ecological niches. Even though only 5% of the described species of Tephritidae are significant as pests of various economically important crops, they are in fact the driving force for the extensive research on fruit flies. They assume paramount significance as they are pests of quarantine concern across the continents due to their concealed feeding and invasive potential. Economic impact of pestiferous species is not only restricted to direct yield loss and increased costs in managing them, but also the loss of export markets and/or the cost of putting up and maintaining fruit treatment and eradication facilities.

In India, nearly 292 species in 89 genera have been recorded in five subfamilies, and several species are being added to the faunal list annually. Species of *Bactocera*, *Zeugodacus*, *Dacus* and *Carpomya* are pests of major horticultural crops, like the Oriental fruit fly, *Bactrocera dorsalis*, infesting major fruit crops; melon fly, *Zeugodacus cucurbitae*, and lesser pumpkin fly, *Dacus ciliates*, attacking a wide range of cucurbits; ber fruit fly, *Carpomya vesuviana*, feeding on ber fruits.

Management of fruit flies in mango, guava and other crops through the use of regular calendar-based insecticide spray schedules is a common practice in orchards. Thanks to the invention of methyl eugenol by Frank Milburn Howlett as a parapheromone attracting largely the males of *B. dorsalis,* and to the subsequent discoveries of cuelure and trimedlure (and their related volatiles) as attractants, the use of these parapheromones in quarantine monitoring and male annihilation techniques gained momentum. Efforts made by Dr Abraham Verghese and his team from the Indian Institute of Horticultural Research, Bengaluru, need special mention in propagating inexpensive wooden dispensers and traps, thus facilitating greater uptake of the parapheromone technology by farmers.

An accidental discovery of a volatile mixture with 2.5 times more attraction than methyl eugenol alone, and the subsequent discovery of a bisexual attractant with higher proportion of females resulted in the efficient management of fruit flies in mango. Instead of using 10 methyl eugenol traps per acre along with the spray of protein hydrolysates, a new recommendation emerged with 5 traps of dorsalure along with 5 bisexual traps per acre with excellent control of fruit fly in mango. The introduction of exotic guava varieties like 'Taiwan Rose' has seen higher incidence of fruit flies causing serious ecomonic loss to the farmers. Through several demonstrations conducted by NBAIR, the guava farmers are now convinced that fruit flies can be managed with the attractants with minimal use of insecticide sprays.

Coorg mandarin, a heritage fruit of Kodagu, suffered serious losses, initially thought to be due to citrus decline, but later turned out that fruit fly infestation had caused early fruit drop. A farmer, who has been using our parapheromone and bisexual attractant, assumed the role of an informal spokesperson to broadcast the benefits of our technology.

Zeugodacus cucurbitae (*Bactrocera cucurbitae*) is an economically important quarantine insect pest, badly affecting the export of cucurbitaceous vegetables (especially gherkins) to European countries. The technology developed by NBAIR, combining both the alcohol-free cuelure technology and bisexual attractant has proved to exert excellent control without the use of insecticide sprays. Similarly, farmers in Kolar (Karnataka) have been largely benefitted by our technology in saving the tomato crop from *Z. cucurbitae* infestation with minimal insecticide use.

Invention of new dispensers (such as nanoparticle-based) and development of fruit volatile-based female attractant is at the top of NBAIR's agenda.

N. Bakthavatsalam
Director (Acting)

Research Highlights

Monograph on the Oriental genus *Apanteles*

A monograph on the *ater*-group, including subgroup *eublemmae* of genus *Apanteles* (Hymenoptera: Braconidae), from the Oriental region was published. Three new synonymies were proposed: *A. chloris* = *A. cornicula*; *A. cavatiptera* = *A. glacilipes* = *A. opacus*.

New species and records of fruit flies

Five new species of fruit flies were described from India. They included *Euphranta siruvani* (Fig. 1) from Tamil Nadu; *Hemilea totu* (Fig. 2) from Himachal Pradesh; and three species of *Campiglossa*, namely, *C. ialong* (Fig. 3) from Meghalaya, *C. shaktii* (Fig. 4) from Sikkim and *C. sherylae* (Fig. 5) from Karnataka. Two fruit fly species were recorded for the first time from India: *Paratrypeta appendiculata* and *Vidalia thailandica*.

Fig. 1: *Euphranta siruvani*

Fig. 2: *Hemilea totu*

Fig. 3: *Campiglossa ialong*

Fig. 4: *Campiglossa shaktii*

Fig. 5: *Campiglossa sherylae*

New species of *Lefroyothrips*

A new thrips species, *Lefroyothrips varatharajani* (Terebrantia: Thripidae) (Figs 6 & 7), was recently described from Karnataka. The species was collected from the flowers of *Mimusops elengi*.

Fig. 6: Female *Lefroyothrips varatharajani*

Fig. 7: Male *Lefroyothrips varatharajani*

New record of long-jawed orb-weaver spider from India

The long-jawed orb-weaver, *Tetragnatha nitens* (Figs 8 & 9), was recorded for the first time from India. It was collected

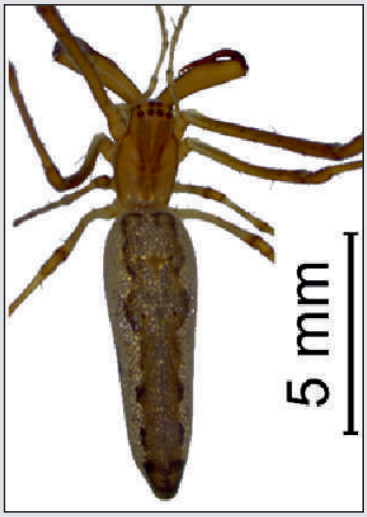


Fig. 8: Female *Tetragnatha nitens*

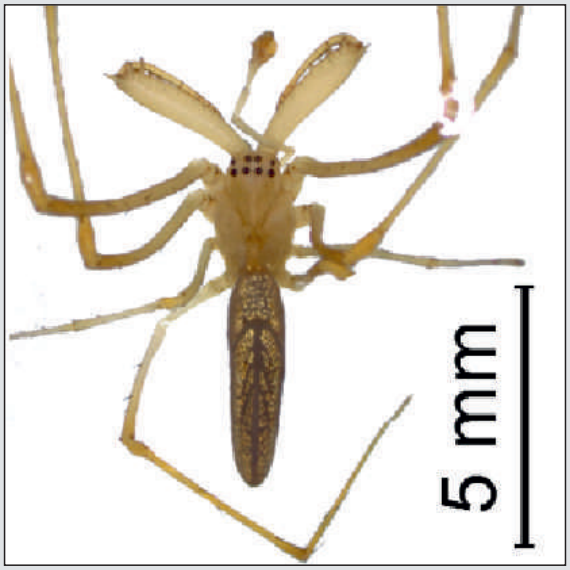


Fig. 9: Male *Tetragnatha nitens*

in a paddy ecosystem in Tamil Nadu. It was earlier reported from the Asian countries Bangladesh, China, Japan and Korea. Distribution of the species in southern India, and diagnostic characters of both sexes, along with differences in pedipalp and vulva (epigyne), were also documented.

Studies on fall armyworm management

Performance of the larval ectoparasitoid *Bracon brevicornis* on the fall armyworm, *Spodoptera frugiperda*, was evaluated. In choice experiments, *B. brevicornis* preferred to parasitise the fourth or fifth instar larvae of *S. frugiperda* over the third instar larvae. The highest parasitoid development was recorded on the fifth instar larva; approximately 293 eggs were laid with 57%, 80% and 70% hatchability, pupation and adult emergence, respectively. Biocontrol potential of three egg parasitoids, *Telenomus remus*, *Trichogramma chilonis* and *Trichogramma pretiosum*, was investigated against *S. frugiperda* through single, simultaneous and sequential releases. In single-release tests, the parasitisation efficiency was estimated as 92% for *T. remus*, 81% for *T. chilonis* and 45% for *T. pretiosum*. Per cent parasitism in simultaneous releases of *T. remus* and *T. chilonis* was on a par with that of the single release of *T. remus*. Per cent parasitism of *T. pretiosum* increased when released simultaneously with *T. remus*.

Shatpada-BPM-2, a mobile app

The mobile app Shatpada-BPM-2 was developed to promote bicontrol measures for the management of insect pests of coconut, rice and sugarcane. The app contains information on the biology, field-level damage symptoms, biocontrol measures and natural enemies of various insect pests. It is available as English, Hindi and Kannada versions, and can be downloaded from Google Play.

NBAIR celebrates Mahila Kisan Diwas

NBAIR celebrated "Mahila Kisan Diwas" on 15 October 2020. Ms B.R. Lalitha Santharam, an ICAR–IARI Innovative Farmer Awardee, graced the occasion as chief guest. Women farmers from Bettahalasur, Kanakapura and Therubidi participated in the programme. Dr N. Bakthavatsalam, Director of NBAIR, spoke on the importance of women farmers in agriculture and laid emphasis on the role played by women in all farm activities. Biocontrol-based organic methods of pest management in agricultural and horticultural crops were exhibited and demonstrated for the benefit of the women farmers.

On-farm demonstration on biocontrol of fall armyworm

NBAIR organised a scientists–farmers interface meeting on the fall armyworm, *Spodoptera frugiperda*, on 17 December 2020. The event held on the Yelahanka campus attracted small and marginal farmers from Moduru of Tumakuru district and Kolavanahalli of Chikkaballapura district. An organic farmers' group from Krishnarajapuram also participated in the programme. Talc formulations of *Pseudomonas fluorescens* (NBAIR-PFDWD) and *Trichoderma asperellum* (NBAIR-TATP) were provided to the farmers.

NBAIR celebrates Swachhta Pakhwada

NBAIR organised "Swachhta Pakhwada" campaign during 16–31 December 2020. The campaign started with oath-taking by the staff members of the bureau. Activities included cleaning of office premises, weeding out of old office records and sprucing up of the farm area on Yelahanka campus. A special "Kisan Diwas" was celebrated at Therubeedi, Kuluvanahalli and Kattigehalli villages during which biopesticides were supplied to the participating farmers to create awareness on biological control of insect pests. Mr Manoj Kumar Shukla, IFS, Chief Conservator of Forests & Executive Director, Mahatma Gandhi Institute of Rural Energy and Development, Bengaluru, delivered a lecture on 'Solid waste management in urban communities' in the valedictory function.

NBAIR and AICRP-BC centres participate in PM-KISAN programme

The staff of NBAIR attended the virtual event of inauguration of Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) programme on 25 December 2020. Around 270 participants, including farmers from Kuluvanahalli and Kattigehalli villages, students and scientists participated in the programme from the institute campuses of NBAIR and AICRP-BC centres. Saplings of trees and biocontrol agents were distributed to the farmers.

NBAIR celebrates Kannada Rajyotsava

NBAIR celebrated "Kannada Rajyotsava" on 29 December 2020. Mr Anant Hegde Ashisar, Chairman of Karnataka Biodiversity Board, graced the occasion as chief guest. The programme started with planting of tree saplings by the chief guest and staff of NBAIR. Mr Ashisar delivered an exhaustive talk on the glory of Kannada and exhorted the scientists to acquaint themselves with the local language for effective transfer of technology to farmers.

NBAIR organises on-farm demonstration on *Trichogrammatoidea bactrae* for the management of pink bollworm

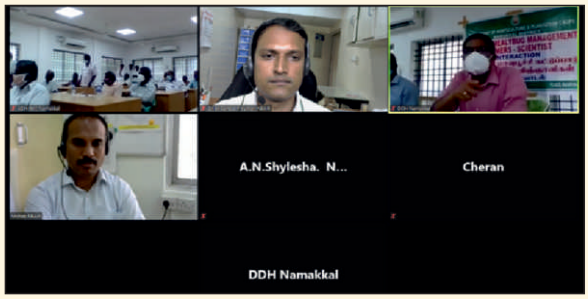
NBAIR in collaboration with ICAR–National Centre for Integrated Pest Management, New Delhi, and Krishi Vigyan Kendra, Jalna, organised a virtual meeting on "On-Farm Demonstration on Egg Parasitoid *Trichogrammatoidea bactrae* for the Management of Pink Bollworm" on 13 October 2020. During the meeting, farmers were sensitised about the benefits of using trichocards in cotton to manage the pink bollworm.

NBAIR organises field day-cum-farmers' awareness meeting on fall armyworm management

NBAIR organised a "Field Day-cum-Farmers' Awareness Meeting on Fall Armyworm Management" in collaboration with CABI at Kadalaveni village in Chikkaballapura district of Karnataka on 7 November 2020. Around 190 farmers and officials from the Department of Agriculture participated in the programme. NBAIR scientists delivered lectures on the biology of the insect and spelt out the various biocontrol options to manage the pest. In the interactive session, the queries raised by the farmers were clarified by NBAIR experts. The programme received good coverage in the mass media.

NBAIR organises awareness creation-cum-empowerment meeting on cassava mealybug management

NBAIR experts participated in the virtual farmers' interaction meeting on 2 December 2020 organised by the Department of Horticulture and Plantation Crops in Rasipuram, Namakkal district of Tamil Nadu. The bioecology of the invasive insect, the symptoms and nature of damage caused and the potential natural enemies were discussed. The initiatives taken by the bureau to import *Anagyrus lopezi*, a classical biocontrol agent, from Thailand and Benin to contain this exotic pest were discussed. The farmers were advised to abstain from the use of chemical insecticides to conserve the native natural enemies for biological control of the pest. Fifty-six progressive farmers and sago mill owners participated in the meeting.



Indian honey bee, *Apis cerana indica*, to be declared as state insect of Karnataka

A meeting was organised to discuss the declaration of the Indian honey bee, *Apis cerana indica*, as the state insect of Karnataka. The meeting was chaired by the honourable Chief Minister of Karnataka, Mr B.S. Yediyurappa. The Chairman of Karnataka Biodiversity Board, Mr Anant Hegde Ashisar, convened the meeting. Dr N. Bakthavatsalam, Director of NBAIR, participated in the meeting and presented his views.

Apis cerana indica

Guest column

Commonwealth Institute of Biological Control – Indian Station: the harbinger of a systematic approach to biological control*

– T.M. Manjunath

It was heartening that the National Bureau of Agricultural Insect Resources of Indian Council of Agricultural Research (ICAR–NBAIR), Bengaluru, organised a virtual meeting to celebrate its 27th Foundation Day on 19 October 2020. I had the privilege of being invited as a Special Guest along with Dr S.N. Puri. I availed the opportunity to go on a nostalgic trip and narrate the history of biological pest control in India and how NBAIR has inherited its historical premises and a rich legacy of biological control from the Indian Station of Commonwealth Institute of Biological Control. I was a close witness to all the developments. Only the section pertaining to CIBC is briefly presented below.

The Indian Station of Commonwealth Institute of Biological Control (CIBC), one of the major units of Commonwealth Agricultural Bureaux (CAB), London, was established in 1957 at Hebbal, Bengaluru (then Bangalore), in the same premises where NBAIR is presently located.

If we look back, during the 1950s and early '60s, biological control was not very familiar. In fact, on seeing the signboard of CIBC displayed on the compound facing the main road (Bellary Road), most people used to mistake it as 'Commonwealth Institute of *Birth* Control.' It was so because in the 1960s, the Government of India was vigorously campaigning for family planning, and 'birth control' was a buzzword then. However, soon, CIBC created a niche for itself and biological control gradually became popular.

The CIBC building, located in Hebbal, which was a desolate area in north Bengaluru then, was very cosy and centrally air-conditioned, a very rare and luxury facility during those days. It was well-equipped for entomological research with the latest microscopes, insect rearing cages, insect storing cabinets, library, etc. I joined CIBC in 1961. It was my first job and there was only about a dozen staff then. Since then I have been closely associated with biological control in one way or the other for the last six decades.

The work culture of CIBC was entirely different. Since we were dealing with live insect cultures, officially the working days included all the seven days in a week with Saturday, Sunday and all general holidays being half-day. Dr V.P. Rao, the Founder Director (Entomologist-in-Charge) of the Indian Station of CIBC, was truly inspirational. He used to take us to the fields and train us in insect collection and rearing. We used to spend more than half-a-day almost daily in fields, making large collections of insect pests for rearing, discovering and studying their natural enemies. He used to tell us that insects are our topmost priority, and we should try to establish a bonding with them and enjoy working with them. In a lighter vein, he used to say that the air-conditioned facilities in the lab are actually meant for insects and that we are the indirect beneficiaries! He inculcated in us a sense of concern and passion for insects. Dr Rao was a walking encyclopaedia on biological control and a perfectionist. He was truly the 'Father of Biological Control in India' and a great role model. Dr T. Sankaran, who worked closely with Dr Rao, and later succeeded him in 1973, was another stalwart. One should have been fortunate to have started a career under such great mentors. I had maintained contact with both Dr Rao and Dr Sankaran till they breathed their last.

Since biological control was almost an unexplored area, CIBC submitted several interesting projects on major crop pests and weeds, and was able to get good funds from various sources, mainly from the US PL-480 scheme in the 1960s. Those projects, which were operated almost concurrently, included systematic exploratory surveys for natural enemies, studying their bioecology, evaluation of their efficacy, developing techniques for culturing them and several other aspects related to biological control. The crop pests included those of rice, sugarcane, cotton, maize, coconut, tea, citrus, potato, tomato, cabbage and other vegetable crops, pulses, fruit trees, forest trees as well as aquatic weeds like water hyacinth, *Pistia* and *Salvinia* and terrestrial weeds like *Chromolaena, Striga, Orobanche, Lantana,* etc. Thus, almost all major crops and weeds were covered.

Dr V.P. Rao, Founder Director, CIBC Indian Station, Bengaluru. 'Father of Biological Control in India'

CIBC main laboratory building in the 1960s

*A part of the talk delivered on the occasion of the 27th Foundation Day of ICAR–NBAIR on 19 October 2020.

With Bengaluru as the coordinating centre, CIBC had opened about 25 sub-stations spread all over India depending upon the crops/pests. These operated depending upon the duration of the concerned projects. A number of scientists and technical assistants were recruited and trained. Besides working at the headquarters in Bengaluru, I as well as several others had the opportunity of working at several sub-stations on various projects at the same time. This provided us an invaluable opportunity and a learning experience.

A large number of parasitoids, predators and pathogens of various crop pests and weeds mentioned above were discovered, most of them being new records, and their bio-ecology and breeding techniques studied for the first time in India. A separate project on the taxonomy of trichogrammatids was initiated and authentic keys were developed for identification of the indigenous as well as exotic species and also several new species were described. Thus, a wealth of information came out from such systematic and pioneering efforts. Besides, several exotic natural enemies, including a few species of *Trichogramma* and tachinids; parasitoids of San Jose scale (*Aphytis, Encarsia*) and potato tuber moth; the insect-parasitic nematode DD-136 (*Neoaplectana carpocapsae*); the reduviid predator *Platymeris laevicollis*; the mosquito larvivorous fish *Nothobranchius guentheri*; specific natural enemies of water hyacinth (*Neochetina, Orthogalumna*) and *Salvinia* (*Cyrtobagous*), and several others were introduced from other countries and tried against some of the invasive pests and weeds. Live cultures of a number of natural enemies and their hosts were maintained in the laboratory. Besides, promising natural enemies of Indian origin were shipped to other countries for trials there. In both the cases, quarantine protocols were strictly followed.

CIBC established a distinct niche for itself not only in India but also it placed India on the global map of biological control. With so many live cultures on display and with the reputation of being an international organisation, CIBC had its own aura. We used to get visitors — scientists, officials, teachers, students, etc. — from all over India and other countries. They used to be thrilled on seeing the facilities and live insects. These created awareness and interest about biological control at all levels. Thus, CIBC was truly the harbinger of a systematic approach to biological control in India.

Dr Rao was hugely responsible for the success of CIBC followed by Dr Sankaran who succeeded him. They had left a lasting impression and a valuable legacy in the staff they trained some of whom rose to occupy responsible positions and contributed to strengthen biological control and other areas of plant protection. Both these stalwarts and the dedicated staffs of CIBC certainly deserve to be acknowledged for their invaluable contributions. I was fortunate to have been associated with CIBC from 1961 to 1976 which gave me an opportunity to learn and contribute.

After a golden period from the 1960s to mid-1970 when CIBC handled several exciting projects, it faced a challenge in getting replacement projects as, due to political and other reasons, there were restrictions on US PL-480 projects. It had to close down most of the sub-stations and was facing an uncertain future. Most of the senior scientists, including me, left in search of alternative jobs. However, it lingered on for a few more years and finally CIBC was taken over by the Government of India and handed over to ICAR in 1988. That marked the end of CIBC Indian Station, but a rich legacy was left behind.

Taking over CIBC was a huge asset for NBAIR, both in terms of scientific facilities, including a large collection of identified and labelled insect specimens, as well as real estate. It is a matter of great pride and satisfaction that NBAIR is continuing the legacy of biological control and striving to take it to the next level along with its other mandated objectives.

I thank Dr N. Bakthavatsalam for inviting me to the Foundation Day. I also thank him and Dr Prakya Sreerama Kumar for their suggestion to write this article.

Affiliations of the author: Entomologist, Commonwealth Institute of Biological Control, Indian Station, Bengaluru, 1961–1976; Entomologist, University of Agricultural Sciences, Bengaluru, 1976–1981; Vice-President, Bio-Control Research Laboratories, PCI, Bengaluru, 1981–1997; Director, Monsanto Research Centre, Bengaluru, 1998–2004; Consultant on Biocontrol, Agri-biotechnology and IPM from 2004. The views, thoughts and opinions expressed in this column belong solely to the author and not necessarily to ICAR or NBAIR.

CIBC staff (1970): Seated, L–R: Ms Sundari, Ms Apitha, Mr Victor Karunan, Dr T.R. Nag Raj*, Dr P.R. Dharmadhikari*, Dr V.P. Rao (Director, India)*, Dr F.J. Simmonds (Global Director)*, Dr Sudha Nagarkatti, Ms Sumithra Manjunath*, Dr T. Sankaran (Associate Director, India)*. Standing, 1st row, 4th from right (behind Dr Sankaran): Dr H. Nagaraja*. Standing, 2nd row: 7th from left with dark shirt, Mr M. Narayana Rao; with tie, Dr T.M. Manjunath*
*(*late – It is unfortunate that most are no more)*

Awards and Recognitions

Dr K. Srinivasa Murthy

Elected as *Fellow of Royal Entomological Society of London* on 29 October 2020.

Dr Prakya Sreerama Kumar

Received membership through President's Circle Program, Entomological Society of America, USA.

Finalist – Top-5, Entomology Games Logo Contest, Entomological Society of America, USA.

Dr K. Selvaraj

Best Oral & Poster Presentation Awards, Webinar on Entomology 2020: Beyond COVID-19, Hyderabad, 11–12 December 2020.

Dr Richa Varshney

Best Oral Presentation Award, National Symposium on Plant Health Management, Navsari Agricultural University, Navsari, 2–4 November 2020.

***Best Worker Awards* received by NBAIR staff under different categories during the 27th "Foundation Day" on 19 October 2020**

Dr K. Selvaraj: Scientific Category.

Mr M.S. Uma: Administrative Category.

Dr N. Bakthavatsalam, Dr K. Subaharan, Dr A. Raghavendra, Mr Senthoorraja, Mr Yeetesh Kumar, Ms M. Sowmya and Mr Vinay: *Dr R.J. Rabindra Team Award* for 2019.

Prof. T.N. Ananthakrishnan Awards

Dr Ankita Gupta: Senior Scientist Award

Dr K. Selvaraj: Young Scientist Award

Awards from Dr B. Vasantharaj David Foundation at the National Conference on Recent Scientific Advances in Agricultural and Environmental Sciences, Chennai, 5 December 2020

Dr M. Pratheepa: *Outstanding Computer Application Scientist Award*

Dr R.S. Ramya: *Young Scientist Award*

Dr Veereshkumar: *Young Scientist Award*

Promotions

Dr K. Sreedevi: Principal Scientist

Dr Ankita Gupta: Senior Scientist

Dr G. Mahendiran: Senior Scientist

Dr Richa Varshney: Scientist (Senior Scale)

Transfer of Technologies

"Aqueous formulation of *Spodoptera frugipeda* nucleopolyhedrovirus (SpfrNPV)1 for the management of fall armyworm" to M/s Biocontrol Lab, Yavatmal.

"Waste to wealth: technology on black soldier fly-mediated bioconversion of farm and kitchen wastes" to M/s Venkatadri Poultries Pvt. Ltd, Guntur.

"*Metarhizium anisopliae* ICAR–NBAIR Ma4 for the management of white grubs in sugarcane" to M/s Siddaganga Oil and Bio Industries LLP, Tumakuru.

"A pest attractant composition and method of preparation thereof for uzi fly, *Exorista bombycis*" to M/s Pure Chemical Laboratories, Bengaluru, and M/s AG Organics, Bengaluru.

Selected Publications

Amala, U., Chaubey, B.K. & Shivalingaswamy, T.M. 2021. *Amegilla violacea* (Lepeletier, 1841) (Anthophorini: Apidae) – a native bee, an effective pollinator of eggplant (*Solanum melongena*). *Journal of Apicultural Research,* https://doi.org/10.1080/00218839.2020.1862393.

Liu, Z., He, J.-H., Chen, X.-X. & Gupta, A. 2020. The *ater*-group of the genus *Apanteles* Foerster (Hymenoptera, Braconidae, Microgastrinae) from China with the descriptions of forty-eight new species. *Zootaxa,* 4807(1): 001–205.

Rachana, R.R. & Manjunath, K. 2020. A new species of the genus *Lefroyothrips* (Thysanoptera: Thripidae) from India. *Zootaxa*, 4896(4): 591–594.

Shivalingaswamy, T.M., Amala,U., Gupta, A. & Raghavendra, A. 2020. Non-Apis bee diversity in an experimental pollinator garden in Bengaluru – a Silicon Valley of India. *Sociobiology*, 67(4): 593–598.

Varshney, R., Poornesha, B., Raghavendra, A., Lalitha, Y., Apoorva, A., Ramanujam, B., Rangeshwaran, R., Subaharan, K., Shylesha, A.N., Bakthavatsalam, N., Chaudhary, M. & Pandit, V. 2020. Biocontrol-based management of fall armyworm, *Spodoptera frugiperda* (J E Smith) (Lepidoptera: Noctuidae) on Indian maize. *Journal of Plant Diseases and Protection*, 128: 87–95.

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