हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
Agrisearch with a human touch

जय किसान जय विज्ञान

स्वच्छ भारत
एक कदम स्वच्छता की ओर

Cleanliness is next to Godliness
150 YEARS OF CELEBRATING THE MAHATMA

ICAR-National Bureau of Agricultural Insect Resources

P.O. Box 2491, H.A. Farm Post, Hebbal, Bengaluru - 560 024, India

Phone: +91 80 2341 4220 ✦ Fax: +91 80 231 1961 ✦ Website: www.nbair.res.in

(ISO 9001: 2008 Certified Institution)

Annual Report 2021

ICAR–National Bureau of Agricultural Insect Resources

Bengaluru, India

Azadi Ka Amrit Mahotsav

Annual Report
2021
वार्षिक प्रतिवेदन

ICAR-NATIONAL BUREAU OF AGRICULTURAL INSECT RESOURCES

Bengaluru, India

राष्ट्रीय कृषि कीट संसाधन ब्यूरो

बेंगलूरु, भारत

Annual Report
2021

ICAR–NATIONAL BUREAU OF AGRICULTURAL INSECT RESOURCES
Bengaluru 560 024, India

Published by
The Director
ICAR–National Bureau of Agricultural Insect Resources
P.O. Box 2491, H.A. Farm Post, Hebbal, Bengaluru 560 024, India
Phone: +91 80 2341 4220; 2351 1998; 2341 7930
Fax: +91 80 2341 1961
E-mail: director.nbair@icar.gov.in
Website: www.nbair.res.in

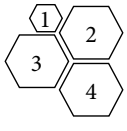
ISO 9001:2008 Certified (No. 6885/A/0001/NB/EN)

Compiled and edited by
Kesavan Subaharan
Amala Udayakumar
Rachana, R.R.
Ramya, R.S.
Deepa Bhagat
Kolla Sreedevi
Ankita Gupta
Mahendiran, G.
Nagesh, M.

Cover and layout designed by
Mahendiran, G.

March 2022

Cover Page Images



Citation
ICAR–NBAIR. 2022. Annual Report 2021. ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, India, vi + 120pp.

Printed at
CNU Graphic Printers
35/1, South End Road
Malleswaram, Bengaluru 560 020
Mobile: 9880 888 399
E-mail: cnu@cnu.net.in

CONTENTS

Cover images

Front

1. *Typhlodromus* (*Anthoseius*) *transvaalensis*, a Type III generalist predatory mite useful against mites and thrips (courtesy: Mahendiran, G. & Prakya Sreerama Kumar)
2. Invasive cassava mealybug, *Phenacoccus manihoti* Matile-Ferrero (courtesy: Sunil Joshi)
3. Aggregation of invasive insect, *Thrips parvispinus* on chilli flower (courtesy: Rachana, R.R.)
4. *Anagyrus lopezi* parasitising cassava mealybug (courtesy: Sampath Kumar, M.)

Back

Scutellera perplexa feeding on star gooseberry (courtesy: Salini, S.)

PREFACE

The COVID-19 pandemic leading to lockdown from early 2020 saw no respite in decline. The Delta variant driven second wave brought hardship to all walks of society across the globe. Amidst the difficult and turbulent times, the Indian farmers toiled hard to keep the food basket full with the support from the research organizations and development agencies. Invasive alien pests have been a threat to field and horticultural crops in India. Focus during the period was to develop strategies to contain the damage caused by them. The challenges posed by entry of the invasive cassava mealy bug (CMB) into the country was effectively managed by coordinated efforts of ICAR by importing the parasitoid *Anagyrus lopezi* from International Institute of Tropical Agriculture (IITA) Republic of Benin. On successful import of the parasitoid post entry quarantine requirements were fulfilled at the quarantine facility at ICAR-NBAIR and the mass production techniques were standardized which enabled the training of the researchers and the development agencies. Even before the celebrations could begin on the success of importing and multiplying CMB parasitoids, there was another invasive pest to the chilli crop, *Thrips parvispinus*, that caused extensive damage. ICAR-NBAIR stood to the expectations of Indian farmers requirements by identifying the pest and suggesting clean and green management measures to bring down the pest incidence.

Despite the travel restrictions in place, ICAR-NBAIR scientists could collect and describe five new species of scarab beetles, fruit flies and two new species of Hymenoptera along with description of fourteen new taxa. Molecular tools were used to decipher the tritrophic relationships among the host, entomopathogenic nematodes (EPN) and entomopathogenic nematode associated bacteria (EPNB) combinations in the fall army worm (FAW), *Spodoptera frugiperda*. A technology for mass production of a generalist predator, *Typhlodromus* (*Anthoseius*) *transvaalensis* has been developed for use against mites and thrips.

BIPM measures developed for the fall armyworm and rugose spiralling whitefly provided a viable option for farmers to scale down the dependence on pesticides. A strain of *Maruca vitrata* nucleopolyhedrovirus (MaviNPV NBAIR1) infecting legume pod borer *Maruca vitrata* was isolated first time in India. Semiochemical based measures using the nanotechnological approaches were developed to manage the stored grain and crop pests.

A mobile app titled BIPM on FAW was developed in regional languages, viz. Marathi, Tamil, Telugu, Bengali and the north-eastern languages (Assamese, Khasi, Manipuri, Nagamese and Sikkimese). Detailed information on FAW biology, damage symptoms and management employing bioagents and behavioural approaches are provided to benefit the farmers, extension agencies and researchers.

The staff members of ICAR-NBAIR have contributed for the significant achievements of this organization. Over 74 papers were published in high rated journals, several virtual meetings, farmers meetings and training programmes were organized. Over eleven technologies were licensed generating a revenue to a tune of ₹ 47.39 lakhs. ICAR-NBAIR has four patents granted during the period under report. The Annual Report is thus a compilation of our efforts and contributions in the area of basic research paving the way for applied research and commercialization.

Bengaluru
28.03.2022

M. Nagesh
Director (Acting)

1. EXECUTIVE SUMMARY

ICAR-National Bureau of Agricultural Insect Resources

Germplasm Collection and Characterisation

Exploratory surveys for the documentation of arthropod biodiversity in India during January–December 2021 yielded 72 species of Tephritidae (40 genera); 64 species of Scarabaeidae (21 genera); 57 species of Pentatomidae (40 genera); 18 species of Thripidae (11 genera); 5 species of Tessaratomidae (4 genera); 3423 specimens of aphids and coccids; 284 specimens of tachinids; 266 specimens of weevils and 261 specimens of trichogrammatids. Samples were collected from Andhra Pradesh, Assam, Chhattisgarh, Karnataka, Kerala, Manipur, Meghalaya, Sikkim, Tamil Nadu, Telangana and Uttar Pradesh. In addition, scarab specimens were also received from Himachal Pradesh, Jharkhand, Maharashtra, Tamil Nadu and Uttar Pradesh for faunal studies.

One isolate of *Steinernema* from Udupi, Karnataka was added to NBAIR's repository of entomopathogenic nematodes (EPN). Over 124 isolates/species of *Steinernema*, *Heterorhabditis* and *Oscheius* nematodes were maintained on wax moth larvae.

Fourteen new taxa across the country were described: in Diptera: a new genus, *Gibbifronta* and three new species of fruit flies, *Elaphromyia juncta*, *Euphranta flavothoracica* and *Gibbifronta pavoniae*; in Hemiptera, six species of pentatomid bugs, *Agathocles flavipes*, *A. joceliae*, *Brachycerocoris davidii*, *B. petrii*, *Lodosocoris santhae* and *Sarju brevirostrata* and a new species of scale insect, *Icerya viraktamathi*; in Hymenoptera, two new species of braconids, *Asobara jenningsi* and *Parahormius similis* and in Thysanoptera, *Neohydatothrips biconcavus*. Additionally, five species of scarab beetles belonging to the tribe Sericini and one nematode species, *Steinernema* sp. of the family Steinernematidae were provisionally reported as new species.

Revisionary works include the revision of four pentatomid genera *viz., Agathocles*, *Brachycerocoris, Sarju* and *Surenus* with redescriptions of eight species and lectotype designation for *Agathocles normalis*; publication of two synonymies for *Halyomorpha picus*, one synonymy each for the genus, *Agathocles* and species, *A. limbatus*; establishment of four new combinations and two tribal transfers; revision of tephritid subtribe Acidoxanthina and elevation to tribal level employing morphological characters and DNA barcoding; publication of one synonymy for *Euphranta figurate*; publication of a junior homonym for braconid species, *Parahormius leucopterae*; redescriptions of twenty-eight species of scarab beetles of subfamily Rutelinae; twenty species of longhorn beetles; three soft scales *viz., Fistulococcus pokfulamensis*, *Kilifia deltoids* and *Paralecanium machili*; one mealybug species, *Antonina thaiensis* and one spider species, *Scytodes fusca*.

New distributional records of six species of pentatomid bugs were documented for Cambodia, China, Indonesia, Laos, Myanmar, Thailand and Vietnam. New distributional records include one pentatomid genus, *Lodosocoris*; two species of soft scales, *Fistulococcus pokfulamensis* and *Paralecanium machili*; one invasive species of aphid, *Patchiella reaumuri*; two species of fruit flies, *Elaphromyia siva* and *E. yunnanensis*; two species of tachinid flies, *Senometopia quarta* and *Argyrophylax cinerellus* and one species of scarab beetle. A spider species, *Tetragnatha nitens* was a new report for India.

New distributional records in India include: the trichogrammatid genus, *Trichogramma* from Sikkim; a tachinid genus, *Aneogmena* from Maharashtra; twelve species of scarab beetles viz. *Adoretus bicaudatus* and *Maladera bombycina* from Andhra Pradesh, *Holotrichia fissa, H. nagpurensis, Mimela inscripta* and *Rhinyptia* sp. from Chhattisgarh, *Holotrichia problematica*, *H. rufoflava* and *Idionycha excisa* from Jharkhand, *Anomala illusa* and *Brahmina mysorensis* from Kerala and *Holotrichia nagpurensis* from Uttarakhand; two aphid species, *Rhopalosiphum rufiabdominale* and *Phorodon cannabis* and one diaspidid species, *Lindingaspis rossi* from Uttar Pradesh; one mealybug species, *Heliococcus singularis* from Karnataka; one species of monophlebid scale, *Perissopneumon tamarindus* from Odisha and one species of tachinid fly, *Trigonospila transvittata* from south India (Tamil Nadu).

New host records documented were: *Cotesia ruficrus* as a parasitoid of rice horn caterpillar; *Perixera*

sp. for *Senometopia quarta*; *Cannabis sativa* for *Rhopalosiphum rufiabdominale*; *Polyalthea longifolia* for *Lindingaspis rossi*; *Terminalia arjuna* for *Heliococcus singularis*; *Annona reticulata* and *Pongamia pinnata* for *Perissopneumon tamarindus*; *Vitex trifolia* for *Brachyecerocoris petrii*; *Ocimum tenuiflorum* and *O. gratissimum* for *Phricodus hystrix*; *Phyllanthus acidus* for *Scutellera perplexa* and *Chrysocoris stockerus*; *Manihot esculenta* for *Biltothrips minutus* and *Apium graveolens* for *Scirtothrips dorsalis*.

Diagnostic keys were published for several insect taxa: Genera of tribe Acidoxanthini; Indian species of *Euphranta*; non-African species of *Elaphromyia*; major genera of gall-forming thrips of North East India; Oriental species of *Brachycerocoris*; Indian species of *Agathocles Sarju* and Indian species of *Ceroplastes*.

Annotated checklist for Indian Curculionidae, Indian Braconidae and subfamily Microgastrinae were prepared. Databases were developed for: "Subfamily Entiminae" (25 factsheets) and "Indian Braconidae" (50 species and 200 wasp/host images). Distribution map of pentatomid bug, *Halyomorpha picus* across India was published.

A multitrophic interaction structured vertically as well as horizontally was noticed in the food web associated with the niche of the invasive cassava mealybug, *Phenacoccus manihoti*. Altogether 45 species were recorded to be associated directly or indirectly with the invasive species: thirty-four species of insects from six orders (Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera and Neuroptera) and eleven species of spiders (Arachnida) were grouped under four trophic levels into 11 guilds. The analysis of trophic guild structure and interaction indicated that indigenous parasitoid species, which qualified to be placed under the fourth trophic level, actively parasitized the potential native predators of the species and thereby negatively impacted the natural biological control of cassava mealybug.

Systematic surveys were conducted to monitor the invasive thrips, *Thrips parvispinus*. A total of 4865 specimens were received from seven states viz., Andhra Pradesh, Chhattisgarh, Gujarat, Karnataka, Maharashtra, Tamil Nadu and Telangana were examined. *T. parvispinus* was recorded on nine host plants, four were fruit crops (*Carica papaya*, *Citrullus lanatus*, *Mangifera indica* and *Punica granatum*); three were ornamentals (*Brugmansia* sp., *Chrysanthemum* sp. and *Dahlia rosea*), one each of vegetable (*Capsicum annuum*) and field crop (*Gossypium* sp.), reflecting the adaptability of *T. parvispinus* and capability to breed in diverse agro-ecosystems. Pest alert on *T. parvispinus* was issued considering the menace caused by this species on chilli cultivation.

Identification services were provided to researchers from agricultural universities, private companies and ICAR institutes.

Genomic Resources

Draft genomes of four entomopathogenic nematodes were generated and submitted to NCBI. Transcriptome analysis of tri-trophic relationships among the host, EPN and entomopathogenic nematode bacteria (EPNB) combinations in Fall Army worm, *Spodoptera frugiperda* indicated that the gene expression related to insect metabolism and immunity primarily included metalloproteases, lipases, proteinases, AMPs and oxidative pathways. Differential gene expression (DEG) in *Galleria mellonella* and *S. frugiperda* using Nanostring Custom Multiplexed assay was accomplished.

Molecular characterisation were carried out and DNA barcodes of agriculturally important insect pests and their natural enemies were generated using different genes, viz. *CO1*, *CO1B*, *TPI*, *CO1* (*Btab* gene–850 bp) and ITS–2, and GenBank accession numbers were obtained for the same. Molecular diagnostic studies were done by testing 23 sets of primers to design a species-specific primer set for the identification of *S. frugiperda*. To establish the specificity of the primers, they were tested for amplification in 8 different insect species, namely *S. frugiperda*, *S. litura*, *Chilo suppressalis*, *Corcyra cephalonica, Leucinodes orbonalis*, *Mythimna separata, Plutella xylostella* and *Spilosoma obliqua.* Three sets of primers were found to be specific to *S. frugiperda* and one of the amplicons was cloned and is being verified and characterised for further use. Heteropteran plant bugs were collected from different locations surrounding Bengaluru region and from North East India (Assam) from vegetable and field crops. A total of 126 plant bug specimens collected, were morphologically identified and characterised using molecular tools.

A novel powder-based formulation of *Bacillus*

thuringiensis was developed using sodium starch glycolate and kaolin with molasses. The viability was monitored for one year.

Twenty-nine subpopulations of *M. vitrata* were collected and mitochondrial *COI* marker was used for differentiating haplotypes. A draft genome assembly for cotton leafhopper, *Amrasca biguttula biguttula* was constructed by assembling reads generated by Pacbio and Illumina. The predicted genome size was 450mb and 28,804 protein coding genes were annotated.

Biochemical characterisation of microflora from black soldier fly, *Hermetia illucens* for hydrolytic enzymes amylase, lipase, protease using qualitative assays revealed 8 isolates positive for starch hydrolysis, 4 isolates for casein hydrolysis and 8 for cellulose hydrolysis. These isolates will be further tested for quantitative analysis.

Gene expression was studied to understand the molecular mechanism of GA3 effect on pink mealybug. The whole transcriptome sequencing was done to investigate the genes and gene pathways involved in the effects of GA3 on pink mealybug.

A mobile app titled BIPM on FAW was developed in English, Hindi, Marathi, Tamil, Telugu, and the North-Eastern languages (Assamese, Bengali, Khasi, Manipuri, Nagamese and Sikkimese). It provides information on the management of *S. frugiperda* in maize. Detailed information on FAW biology, damage symptoms and management employing bioagents and behavioural approaches are provided.

Germplasm Conservation and Utilisation

A total 64 strains of Trichogrammatids belonging to 14 species were screened against *Spodoptera frugiperda*. *Trichogramma chilonis* caused higher parasitization on *S. frugiperda* eggs to a tune of 66.25% in laboratory and 42.15% in field conditions.

Simultaneous release of *Telenomus remus* and *T. chilonis* against fall armyworm exhibited 88.9 per cent parasitism and was on par with the single release of *T. remus*. *Bracon brevicornis* preferred fifth instar larvae of fall armyworm with higher fecundity; per cent pupal formation and per cent adult emergence. Field release of this parasitoid against fall armyworm exhibited 54% reduction in the infestation.

Prophylactic spray of an aqueous suspension of SpfrNPV NBAIR1 @ 4 ml per litre twice at 1.5x 10^{12} POBs/ha at 20 and 35 days after sowing reduced infestation of fall armyworm by 62% during Kharif season.

IPM trial on fall armyworm showed 79.23% reduction in the larval population and 81.56% egg reduction compared to control at Devasthethalli, Nandi Cross, Karnataka.

Entomopathogenic fungi strains (*Beauveria bassiana* and *Metarhizium anisopliae*) were effective in the management of sucking pests *Aphis gossypii* and *Amrasca biguttula biguttula* in bhendi. Entomopathogenic fungus, *Aschersonia aleyrodis* isolated from naturally infected colonies of citrus black fly, *Dialeurodes citri* in Kinnow mandarin were morphologically and molecularly characterised. The mulberry root rot disease was managed using NBAIR-TATP *Trichoderma asperellum* strain.

Treating with a high dose of *Dortus primarius* (2 pairs/plant and 5 releases) in tomato caused significantly less number of *T. absoluta* eggs and larvae. Weekly release of *Blaptostethus pallescens* @ 20-30 per square meter (total 4-5 releases) with alternation of biopesticide *Bacillus subtilis* resulted in a significant reduction of thrips population in capsicum.

Fitness attributes and collection of passport data for 40 entomopathogenic nematodes (EPN) isolates was completed. Field studies on the effect of WP formulation of *Heterorhabditis indica* NBAII Hi101 in combination with intercropping (1:1) maize with red gram, fodder dhaincha and marigold on the incidence of fall armyworm and crop damage during rabi (2020-2021) and kharif (2021-2022) was conducted.

A total 124 isolates/species of *Steinernema*, *Heterorhabditis* and *Oscheius* nematodes were maintained on wax moth larvae. One *Steninernema* species NBAIRS58 was isolated from Udupi, Karnataka and added to the EPN repository. Field studies confirmed *H. indica* NBAIIH38 is a promising biocontrol agent against *Holotrichia* species in sugarcane.

A strain of *Maruca vitrata* nucleopolyhedrovirus (MaviNPV NBAIR1) infecting legume pod borer *Maruca vitrata* was isolated first time in India from

diseased larvae. Electron microscopic studies showed irregularly shaped occlusion bodies of size 0.9 to 1.4 µm. First instar *Maruca vitrata* larvae were most susceptible (LC_{50} 2.021 OBs/m^2) to MaviNPV.

Coconut shell traps were used to attract the natural swarms of stingless bees, *Tetragonula iridipennis*. Strong colony of *T. iridipennis* divided with queen cells recorded 80% establishment. Rice bran and rice bran + vegetable supplemented diet recorded the lowest larval development period of *Zophobas morio* and *Tenebrio molitor*. Rice bran recorded highest individual larval weight of *Z. morio* and *T. molitor*.

Expansion of geographical and host distribution for recent invasive whiteflies along with associated natural enemies has been documented. Augmentation and conservation strategies have been advocated for the management of invasive whiteflies through demonstration, awareness and training programmes.

The major component of *Spodoptera frugiperda* pheromone (Z)-9-tetradecenyl acetate was synthesized.

A field day was conducted to demonstrate the use of black solder fly for converting organic waste into manures at Thalahalli, Nandi Hobli, Chikkaballapura district under 'Swachh Bharat Abhiyan'. 'Waste to wealth: Technology on Black Soldier Fly mediated bioconversion of farm and kitchen wastes' was commercialized to one firm.

All India Coordinated Research Project on Biological Control of Crop Pests

Biological control of sugarcane pests

Six releases of *Trichogramma chilonis* @ 50,000 parasitoids/ha at weekly intervals starting from 40 days after emergence of shoots were found significantly superior to untreated control in reducing early shoot borer infestation.

Three sprays of endophytic entomopathogenic fungal strains NBAIR Ma35, NBAIR Bb23 (5g/l) were found effective in the management of sugarcane early shoot borer.

Application of wettable powder formulation of entomopathogenic nematode, *Heterorhabditis indica* NBAIR Hi101 @ 22.50 kg/ha significantly reduced the white grub infestation in sugarcane.

Biological control of cotton pests

BIPM module with the release of *Trichogrammatoidea bactrae* @2cc/acre + pheromone traps reduced the damage caused by pink bollworm in cotton.

Biological control of maize pests

The fall armyworm incidence in the plots treated with *T. chilonis* + *Metarhizium anisopliae* Ma 35 was at low (14%).

Biological control of pulse pests

Chitin based formulation of entomopathogenic fungus, *Lecanicillium saksenae* (10^7 spores ml/l) @10 ml/l effectively reduced the population of pod bugs in cowpea.

Biological control of tropical fruit pests

Soil application of CISH strain *Purpureocillium lilacinum* and CISH strain *Bacillus* spp along with vermicompost reduced the incidence of wilt and root knot nematode in guava compared to untreated control.

Biological control of temperate fruit pests

Release of anthocorid predator, *Blaptostethus pallescens* (two releases) @ 400 bugs/ plant resulted in 25.27 and 35.91% reduction in European red mite and two-spotted spider mite infestation on apple.

Spraying of NBAIR strain *Lecanicilium lecanii* @ 5.0 ml/l combined with Azadirachtin 1500 ppm reduced the incidence of green apple aphid and mites.

Biological control of plantation crop pests

Foliar application of NBAIR strain *Isaria fumosorosea* @5gm/l at 15 days intervals resulted in a significant reduction of egg spirals and nymphs of rugose spiralling whitefly infesting coconut.

Conservation of potential parasitoid *Encarsia guadeloupae* and sooty mould scavenger beetle, *Leiochrinus nilgirianus* reduced the infestation of rugose spiralling whitefly in coconut.

Biological control of vegetable pests

BIPM module with the release of egg parasitoid, *T. chilonis* + spraying of *Bacillus thuringiensis Bt*1+ application of entomopathogenic nematode *Steinernema* sp AAU Strain 8 effectively reduced the infestation of the shoot and fruit borer.

2. INTRODUCTION

ICAR-National Bureau of Agricultural Insect Resources (ICAR-NBAIR) came into existence on 9 October 2014. Insects not only constitute the bulk of living organisms in our world but also render a host of ecosystem services like pollination, natural pest control, recycling of organic matter, dispersal of seeds, maintenance of soil fertility and so forth. Their notoreity as pests of agricultural crops, however, has drawn the maximum attention of entomologists. It is only with the knowledge of the insect fauna in agricultural and adjacent ecosystems that we can formulate pest management strategies to ensure the productivity and sustainability of our agricultural systems.

This shifting perspective on insects in agriculture has been mirrored in the evolution of this bureau. When the possibility of using insects instead of harmful chemicals for the management of insect pests in agriculture was realised, the Indian Council of Agricultural Research (ICAR) initiated the All-India Coordinated Research Project (AICRP) on Biological Control of Crop Pests and Weeds in 1977.

Though initially funded by the Department of Science and Technology, Government of India, ICAR began extending full financial support to the programme from 1979. To further strengthen research on biological control the Project Directorate of Biological Control was established on 19 October 1993. With the growing realisation that effective biological control was predicated on sound taxonomic and ecological knowledge, the National Bureau of Agriculturally Important Insects (NBAII) was created on 29 June 2009, and the transition of NBAII to NBAIR happened in 2014.

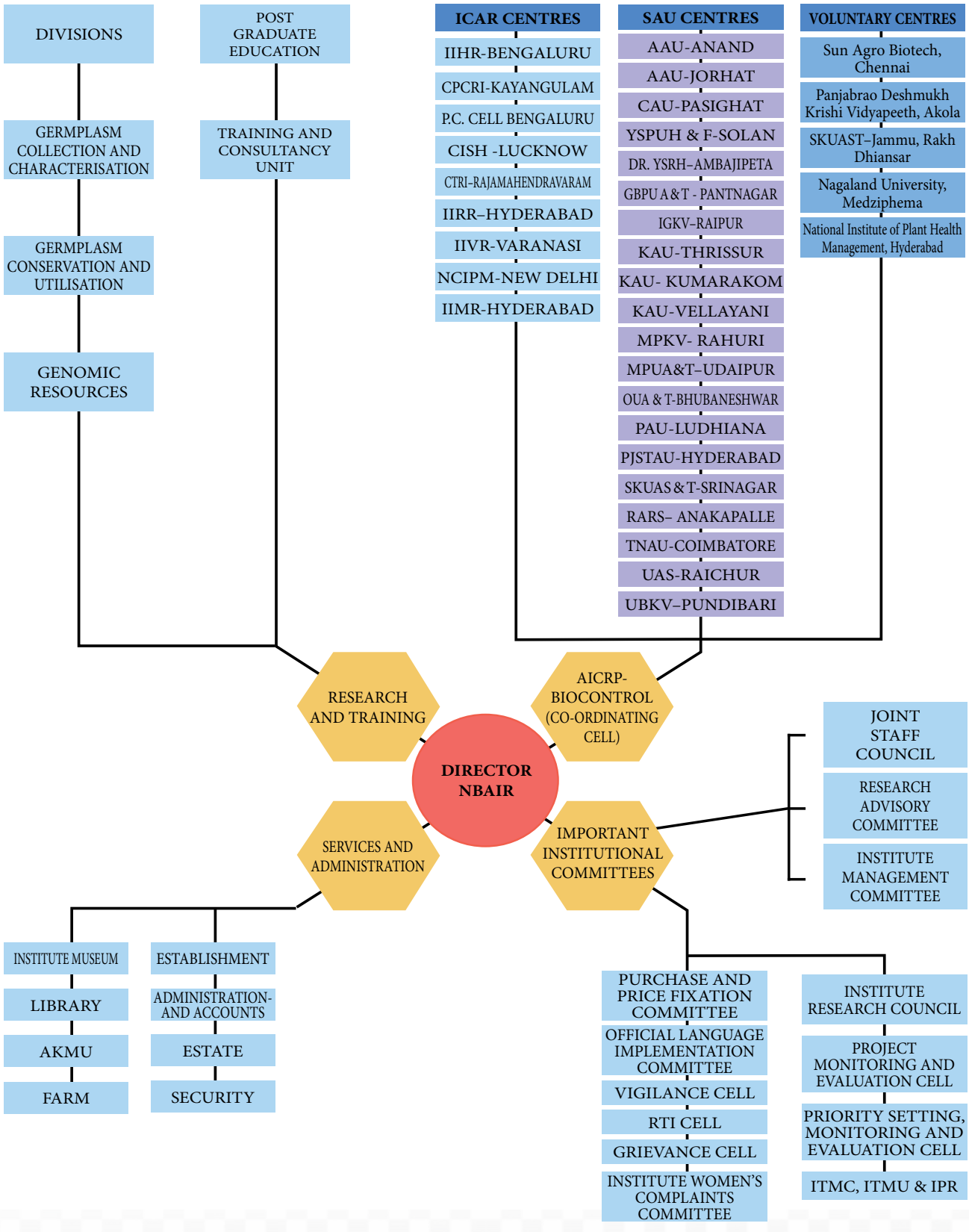
This bereau was recognised by the Ministry of Environment & Forests (presently MoEF&CC) in 2012 as the designated National Repository for preservation of insects, spiders and mites. The repository currently holds nearly 2,16,093 specimens, and 421 types. This is the only national bureau under the National Agricultural Research System (NARS) that acts as the nodal agency for collection, characterisation, documentation, conservation, exchange, research and utilisation of agriculturally important insect resources (including mites, spiders and related arthropods) for sustainable agriculture. Most of the specimens in the collection are Indian, but there is a unique representation of exotic beetles, wasps, flies and moths from various countries, including Australia, Argentina, the West Indies, Japan and USA. The museum is also unique in having one of India's largest collections of economically important taxa, including various biological control agents, viz. parasitic Hymenoptera (parasitoids), Coleoptera(Coccinellidae), along with major collections of groups with members which are pests, viz. Coleoptera, Hemiptera, Diptera, Lepidoptera and Orthoptera. Besides holding the world's smallest insect, *Kikiki huna,* in its collection, the museum also holds many undescribed species, and some species found in other collections in the world. Online web diagnostic portals/web pages are hosted in NBAIR domain. Presently there are 26 databases on the NBAIR website.

ICAR–NATIONAL BUREAU OF AGRICULTURAL INSECT RESOURCES
To act as a nodal agency for collection, characterisation, documentation, conservation, exchange, research and utilisation of agriculturally important insect resources (including mites, spiders and related arthropods) and insect–derived resources for sustainable agriculture. Capacity building, development of technologies for non-chemical pest management, dissemination of technologies and forging linkages with stakeholders
AICRP ON BIOLOGICAL CONTROL OF CROP PESTS
Promotion of biological control as a component of integrated pest and disease management in agriculture and horticultural crops for sustainable crop production. Demonstration of usefulness of biocontrol in IPM in farmers' fields.

Organisational set-up

Research is undertaken in the Divisions of Germplasm Collection and Characterisation; Genomic Resources; and Germplasm Conservation and Utilisation. Basic and applied research on biocontrol is addressed under the AICRP on Biocontrol. The organogram is given on page 7.

Organogram


DIVISIONS
GERMPLASM COLLECTION AND CHARACTERISATION
GERMPLASM CONSERVATION AND UTILISATION
GENOMIC RESOURCES
POST GRADUATE EDUCATION
TRAINING AND CONSULTANCY UNIT
ICAR CENTRES
IIHR-BENGALURU
CPCRI-KAYANGULAM
P.C. CELL BENGALURU
CISH -LUCKNOW
CTRI-RAJAMAHENDRAVARAM
IIRR–HYDERABAD
IIVR-VARANASI
NCIPM-NEW DELHI
IIMR-HYDERABAD
SAU CENTRES
AAU-ANAND
AAU-JORHAT
CAU-PASIGHAT
YSPUH & F-SOLAN
DR. YSRH–AMBAJIPETA
GBPU A&T - PANTNAGAR
IGKV–RAIPUR
KAU-THRISSUR
KAU- KUMARAKOM
KAU-VELLAYANI
MPKV- RAHURI
MPUA&T–UDAIPUR
OUA & T-BHUBANESHWAR
PAU-LUDHIANA
PJSTAU-HYDERABAD
SKUAS & T-SRINAGAR
RARS– ANAKAPALLE
TNAU-COIMBATORE
UAS-RAICHUR
UBKV–PUNDIBARI
VOLUNTARY CENTRES
Sun Agro Biotech, Chennai
Panjabrao Deshmukh Krishi Vidyapeeth, Akola
SKUAST–Jammu, Rakh Dhiansar
Nagaland University, Medziphema
National Institute of Plant Health Management, Hyderabad
RESEARCH AND TRAINING
AICRP-BIOCONTROL (CO-ORDINATING CELL)
DIRECTOR NBAIR
SERVICES AND ADMINISTRATION
IMPORTANT INSTITUTIONAL COMMITTEES
JOINT STAFF COUNCIL
RESEARCH ADVISORY COMMITTEE
INSTITUTE MANAGEMENT COMMITTEE
INSTITUTE MUSEUM
LIBRARY
AKMU
FARM
ESTABLISHMENT
ADMINISTRATION-AND ACCOUNTS
ESTATE
SECURITY
PURCHASE AND PRICE FIXATION COMMITTEE
OFFICIAL LANGUAGE IMPLEMENTATION COMMITTEE
VIGILANCE CELL
RTI CELL
GRIEVANCE CELL
INSTITUTE WOMEN'S COMPLAINTS COMMITTEE
INSTITUTE RESEARCH COUNCIL
PROJECT MONITORING AND EVALUATION CELL
PRIORITY SETTING, MONITORING AND EVALUATION CELL
ITMC, ITMU & IPR

Research achievements

Basic research

- Five species of scarab beetles, *Lepidoserica barapaniensis*, *Maladera kaimurensis*, *M. kottagudiensis*, *M. silviafabriziae* and *M. tripuraensis* were provisionally reported as new species.
- Five new species of fruit flies, *Campiglossa ialong, C. shaktii*, *C. sherlyae*, *Euphranta siruvani* and *Hemilea totu* were reported.
- Systematic surveys were conducted to monitor the invasive thrips species, *Thrips parvispinus* and a total of 4865 specimens were examined from seven states viz. Andhra Pradesh, Chhattisgarh, Gujarat, Karnataka, Maharashtra, Tamil Nadu and Telangana.
- A spider species, *Tetragnatha nitens* was also reported as a new report for India.
- *Scirtothrips dorsalis*, the chilli thrips, was reported for the first time as a pest of celery, *Apium graveolens*.
- Fourteen new taxa across the country were described: in Diptera: a new genus, *Gibbifronta* and three new species of fruit flies, *Elaphromyia juncta*, *Euphranta flavothoracica* and *Gibbifronta pavoniae*; in Hemiptera, six species of pentatomid bugs, *Agathocles flavipes*, *A. joceliae*, *Brachycerocoris davidii*, *B. petrii*, *Lodosocoris santhae* and *Sarju brevirostrata* and a new species of scale insect, *Icerya viraktamathi*; in Hymenoptera, two new species of braconids, *Asobara jenningsi* and *Parahormius similis* and in Thysanoptera, *Neohydatothrips biconcavus*.
- A total of 72 putative CYP genes were identified from the genome and transcriptome of *Leucinodes orbonalis*.
- Twenty nine subpopulations of *Maruca vitrata* were collected and mitochondrial COI marker was used for differentiating haplotypes.
- Transcriptome analysis of tritrophic relationships among the host, entomopathogenic nematodes (EPN) and entomopathogenic nematode associated bacteria (EPNB) combinations in fall army worm, *Spodoptera frugiperda* indicated that the gene expression related to insect metabolism and immunity primarily included metalloproteases, lipases, protein-ases, AMPs and oxidative pathways.
- Differential gene expression (DEG) in *Galleria mellonella* and *S. frugiperda* using Nanostring Custom Multiplexed assay was accomplished.

Applied research (Biological control)

- A total 64 strains of Trichogrammatids belonging to 14 species were screened against *Spodoptera frugiperda* and *Trichogramma chilonis* parasitised higher percentages of the host eggs.
- Weekly release of anthocorid predator, *Blaptostethus pallescens* @ 20-30 per square meter (total 4-5 releases) with alternation of biopesticide *Bacillus subtilis* resulted in reduction of thrips population in capsicum.
- A mycelial-condial liquid formulation of *Hirsutella thompsonii* (ICAR-NBAIR-MF(Ag)66) was effective among the three biocontrol agents the broad mite, *Polyphagotarsonemus latus*, in mulberry.
- Entomopathogenic fungus, *Aschersonia aleyrodis* was isolated from naturally infected colonies of citrus black fly, *Dialeurodes citri* in Kinnow mandarin and morphologically and molecularly characterised.
- Soil drenching with *Trichoderma asperellum* strain NBAIR-TATP @ 2% solution @ 50 ml per plant effectively suppressed the root rot disease in mulberry and controlled the further spread of the disease.

- A strain of *Maruca vitrata* nucleopolyhedrovirus (MaviNPV NBAIR1) infecting legume pod borer *Maruca vitrata* was isolated first time in India from diseased larvae.
- A mobile app titled BIPM on FAW was developed in English, Hindi, Marathi, Tamil, Telugu, and the North-Eastern languages like Assamese, Bengali, Khasi, Manipuri, Nagamese and Sikkimese which contains information on the management of *Spodoptera frugiperda* in maize.
- Y-terpinene exhibited highest repellency (96.66 %) of *Triboilum castaneum* at lower concentration (57.6 nL/cm^2).
- The major component of *Spodoptera frugiperda* pheromone (Z)-9-tetradecenyl acetate was synthesised.
- Coconut shell traps were viably used for trapping the swarms of stingless bees, *Tetragonula iridipennis*.
- The culture of mealworm, *Tenebrio molitor* and superworms, *Zophobas morio* were reared in bran based diets.

FINANCIAL STATEMENT 2021

ICAR-National Bureau of Agricultural Insect Resources

Head	Amount (₹ in lakhs)
Pay & allowances	1088.08
TA	3.47
Other charges, including equipment and office buildings	430.33
Information technology	6.68
Works and petty works	6.44
HRD	0.80
Pension	152.86
Loan	0
Total	**1688.66**

All-India Coordinated Research Project on Biological Control of Crop Pests and Diseases

Name of the centres	Salaries	Capital	TA	RC	TSP	Total (₹ in lakhs)
AAU, ANAND	21.69	0.00	2.00	20.00	3.00	**46.69**
AAU, JORHAT	13.80	6.10	0.60	9.92	5.61	**36.03**
RARS-ANAKAPALLE	9.00	0.00	2.00	14.00	3.16	**28.16**
PJTSAU, TELANGANA	14.96	0.00	0.75	5.00	0.00	**20.71**
DR. YSPUH&F, SOLAN	20.33	0.00	1.00	9.50	1.00	**31.83**
GBPUAT, P'NAGAR	10.52	0.00	0.75	10.00	4.50	**25.77**
KAU, THRISSUR	10.67	0.00	0.60	15.00	0.00	**26.27**
MPKV, PUNE	20.40	0.00	1.20	11.40	0.00	**33.00**
PAU, LUDHIANA	23.96	0.00	1.00	10.00	0.00	**34.96**
SKUAST, SRINAGAR	21.05	0.00	2.25	2.50	2.25	**28.05**
TNAU, COIMBATORE	14.52	0.00	1.00	10.00	0.00	**25.52**
MPUAT, UDAIPUR	0.00	0.00	1.00	4.00	0.00	**5.00**
OUAT, B'WAR	0.00	0.00	0.75	1.26	1.23	**3.24**
CAU, PASIGHAT	0.00	0.00	1.01	7.50	3.00	**11.51**
UAS, RAICHUR	0.00	0.00	0.62	16.51	1.26	**18.39**
ICAR–CPCRI, KAYANKULAM	0.00	0.00	1.00	5.00	0.00	**6.00**
ICAR–IIHR, BENGALURU	0.00	0.00	1.00	5.00	0.00	**6.00**
ICAR–P.C. CELL, BENGALURU	0.00	0.00	3.57	25.76	0.00	**29.33**
ICAR–CISH, LUCKNOW	0.00	0.00	0.00	5.20	0.00	**5.20**
ICAR–IIRR, HYDERABAD	0.00	0.00	1.00	3.00	0.00	**4.00**
ICAR–IIMR, HYDERABAD	0.00	0.00	1.00	3.00	0.00	**4.00**
ICAR–IIVR, VARANASI	0.00	0.00	0.40	1.85	0.00	**2.25**
ICAR–NCIPM, NEW DELHI	0.00	0.00	0.25	0.50	0.00	**0.75**
IGKV, RAIPUR	0.00	0.00	1.00	5.00	10.00	**16.00**
KAU, KUMARAKOM	0.00	0.00	0.75	8.00	0.00	**8.75**
KAU, VELLAYANI	0.00	0.00	0.50	7.50	0.00	**8.00**
DR. YSRHU, AMBAJIPETA	0.00	0.00	0.75	6.00	0.00	**6.75**
UBKV, PUNDIBARI	0.00	0.00	0.75	2.25	0.50	**3.50**
Total	**180.90**	**6.10**	**28.50**	**224.65**	**35.51**	**475.66**

3. RESEARCH ACHIEVEMENTS

ICAR-National Bureau of Agricultural Insect Resources

Division of Germplasm Collection and Characterisation

Surveys and explorations

Surveys were undertaken to document the fauna of insects, spiders, mites and entomopathogenic nematodes across the states of Andhra Pradesh, Assam, Chhattisgarh, Karnataka, Kerala, Manipur, Meghalaya, Sikkim, Tamil Nadu, Telangana and Uttar Pradesh amidst the travel regulations due to COVID-19. Scarab specimens received from Himachal Pradesh, Jharkhand, Maharashtra, Tamil Nadu and Uttar Pradesh for faunal studies. Expeditions undertaken yielded 72 species of Tephritidae in 40 genera; 64 species of Scarabaeidae in 21 genera; 57 species of Pentatomidae in 40 genera; 18 species of Thripidae in 11 genera; 5 species of Tessaratomidae in 4 genera; 3423 specimens of aphids and coccids; 284 specimens of tachinids; 266 specimens of weevils and 261 specimens of trichogrammatids.

Description of new genus

A new genus of fruit fly, *Gibbifronta* David, Hancock & Han (Fig. 1) was described from India with *Gibbifronta pavoniae* as its type species. Flies were collected on flowers of Fragrant swamp mallow, *Pavonia odorata* (Malvaceae), GKVK Botanical Garden, Bengaluru.

Description of new species

Thirteen species of insects were described across various insect orders namely Diptera, Hemiptera, Hymenoptera and Thysanoptera. Six species of Pentatomidae in four genera, three species of Tephritidae in three genera, two species of Braconidae in two genera, one each of Monophlebidae and Thripidae were described from India (Table. 1). Five species of Scarabaeidae belonging to the tribe Sericini and one nematode species (*Steinernema* sp.) of the family Steinernematidae were provisionally reported as new species.

Table 1. List of new species described

Sl. No.	Scientific name	Family	Holotype deposited
	Diptera		
1.	*Elaphromyia juncta* David, Hancock & Sachin (Fig. 9)	Tephritidae	NBAIR, Bengaluru
2.	*Euphranta flavothoracica* David, Hancock & Sachin (Fig. 8)	Tephritidae	NBAIR, Bengaluru
3.	*Gibbifronta pavoniae* David, Hancock & Han (Fig. 10)	Tephritidae	NBAIR, Bengaluru
	Hemiptera		
4.	*Agathocles flavipes* Salini & Kment (Fig. 3)	Pentatomidae	NBAIR, Bengaluru
5.	*Agathocles joceliae* Salini & Kment (Fig. 4)	Pentatomidae	Naturhistorisches Museum in Wien, Vienna, Austria (NHMW)
6.	*Brachycerocoris davidii* Roca-Cusachs & Salini (Fig. 7)	Pentatomidae	Marcos Roca-Cusachs personal collection, University of Barcelona, Spain
7.	*Brachycerocoris petrii* Salini & Roca-Cusachs (Fig. 6)	Pentatomidae	NBAIR, Bengaluru
8.	*Lodosocoris santhae* Salini (Fig. 5)	Pentatomidae	NBAIR, Bengaluru

Sl. No.	Scientific name	Family	Holotype deposited
9.	*Sarju brevirostrata* Salini and Rabbani (Fig. 2)	Pentatomidae	UAS, Bengaluru
10.	*Icerya viraktamathi* Joshi (Fig. 14)	Monophlebidae	NBAIR, Bengaluru
	Hymenoptera		
11.	*Asobara jenningsi* Gupta (Fig. 12)	Braconidae	NBAIR, Bengaluru
12.	*Parahormius similis* Gupta (Fig. 11)	Braconidae	NBAIR, Bengaluru
	Thysanoptera		
13.	*Neohydatothrips biconcavus* Rachana (Fig. 13)	Thripidae	NBAIR, Bengaluru

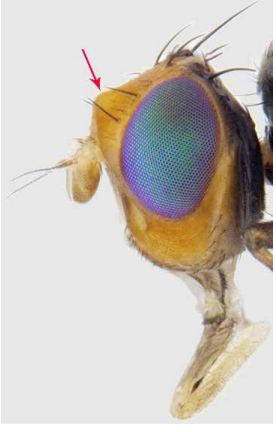
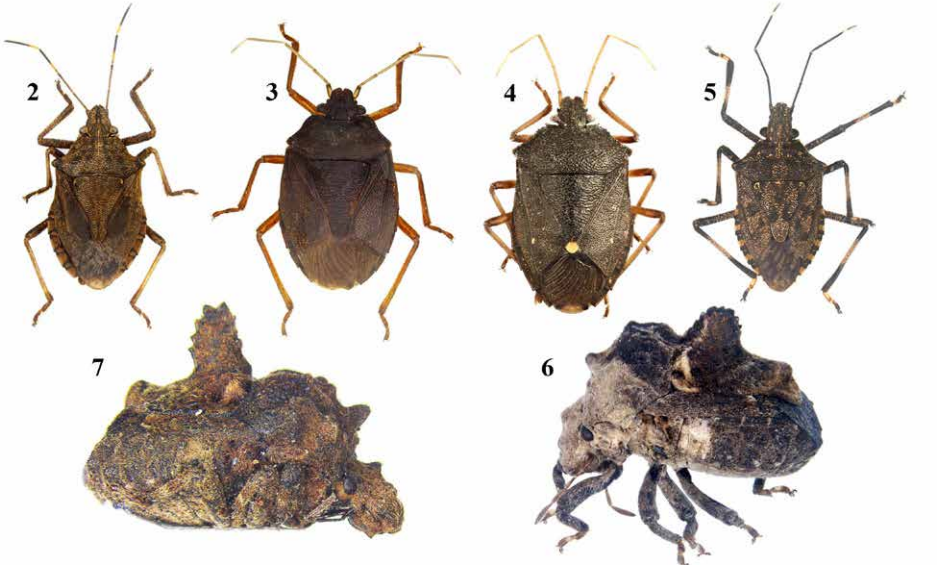


Figure 1. Head of *Gibbifronta pavoniae* David, Hancock & Han (lateral view) showing protuberance on the frons



Figures 2–7. New pentatomid taxa described from India. 2, *Sarju brevirostrata* Salini and Rabbani; 3, *Agathocles flavipes* Salini & Kment; 4, *Agathocles joceliae* Salini & Kment; 5, *Lodosocoris santhae* Salini; 6, *Brachycerocoris petrii* Salini & Roca-Cusachs; 7, *Brachycerocoris davidii* Roca- Cusachs & Salini

Revisions/redescriptions of taxa

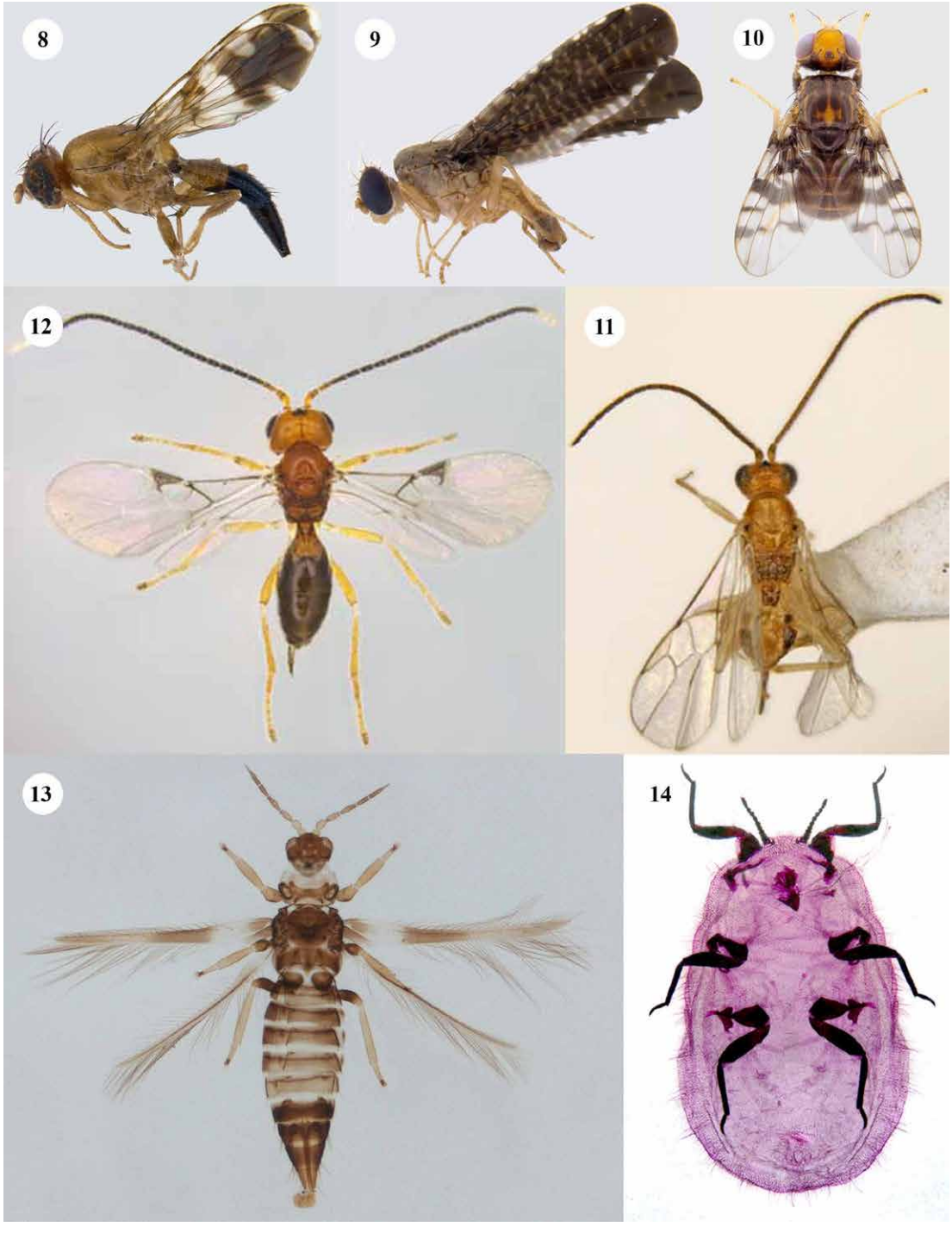
Revised four pentatomid genera *viz. Agathocles*, *Brachycerocoris, Sarju* and *Surenus*. The genus, *Surenus* was synonymised with *Agathocles* Stål. *Agathocles yunnanensis* Zhang & Lin was synonymised with *A. limbatus* Stål. Established *Halyomorpha azhari* Ahmad & Zaidi and *H. punjabensis* Ahmad & Kamaluddin as synonyms of *H. picus*. Lectotype was designated for *Agathocles normalis* (Distant). Gender agreement and authorship of the name *Riazocoris niger* Ahmad and Afzal in Ahmad *et al.* (1977:161) was corrected and status of its name bearing type was clarified as lectotype. The following new combinations were made: *A. normalis*, *Caystrus dubius* (Distant), *Paramecocoris ruficornis* (Fieber) and *Sarju nodula* (Fan and Liu). Type locality of *P. ruficornis* was clarified as Tenasserim (South Myanmar). Two tribal transfers were published: *Agathocles*, which was presently a member of Rolstoniellini was transferred to Caystrini and *Kyrtalus mackiei* from Caystrini was transferred to Myrocheini. Subtribe Acidoxanthina (Diptera: Tephritidae) was revised, raised to tribal level employing morphological characters and DNA barcoding. *Ichneumonomacula wangyongi* Chen was synonymised with *Euphranta figurata* (Walker). *Parahormius leucopterae* Ahmad & Ahmed (Hymenoptera: Braconidae) was published as a junior homonym of *P. leucopterae* Nixon. Redescribed *A. limbatus*, *Brachycerocoris camelus* Costa, *B. dromedarius* (Vollenhoven), *Chrysocoris stockerus* (Linn.), *Phricodus hystrix* (Germer), *Sarju farida* Ghauri, *S. nigricollis* (Westwood) and *Scutellera perplexa* (Westw.). Eighteen species of genus *Adoretus* and 10 species of genus *Popillia* belonging to subfamily Rutelinae (Coleoptera: Scarabaeidae) were redescribed with detailed illustrations of important species delineating characters along with morphometric measurements. Twenty species of longhorn beetles belonging to the tribe Saperdini of subfamily Lamiinae (Coleoptera: Cerambycidae) were redescribed with comprehensive documentation of morphological characters. Soft scales, *Fistulococcus pokfulamensis* Hodgson & Martin, *Kilifia deltoides* De Lotto and *Paralecanium machili* Takahashi as well as mealybug species, *Antonina thaiensis* Takahashi were redescribed. Spitting spider, *Scytodes fusca* was redescribed and illustrated in detail with natural history notes, illustrations, diagnostic characters along with its distributional records across India.

New distributional records

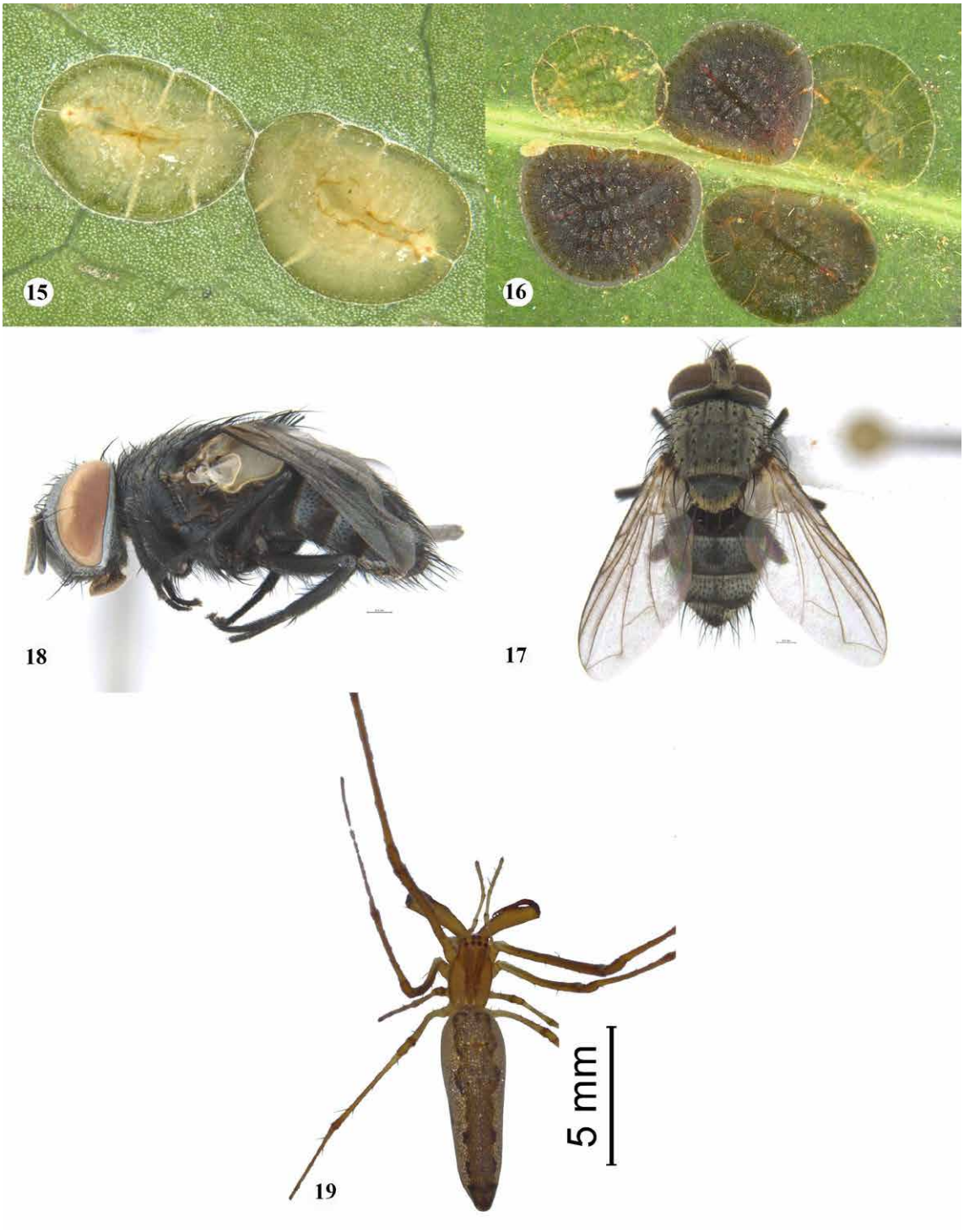
New distributional records of pentatomid bugs were documented: *Agathocles limbatus* from Cambodia, China, Laos and Thailand; *A. normalis*, *Caystrus obscurus* (Distant) and *Critheus lineatifrons* Stål from Laos; *Amasenus corticalis* Stål from Cambodia, Indonesia, Laos, Myanmar and Thailand and *Rolstoniellus boutanicus* (Dallas) from Vietnam. New distributional records for India include two soft scale species, *Fistulococcus pokfulamensis* (Fig. 15) infesting *Heptapleurum actinophyllum* (Araliaceae), *Syzygium cumini* (Moraceae) and *Mangifera indica* (Anacardiaceae), *Paralecanium machili* (Fig. 16) infesting *Cinnamomum tamala* (Lauraceae) and an invasive species of root aphid, *Patchiella reaumuri* (Kaltenbach) infesting taro. A pentatomid genus, *Lodosocoris* was a new report for India. In Diptera, two species of fruit flies, *Elaphromyia siva* Frey and *E. yunnanensis* Wang were recorded. *Senometopia quarta* (Baranov) (Fig. 17) reared on *Perixera* sp., which is an inflorescence pest of cashew and *Argyrophylax cinerellus* Mesnil (Fig. 18), reared on *Maruca vitrata* were the two tachinid flies reported. In Coleoptera, one species of scarab beetle was newly reported for India. A spider species, *Tetragnatha nitens* (Audouin) (Fig. 19) was a new report for India. Distribution of the species in south India, diagnostic characters of both sexes along with differences in pedipalp and vulva (epigyne) were studied and digitized.

On the new distribution records for the state; a tachinid genus, *Aneogmena* (Fig. 20) was recorded from Maharashtra; the genus *Trichogramma* was recorded from Sikkim. Twelve scarab beetles viz. *Adoretus bicaudatus* and *Maladera bombycina* were recorded from Andhra Pradesh, *Holotrichia fissa, H. nagpurensis, Mimela inscripta* and *Rhinyptia* sp. from Chhattisgarh, *Holotrichia problematica*, *H. rufoflava* and *Idionycha excisa* from Jharkhand, *Anomala illusa* and *Brahmina mysorensis* from Kerala and *Holotrichia nagpurensis* from Uttarakhand. The aphid species, *Rhopalosiphum rufiabdominale* (Sasaki), *Phorodon cannabis* Passerini and one diaspidid species, *Lindingaspis rossi* (Maskell) were reported from Uttar Pradesh; one mealybug species, *Heliococcus singularis* Avasthi & Shafee from Karnataka and monophlebid scale, *Perissopneumon tamarindus* (Green) from

Odisha. A species of Tachinidae, *Trigonospila transvittata* (Pandelle) (Fig. 21) was recorded from south India (Tamil Nadu).



Figures 8–14. New taxa described from India. 8, *Euphranta flavothoracica* David, Hancock & Sachin; 9, *Elaphromyia juncta* David, Hancock & Sachin; 10, *Gibbifronta pavoniae* David, Hancock & Han; 11, *Parahormius similis* Gupta; 12, *Asobara jenningsi* Gupta; 13, *Neohydatothrips biconcavus* Rachana; 14, *Icerya viraktamathi* Joshi



Figures 15–19. New distributional records for India. 15, *Fistulococcus pokfulamensis* Hodgson & Martin; 16, *Paralecanium machili* Takahashi; 17, *Senometopia quarta* (Baranov); 18, *Argyrophylax cinerellus* Mesnil; 19, *Tetragnatha nitens* (Audouin)

Figures 20–21. New regional records. 20, *Aneogmena fischeri* Brauer & Bergenstamm; 21, *Trigonospila transvittata* (Pandelle)

New host records/new pest records

Cotesia ruficrus (Haliday) was reported to parasitize rice horn caterpillar, *Melanitis leda* (Linnaeus) (Lepidoptera: Nymphalidae) in Assam. *Perixera* sp. was recorded as a new host insect for the tachinid fly, *Senometopia quarta*. *Cannabis sativa* was reported as a new host plant for *Rhopalosiphum rufiabdominale*. *Polyalthea longifolia* and *Terminalia arjuna* were documented as new host plants for *Lindingaspis rossi* and *Heliococcus singularis*, respectively. *Annona reticulata* and *Pongamia pinnata* were the new host plants recorded for *Perissopneumon tamarindus*. *Brachyecerocoris petrii* was recorded on *Vitex trifolia*. *Ocimum tenuiflorum* and *O. gratissimum* were documented as host plants of *Phricodus hystrix* (Germer). *Scutellera perplexa* (Westw.) and *Chrysocoris stockerus* (Linn.) were found feeding on *Phyllanthus acidus* (Fig. 22). *Manihot esculenta* was reported as a new host plant of *Biltothrips minutus* Bhatti. *Scirtothrips dorsalis* (Hood) was reported for the first time as a pest of celery, *Apium graveolens*.

Figure 22. Scutellarid bug feeding on *Phyllanthus acidus*

Development of diagnostic keys/ tools/websites/ checklists/distribution maps

Diagnostic keys to the following taxa have been published

- Genera of tribe Acidoxanthini, Indian species of *Euphranta* and non-African species of *Elaphromyia*
- Major genera of gall-forming thrips of North East India.
- Oriental species of *Brachycerocoris* Costa, Indian species of genera *Agathocles* and *Sarju*.
- Indian species of soft scale genus *Ceroplastes* Gray.

Host plant list for 42 gall-forming thrips of family Phlaeothripidae from North East India was documented. Annotated checklist has been prepared for Indian Curculionidae. Checklists of Indian Braconidae and subfamily Microgastrinae were prepared. A database for subfamily Entiminae was prepared. A database entitled "Indian Braconidae" (50 species and 200 wasp/host images) were prepared and published online. Watermarks were incorporated for images of databases viz. Indian fauna of Pteromalidae, Indian genera of Chalcididae, and Amazing creatures: Myths & facts. A distribution map of pentatomid bug, *Halyomorpha picus* across India was published. During the period under report, 44 species and 410 specimens were added to the voucher specimens in the Insect Museum of ICAR-NBAIR. Catalogued 1486 specimens of Carabidae, 1570 specimens of Coccinellidae, 340 specimens of Dytiscidae, 296 specimens of Cicindellidae and 110 specimens of Curculionidae preserved in the Insect Museum of ICAR-NBAIR.

Studies on invasive pests

In the comprehensive yet complicated food web associated with the niche of the recently invaded cassava mealybug (CMB), *Phenacoccus manihoti* (Homoptera: Pseudococcidae), there was a multitrophic interaction structured vertically as well as horizontally (Fig. 23). Altogether 45 species were recorded for the first time to be associated directly or indirectly with CMB: thirty four species of insects from six orders (Coleoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera and Neuroptera) and eleven species of spiders (Arachnida) were grouped under four trophic levels into 11 guilds. The analysis of trophic guild structure and interaction indicated that many indigenous parasitoid species, which qualified to be placed under the fourth trophic level, actively parasitized the potential native predators of CMB and thereby negatively impacted the natural biological control of CMB. The different associations found in the food webs of CMB were: The hymenopteran parasitoids (Figs. 24 A–L)—*Aprostocetus* sp. (Eulophidae), *Homalotylus turkmenicus* (Encyrtidae), *Metastenus concinnus* (Pteromalidae) and *Chartocerus* sp. (Signiphoridae) parasitizing immature stages of *Hyperaspis maindroni* (Coleoptera: Coccinellidae) while *Tetrastichus* sp. (Eulophidae) and *Brachycyrtus* sp. (Ichneumonidae) were parasitic on *Mallada desjardinsi* (Neuroptera: Chrysopidae) actively predating on CMB. *Antrocephalus japonicas* (Chalcididae) was parasitic on pupae of *Autoba silicula* (Erebidae) while *Apanteles* sp. (Braconidae), *Brachymeria* sp. (Chalcididae), *Bucekia differens* (Chalcididae), *Elasmus anticles* (Elasmidae), *Eurytoma* sp. (Eurytomidae), *Hockeria nikolskayae* (Chalcididae), *Hockeria* sp., *Phanerotoma* sp. (Braconidae) and indetermined Bethylidae were parasitic on immature stages of lepidopteran species complex in the CMB colonies. The following species were observed in the Lepidoptera species complex (Figs. 25 A–I): *Autoba silicula* (Erebidae), *Anatrachyntis* sp. (Cosmopterigidae), *Conogethes* sp. (Crambidae), *Lobesia* sp. (Tortricidae), *Nola* sp. (Nolidae), *Psuedohypatopa* sp. (Blastobasidae), *Spalgis epius* (Lycaenidae), *Stathmopoda* sp. (Oecophoridae) and indetermined Pyralidae. Among all the moth species, *S. epius* was found most actively predating on CMB. The neuropteran predators associated with CMB were: *Mallada desjardinsi*, *Pseudomallada astur* and *Apertochrysa* sp. and among them, *M. desjardinsi* was observed as the most predominant predator of CMB. The other miscellaneous species associated were: *Cheilomenes sexmaculata* (Coccinellidae), *Carpophilus mutilates* (Nitidulidae) and two indeterminate species of Diptera and Hemiptera (Geocoridae), respectively (Figs. 26A–L).

Thrips parvispinus (Karny) (Fig. 27) is a cosmopolitan species of quarantine importance and has been reported from Thailand to Australia. Since its first report from our country in 2015, systematic surveys were conducted to monitor the species and a total of 4865 specimens were examined from seven states viz. Andhra Pradesh, Chhattisgarh, Gujarat, Karnataka, Maharashtra, Tamil Nadu and Telangana. The species was collected from nine different hosts belonging to seven families. Out of nine recorded host plants, four were fruit crops (*Carica papaya*, *Citrullus lanatus*, *Mangifera indica* and *Punica granatum*), three were ornamentals (*Brugmansia* sp., *Chrysanthemum* sp. and *Dahlia rosea*), one each of vegetable (*Capsicum annuum*) and field crop (*Gossypium* sp.), reflecting the adaptability of this thrips species and capability to breed in diverse agro-ecosystems. Since October 2021, a sudden upsurge of the species was noticed on chilli. Thrips population congregated on the underside of leaves (Fig. 31) as well as on flowers (Fig. 28) of chilli. Heavy infestation eventually led to a large scale shedding of flowers, malformation of fruits and fruit drop in chilli (Figs 29–30). About 90 to 95 per cent of flowers were badly damaged, and on average, 18–20 thrips were recorded per chilli flower. Multiple samples received from the above states for identification cited the prime reason that farmers were unable to control this species after the repeated application of insecticides. A pest alert on *T. parvispinus* was issued considering the menace caused by this species on chilli cultivated areas.

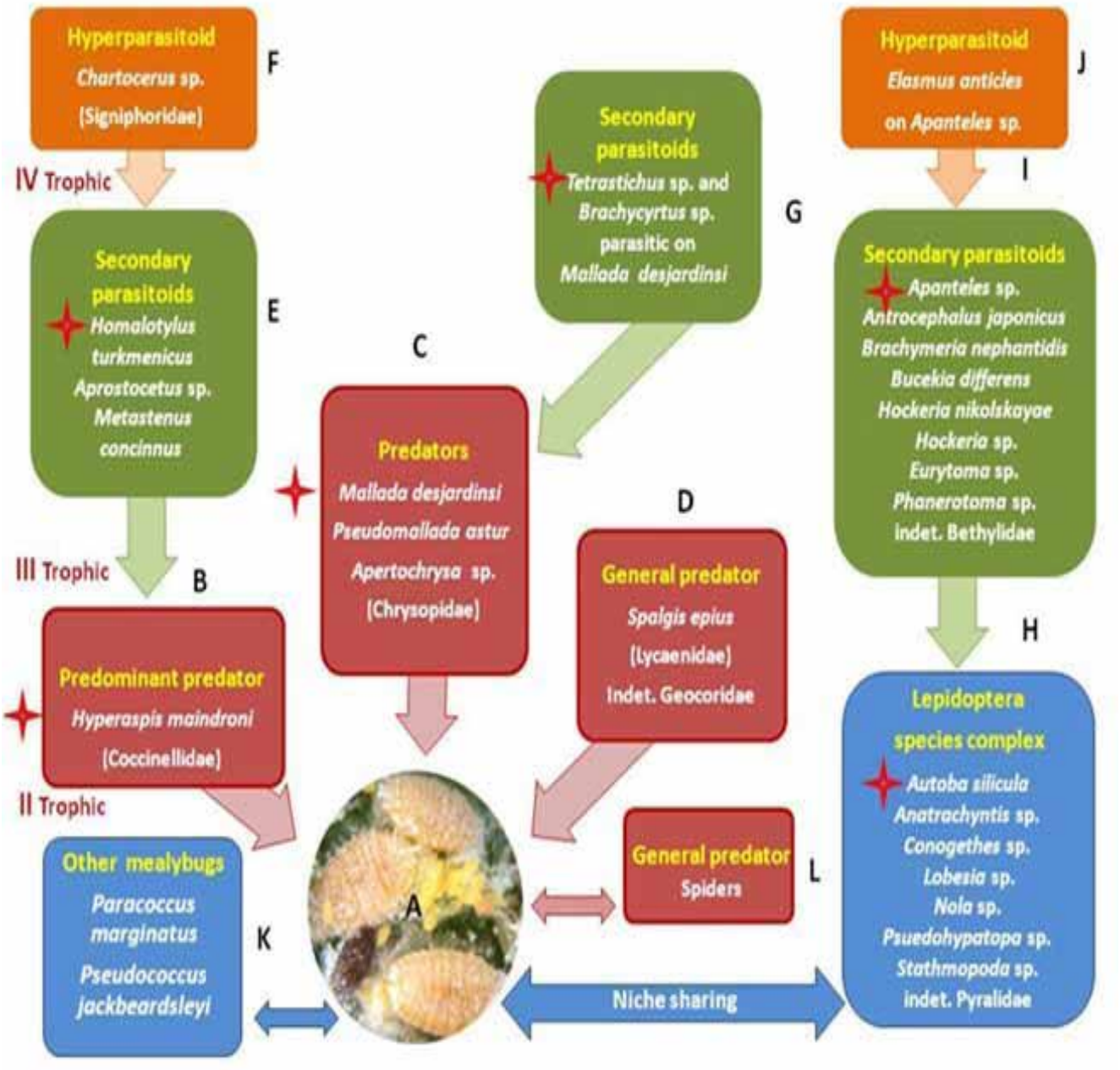
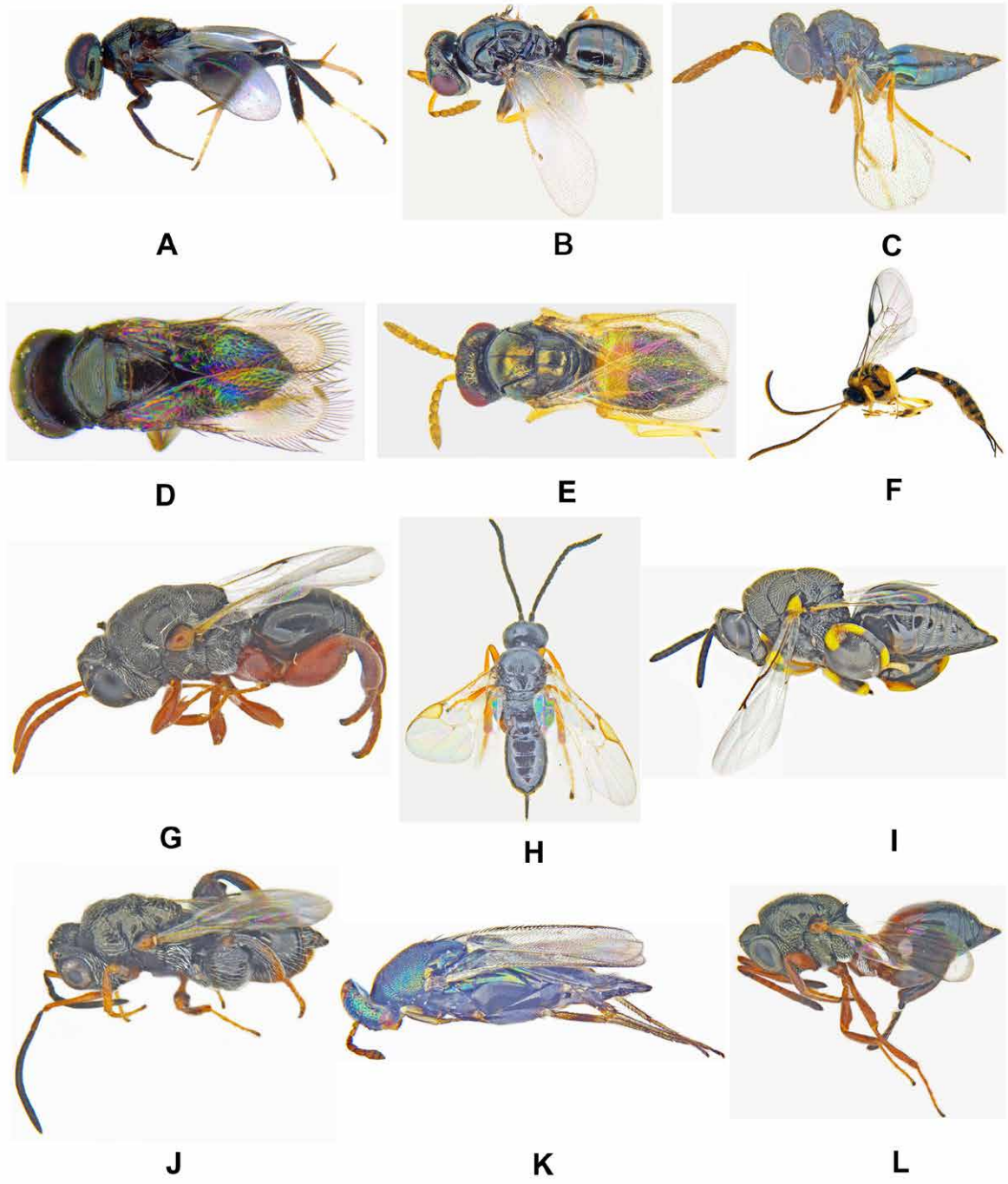
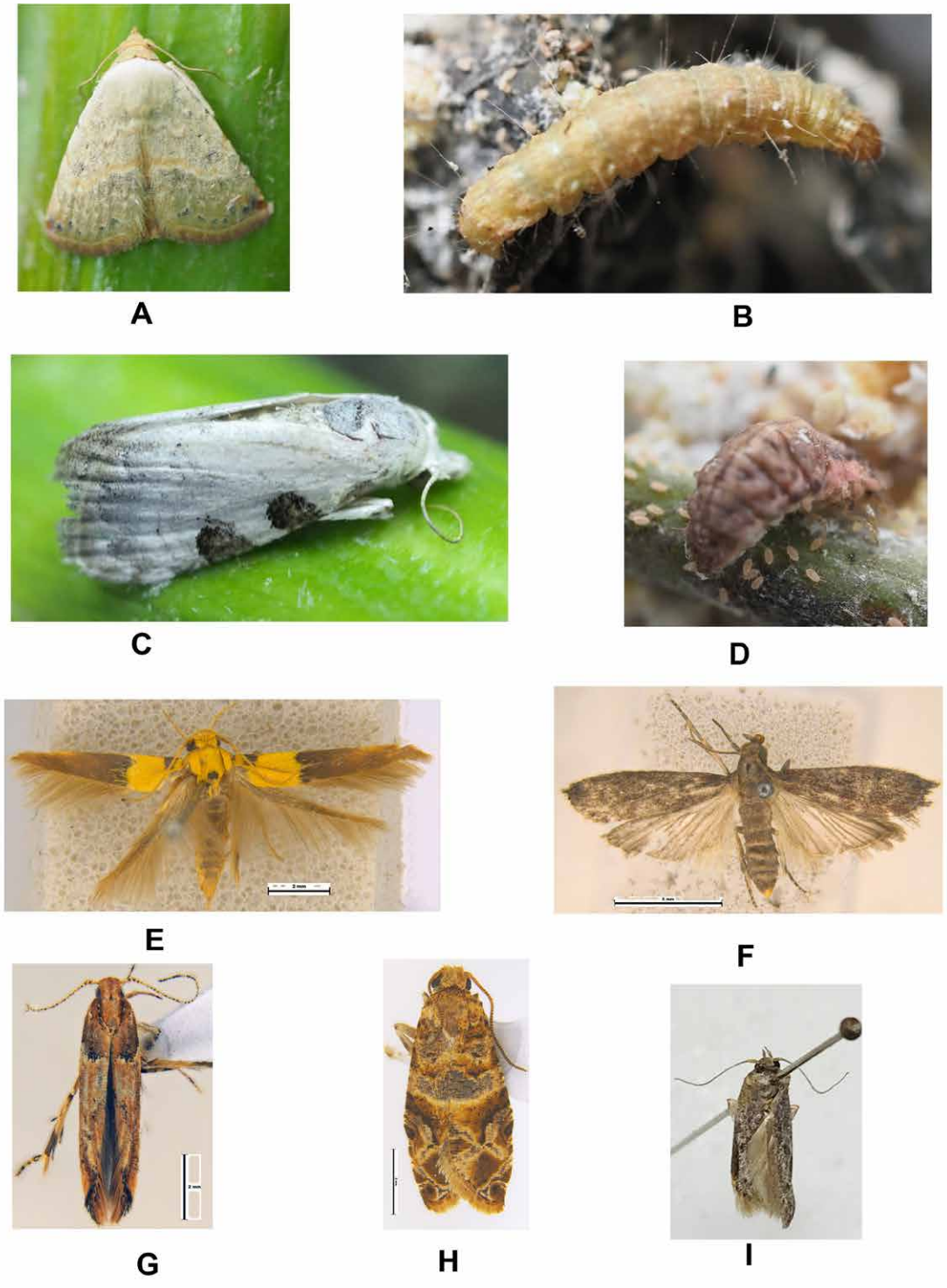


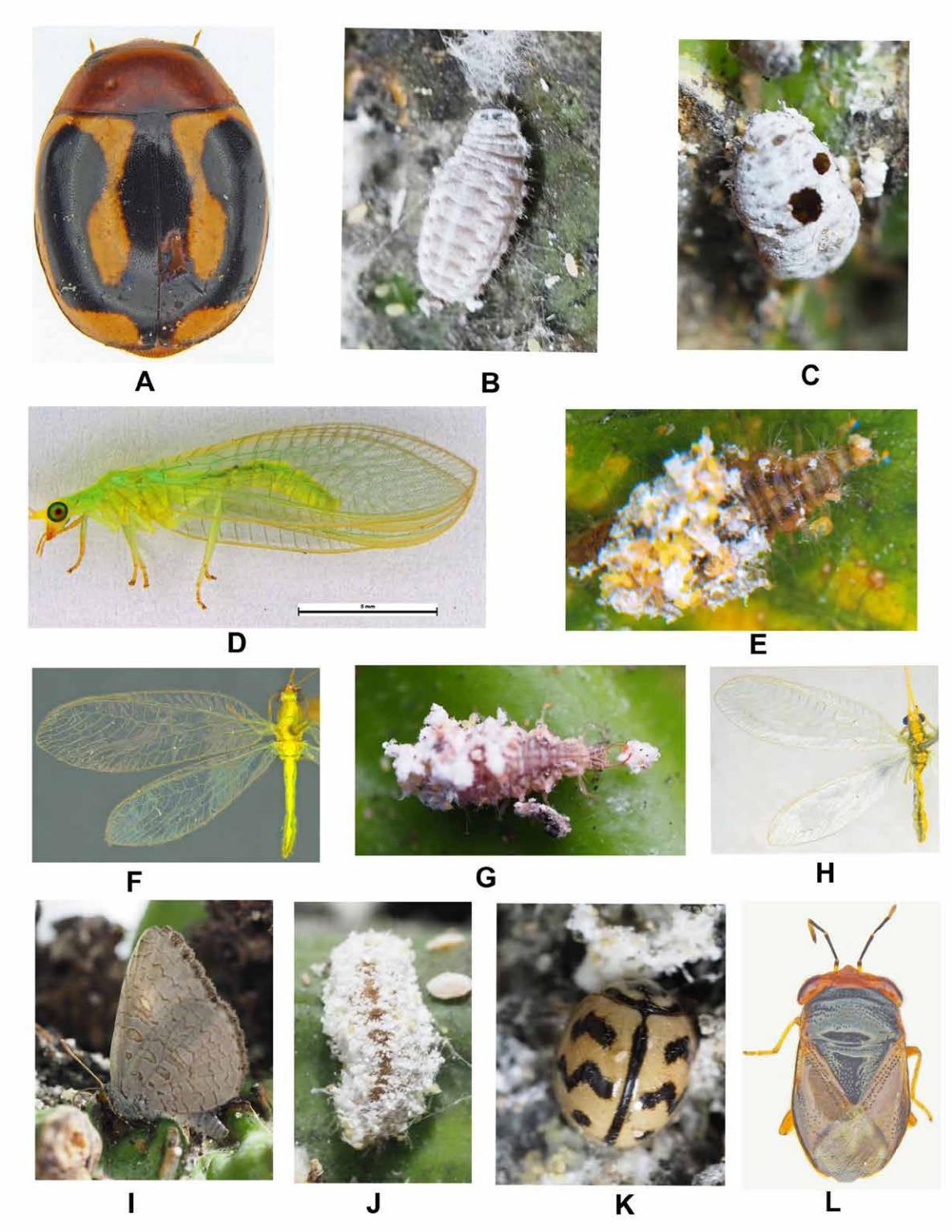
Figure 23. Ecological interactions in the major food webs of insects associated with *Phenacoccus manihoti* showing various guilds at different trophic levels (A-L)



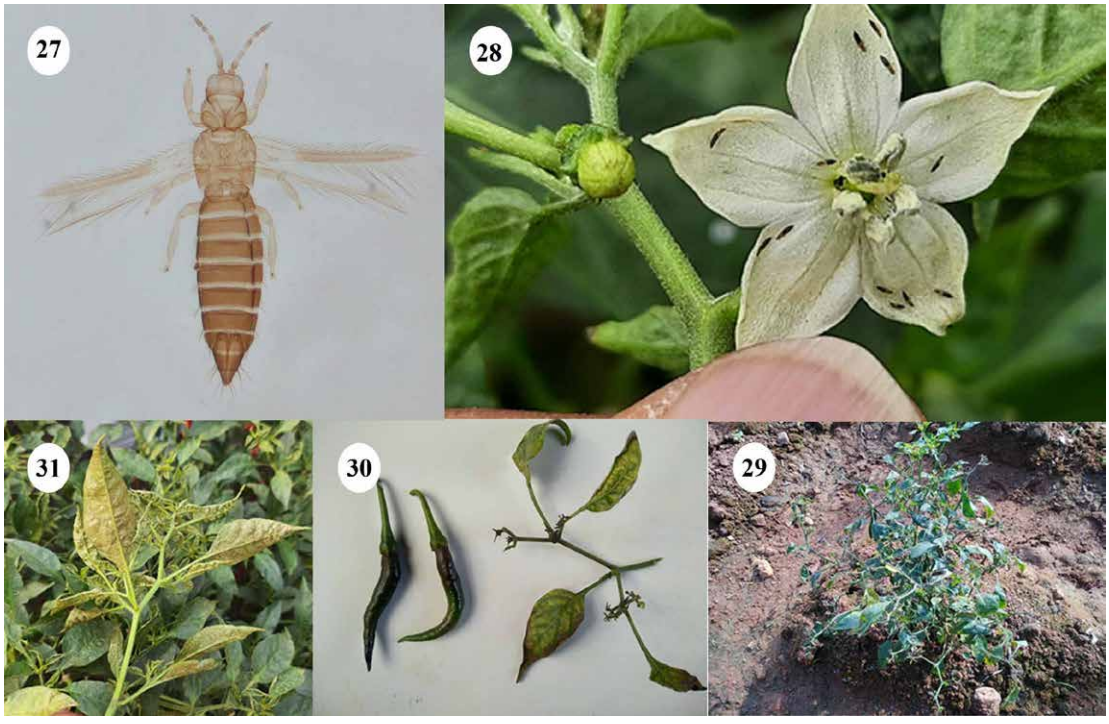
Figures 24A–L. Fourth trophic level hyperparasitoids (secondary parasitoids) in the CMB colonies. A, *Homalotylus turkmenicus*; B, *Tetrastichus* sp.; C, *Metastenus concinnus*; D, *Chartocerus* sp.; E, *Aprostocetus* sp.; F, *Brachycyrtus* sp.; G, *Antrocephalus japonicus*; H, *Apanteles* sp.; I, *Brachymeria* sp.; J, *Bucekia differens*; K, *Elasmus anticles*; L, *Hockeria nikolskayae*



Figures 25A–I. Lepidoptera species complex in the CMB colonies. A, *Autoba silicula* adult; B, *A. silicula* larva; C, *Nola* sp. adult; D, *Nola* sp. larva; E, *Stathmopoda* sp.; F, indeterminate Pyralidae; G, *Anatrachyntis* sp.; H, *Lobesia* sp.; I, *Psuedohypatopa* sp.



Figures 26A–L. Third trophic level active predators of cassava mealybug colonies. A, *Hyperaspis maindroni* adult; B, *H. maindroni* grub; C, *H. maindroni* grub with parasitoid emergence holes; D, *Mallada desjardinsi* adult; E, *M. desjardinsi* grub; F, *Pseudomallada astur* adult; G, *Pseudomallada* sp. grub; H, *Apertochrysa* sp. adult; I, *Spalgis epius* adult; J, *S. epius* grub; K, *Cheilomenes sexmaculata* adult; L, indeterminate Geocoridae



Figures 27–31. Thrips infestation on chilli. 27, *Thrips parvispinus* (Karny); 28, thrips congregation on flowers; 29, damaged chilli plant; 30, damaged fruits and leaves; 31, damage symptoms on leaves

Diversity studies

The species composition of thrips in solanaceous vegetable crops *viz.* brinjal, chilli and tomato in south Bihar was determined. Collected 1858 specimens of four species *viz. Scirtothrips dorsalis* (887 specimens), *Thrips palmi* Karny (769 specimens), *Frankliniella schultzei* Trybom (106 specimens) and *Thrips tabaci* Lindeman (96 specimens). In terms of thrips diversity index, the highest Shannon-Wiener index, Margelef richness index and Pielou's evenness index was recorded on brinjal followed by tomato and chilli. The domination coefficient of thrips species revealed that *S. dorsalis* and *T. palmi* were the most eudominant species, whereas, *F. schultzei* and *T. tabaci* were the subdominant species.

The diversity of flower inhabiting thrips from the Western ghats of Karnataka was documented. The study revealed the presence of 12 thrips species on 25 plant species belonging to 14 plant families. Invasive thrips, *Thrips parvispinus* was also observed on *Brugmansia* sp. (Solanaceae).

Tetragnathid spider diversity in the paddy ecosystem from different agro-climatic zones of Tamil Nadu (14 locations) was documented (Fig. 32). Collected specimens belonging to two genera, *Tetragnatha* Latreille and *Leucauge* White, and six species viz. *Tetragnatha javana* Thorell (10.75%) (Fig. 33), *T. keyserlingi* Simon (58.78%) (Fig. 34), *T. mandibulata* Walckenaer (Fig. 36), *T. nitens* Audouin (13.26%), *T. vermiformis* Emerton (5.81%) (Fig. 37) and *Leucauge decorata* Blackwall (0.71%) (Fig. 35).

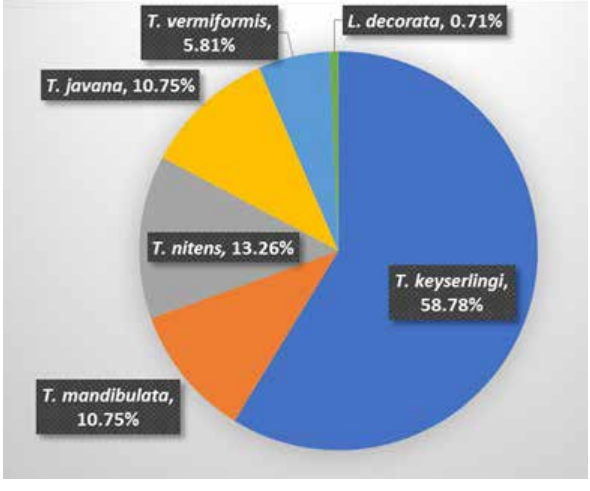
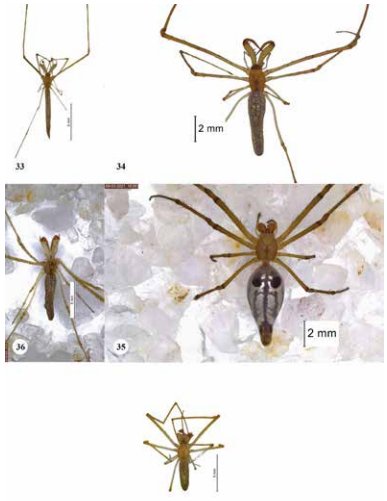


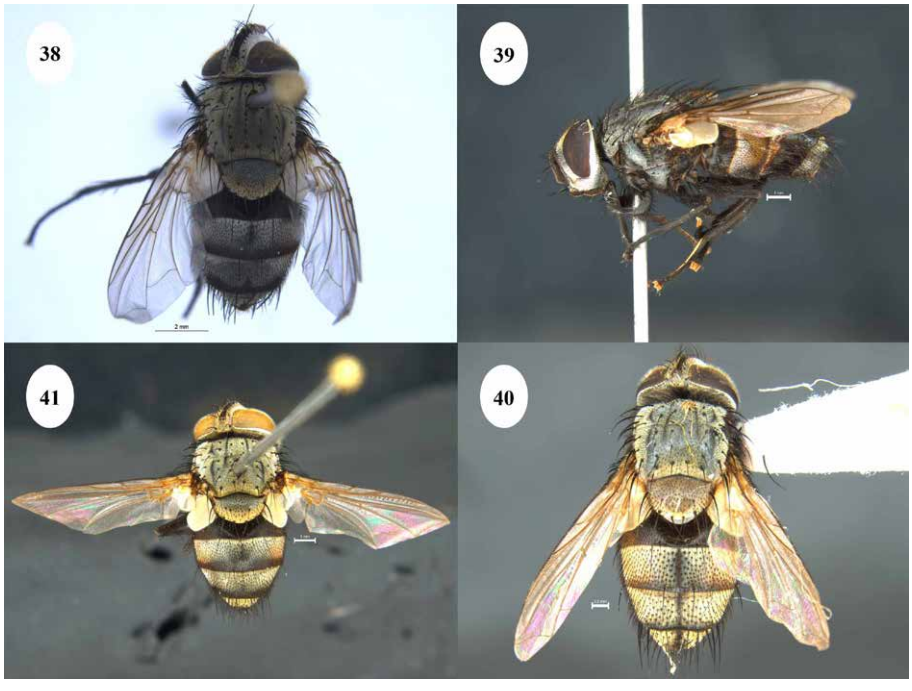
Figure 32. Tetragnathid spider diversity in paddy ecosystem

Eight genera of trichogrammatids viz. *Aphelinoidea*, *Chaetostricha*, *Megaphragma, Oligosita, Paracentrobia, Trichogramma*, *Trichogrammatoidea* and *Xiphogramma* were documented.



Figures 33–37. Spider species. 33, *Tetragnatha javana* Thorell; 34, *Tetragnatha keyserlingi* Simon; 35, *Leucauge decorata* Blackwall; 36, *Tetragnatha mandibulata* Walckenaer; 37, *Tetragnatha vermiformis* Emerton

Six species of tachinids were identified with their associated hosts. The identified tachinids were *Senometopia illota* (Curran) (Fig. 38) which was reared from *Helicoverpa armigera*, *Senometopia* sp. (Fig. 40) from *Psalis pennatula*, *Argyrophylax* sp. (Fig. 39) from *Orsotriaena medus*, *Thecocarcelia* sp. and *Senometopia* sp. (Fig. 41) from *Pelopidas agna* and *Thecocarcelia* sp. from *Melanitis leda ismene.*



Figures 38–41. Tachinid species. 38, *Senometopia illota* (Curran); 39, *Argyrophylax* sp. reared from *Orsotriaena medus*; 40, *Senometopia* sp. reared from *Psalis pennatula*; 41, *Senometopia* sp. reared from *Pelopidas agna*

A melolonthine species, *Maladera rufocuprea* was found to be the predominant species in Visakhapatnam, Andhra Pradesh and Vijayapura district, Karnataka. *Holotrichia fissa* was documented as the predominant species in Dakshina Kannada district, Karnataka. Two melolonthine species, *Holotrichia reynaudi* and *Brahmina mysorensis* were found to be predominant in groundnut growing region of Tirupati, Andhra Pradesh.

Division of Genomic Resources

Molecular studies on entomopathogenic nematodes

Mitochondrial and draft whole genomes of four entomopathogenic nematode species were sequenced and submitted to NCBI.

Molecular analysis of tri-trophic relationships among insect host, EPN and bacterium

Transcriptome analysis of tritrophic relationship among the host, EPN and EPNB combinations in Fall Armyworm (FAW), *Spodoptera frugiperda* indicated that the gene expression related to insect metabolism and immunity primarily included metalloproteases, lipases, proteinases, AMPs, and oxidative pathways similar to that in *Galleria mellonella*. The RNA profiles of the 13 samples of FAW larvae treated with EPN for transcriptome analysis are depicted in Fig. 39.

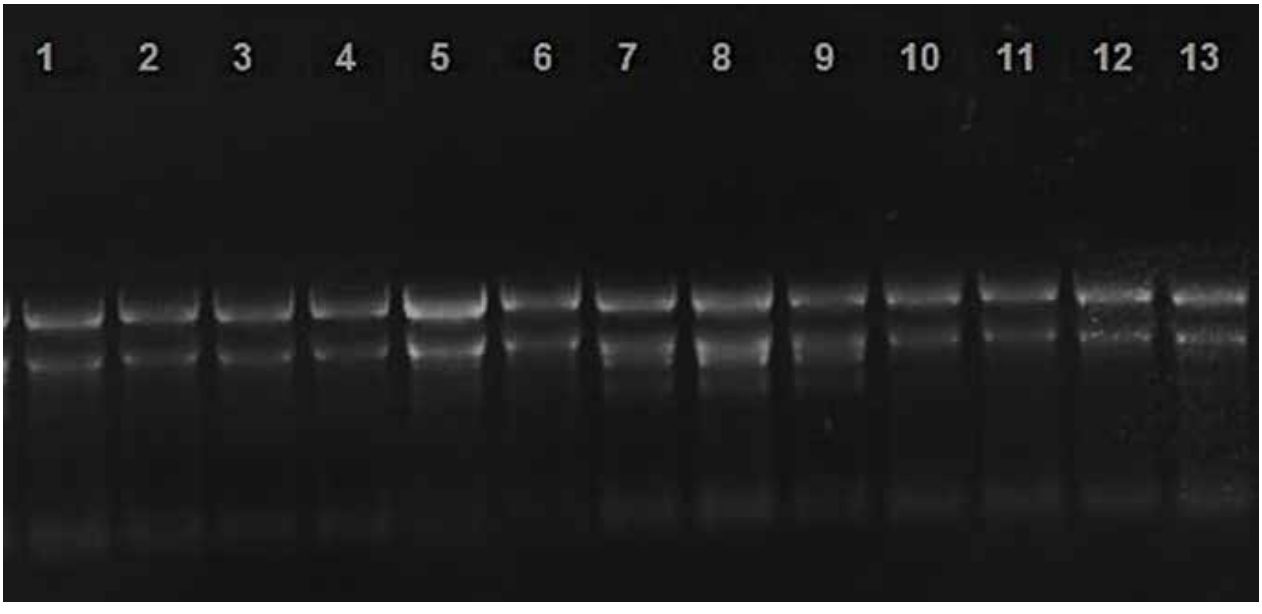


Figure 39. RNA profiles of *Spodoptera frugiperda* larvae treated with EPN

Differential gene expression (DEG) in *Galleria mellonella* and *Spodoptera frugiperda* using Nanostring Custom Multiplexed assay

RNA was extracted from the larvae of *G. mellonella* and *S. frugiperda* infected with EPN-B. Quantitative (Qubit RNA High Sensitivity – catalogue no. Q32855) and qualitative (Bioanalyzer 2100 RNA Nano – catalogue no. 5067 -1511) assays were performed and a sufficient amount of RNA was extracted suitable for NanoString custom assays. Specific probes were designed for 19 genes of host insect and EPN-B and multiplexed assays were performed on the nCounter sprint platform. Expression patterns of specific genes in treated *vs* healthy were recorded (Table 2 and Fig. 40).

Table 2. Raw data on differential expression of genes in *Spodoptera frugiperda* tritrophism with EPN & EPN-B.

DEG	NCBI Accession No.	Class Name	S-1 F-Healthy	S-2 F-HiM	S-3 F-HiD	S-4 F-AkM	S-5 F-AkD
Defensin	AY128091.1	Endogenous	208	234	143	168	164
Galliomycin	AY528421.1	Endogenous	6	7	3	8	10
IL6R	XM_033925695.1	Endogenous	27	45	23	26	34
MCF	KJ584647.1	Endogenous	6	7	1	2	3
Moricin	EF564365.1	Endogenous	7	4	1	3	4
Nematophin	KY346862.1	Endogenous	9	5	3	6	5
Spodoptericin	AY238439.1	Endogenous	130	113	45	157	247
TCDA	AF188483.1	Endogenous	3	38	24	3	4
XNA1	CCWM01000182.1	Endogenous	63	62	44	79	70
Gallerimycin	AF453824.1	Endogenous	3	3	1	4	4
glv1	NM_001043465.1	Endogenous	29	30	22	41	19
psidin	NM_142601.2	Endogenous	6	7	2	8	14
txp40	DQ242625.1	Endogenous	14	11	8	14	8
Cyp1	NM_078642.4	Housekeeping	7	5	2	3	6
Cyp6B2	MG846941.1	Housekeeping	7	4	1	7	6
Lux	AF403784.1	Housekeeping	22	68	55	23	17
Sod1	NM_057387.5	Housekeeping	13	20	9	7	8
Glutathione-S-transferase	AF179869.1	Housekeeping	118	152	76	134	90
hsp4	MF752442.1	Housekeeping	6	2	4	1	2

Molecular characterisation and DNA barcoding of agriculturally important insects

Molecular characterisation based on mitochondrial markers like *CO1* (*Cytochrome Oxidase 1* gene–658bp), *CO1* (*Btab gene*–850bp), *CO1B* gene, and nuclear markers, viz. *ITS-2* and *Tpi* (*Triosphosphate*) were carried out and DNA barcodes were generated for 75 agriculturally important insects like pests, parasitoids and predators. The insect species were collected / received from different parts of the country, *viz.* Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Jammu and Kashmir, Karnataka, Kerala, Maharashtra, Punjab, Tamil Nadu and West Bengal, and also from the International Institute of Tropical Agriculture, Republic of Benin. Around 22 populations of *S. frugiperda*, which were received from different parts of the country were molecularly identified and barcoded using *CO1*, *CO1B* and *Tpi* genes. Twenty-two populations of *Bemisia tabaci* were collected from different parts of the country and *CO1* gene of 850bp was used for molecular identification and genetic groups were identified by phylogenetic analysis. Five field collected specimens of *Trichogramma chilonis* from Tamil Nadu were identified using morphological and molecular tools. Different populations of invasive cassava mealybug *Phenacoccus manihoti* was identified using *cytochrome oxidase–I* gene (*CO-1*) for the first time in India and DNA barcode was generated for the same. The parasitoid *Anagyrus lopezi* received from IITA, Republic of Benin was identified using molecular tools and GenBank Acc. No. (OK85480) and barcode was generated. Specimens of the invasive thrips in chilli were received from different parts of Andhra Pradesh, and it was identified as *Thrips parvispinus* (OM095426, OM095429, OM085663 and OM085664) employing morphological and molecular tools.

Twenty three sets of primers were tested to design a species-specific primer set for identification of *S. frugiperda*. To establish the specificity of the primers, they were tested for amplification in 8 different insect species, namely *S. frugiperda*, *S. litura*, *Chilo suppressalis*, *Corcyra cephalonica, Leucinodes orbonalis*, *Mythimna separata, Plutella xylostella* and *Spilosoma obliqua*. Three sets of primers were found to be specific to *S. frugiperda* and one of the amplicons was cloned and is currently being verified and characterised for further use.

Molecular characterisation of 14 coleopterans viz. *Adoretus ovalis*, *Anomala communis*, *A. dorsalis*, *A. ruficapilla*, *Anomala* sp., *Apomecyna* sp., *Brahmina coriacea*, *Euplatypus parallelus*, *Holotrichia fissa, H. serrata*, *H. sikkimensis*, *Hybosorus orientalis*, *Miridiba excisa* and *Xylosandrus compactus* were carried out and mitochondrial *CO1* gene sequences were submitted, for which barcodes were developed subsequently. Of these, *A. ovalis*, *A. ruficapilla* and *H. orientalis* were first time depositions in the NCBI database.

Heteropteran plant bugs were collected from areas around Bengaluru, and Assam. A total of 126 samples from Bengaluru and 30 samples from Assam were collected from crops, viz. beans, brinjal, castor, cauliflower, chilli, maize, mango, mulberry, red gram, ridge gourd, summer squash and tomato. The bugs were collected by sweep netting at weekly intervals. The collected insects were sorted out to respective taxa based on taxonomic characters. The occurrence of the plant bugs varied with respect to the crops in the locations surveyed. Plant bugs belonging to nine families, viz. Alydidae, Coreidae, Lygaeidae, Miridae, Pentatomidae, Plataspidae, Pyrrhocoridae, Reduviidae and Scutelleridae were recorded. The species composition of plant bugs was more diversified in the family Pentatomidae followed by Coreidae. *Dysdercus koenigii* was the only bug observed under the family Pyrrhocoridae (Table 3). Among the plant bugs, the shield bugs or stink bugs (Pentatomidae) comprised 29.85%, followed by the leaf-footed bugs (Coreidae) (28.35%). Alydidae (broad-headed bugs) and Miridae (capsid bugs) accounted for 16.41 and 11.94%, respectively. The milk weed bugs (Lygaeidae), the predatory assassin bugs (Reduviidae) and the jewel bugs (Scutelleridae) comprised for 2.98%, while Plataspidae (Kudzu bugs or globular stink bugs) and Pyrrhocoridae (red bugs or strainers) accounted for 1.49% (Fig. 40). Genomic DNA was extracted from the legs of ethanol-preserved specimens using Qiagen DNeasy Blood & Tissue kit. PCR was run and the products were identified on 1% agarose gel electrophoresis with EtBr staining under UV light, purified by PEG-NaCl method. The PCR products were submitted for sequencing.

Table 3. Plant bug species recorded in different locations

Sl. No.	Family	Species of plant bugs recorded
1	Alydidae	*Riptortus pedestris*
2	Coreidae	*Anoplocnemis phasianus* *Clavigralla gibbosa* *Cletus bipunctatus* *Cletus signatus* *Gralliclava horrens horrens*
3	Lygaeidae	*Graptostethus servus*
4	Miridae	*Mircarvalhoia arecae* *Nesidiocoris tenuis*
5	Pentatomidae	*Bagrada hilaris* *Halyomorpha picus* *Halys serrigera* *Megacopta cribraria* *Nezara viridula* *Tolumnia basalis*
6	Plastaspidae	*Coptosoma* sp.
7	Pyrrochoridae	*Dysdercus koenigii*
8	Reduviidae	*Endochus* sp. *Scipinia* sp.
9	Scutellaridae	*Chrysocoris stockerus* *Hotea curculionoides*

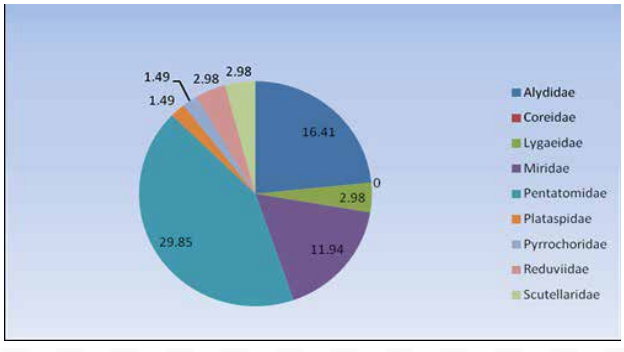


Figure 40. Taxonomic composition of plant bugs

Interception of Green stink Bug: *Nezara viridula* from the shipment

A Pharmaceutical company contacted ICAR–NBAIR, Bengaluru to identify a dead insect specimens (2 bugs) found in the packaging material of a consignment. Subsequently, the dead insect specimens were identified using both molecular and morphological techniques. The voucher specimens were stored at ICAR–NBAIR, Bengaluru. DNA sequencing matched 99.9% with GenBank accession numbers (KJ642018, KF303511, KR037758, KR044112) and the identity was fixed as Green stink bug *Nezara viridula* (Linnaeus) (Hemiptera: Pentatomidae).

Studies on genetic diversity of legume pod borer, *Maruca vitrata*

Host plants play a major role in differentiation and diversification of insect species. The legume pod borer, *Maruca vitrata* (Lepidoptera: Crambidae) is an important polyphagous insect pest of legume crops and is known for genetic variations. Genetic variation can arise among subpopulations that feed on different host plants. Twenty nine subpopulations of *M. vitrata* were collected and mitochondrial *COI* marker was used for differentiating haplotypes. The neighbour-joining (NJ) tree was performed with bootstrap analysis (1,000 replicates) in MEGA 11 to study the phylogenetic relationship among *Maruca vitrata* populations based upon a 658bp mitochondrial *CO1* gene fragment (Fig. 41).

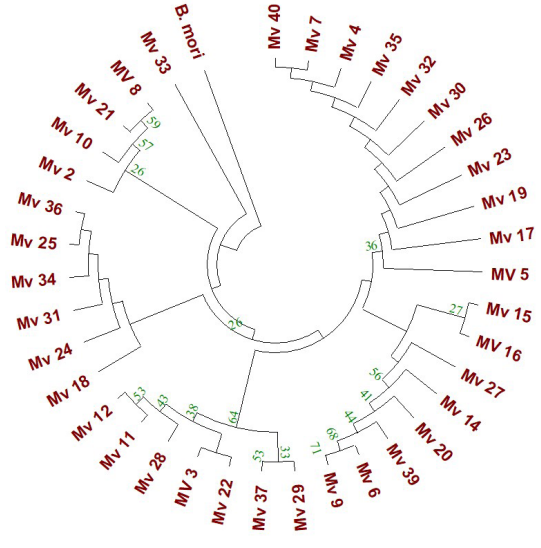


Figure 41. Phylogenetic relationship among *Maruca vitrata* populations based upon a 658bp mitochondrial *CO1* gene

Construction of draft genome assembly of cotton leafhopper, *Amrasca bigutulla bigutulla*

The cotton leafhopper, *Amrasca biguttula biguttula* (Hemiptera: Cicadellidae) is a key insect pest of brinjal, cotton, cowpea, okra, potato, sunflower and many other economically important crop plants. Its occurence on *Bt* cotton in Haryana, Maharashtra, Punjab and Rajasthan during early stages of the crop growth was high. To develop genome based management methods, a draft genome assembly for this pest was developed (BioProject: PRJNA555157, BioSample accession-SAMN16833492) using reads generated both by Pacbio and Illumina platforms. The genome size is estimated at 450mb with prediction of 28,804 protein coding genes. Subsequently, the genome information was used for the identification of genes and gene families involved in insecticide resistance as well as growth & development.

Reports have demonstrated a relationship in growth between insecticide resistance and altered expression of genes coding metabolic enzymes and the ABC transporters in insects. RNA extraction and preparation of cDNA libraries were undertaken for third instar nymphs of insecticide resistant and susceptible populations of cotton leafhopper for Illumina Hiseq sequencing, read mapping and gene expression analysis. The differential expression analysis was performed using DEGseq R package. The assembled transcripts were used to predict protein coding sequence using TransDecoder.

The protein sequences were annotated against NCBI nr, Uniprot, Swissprot and Uniref100 protein database using BLASTp module of Diamond (Fig. 42). Any transcript that mapped onto the database with E-value lower than 1e-04 were considered for downstream analysis. PFAM hits for the transcribed proteins were generated using hmmscan against pfam v32.0. The transcript annotations were used to refine the best transcripts using Transdecoder Predict. The results of the differentially expressed transcripts are shown in Table 4 and also depicted in the form of Volcano plot (Fig. 43). The differentially expressed genes were validated and gene targets were identified for RNAi validation.

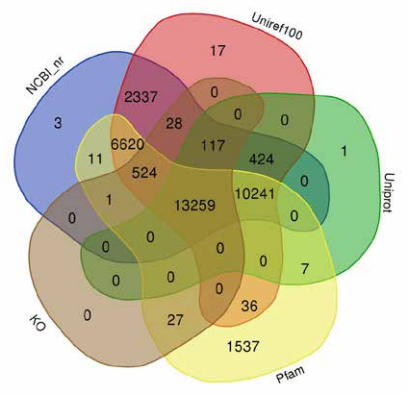


Figure 42. Protein sequence annotation using BLASTp module of Diamond

Table 4. Summary of differential expression results

Condition	Significantly Expressed Transcripts	Up Regulated Transcripts	Down Regulated Transcripts
Resistant vs Suceptible	177	67	110

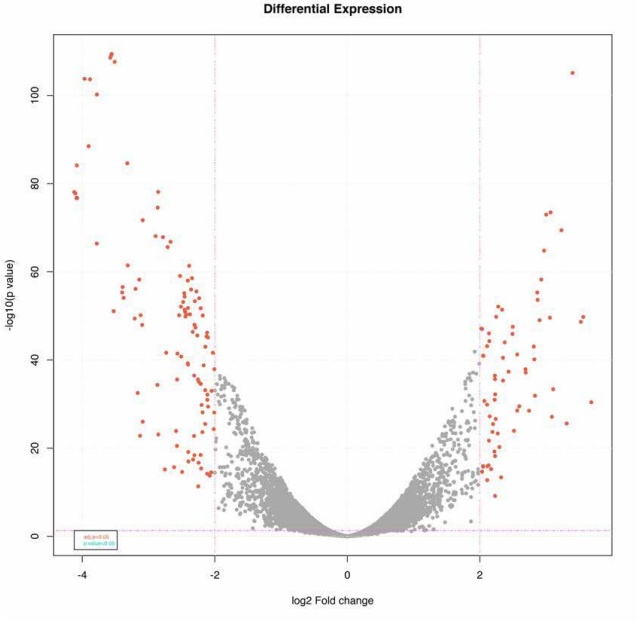


Figure 43. Volcano plot showing the differential transcript expression profile. Red dots indicate absolute log2 fold change≥1.5 and FDR/adjusted p value≤0.05.

Designing of novel formulation of *Bacillus thuringiensis*

A novel powder-based formulation of *Bacillus thuringiensis* was designed with the use of sodium starch glycolate and kaolin with molasses. The viability was monitored for 180 days and continued. A total of 24 treatments were monitored. Significant differences were noticed in the viable count during the period. The treatments with 55 to 65% kaolin and 20% sodium starch glycolate gave significantly high cfu count throughout the period. At 180 days, highest cfu of log 9.79 was obtained. However, it was also noticed that there was gradual increase of cfu in all the treatments up to 180 days indicating that none of the treatments has any detrimental effect on the viability up to 180 days. The viability will be monitored for one more year.

Microflora associated with insects and their role in farm waste management

The five larval instars of black soldier fly (*Hermetia illucens*) were collected for isolation of gut microflora. The larvae were starved overnight, surface sterilised and were dissected under sterile conditions. The gut region was crushed using micropestle and mortar. The aliquot obtained was serially diluted up to 10^{-5} and spread plated on Luria Bertani medium, actinomycetes isolation agar and potato dextrose agar. A total of nine representative microflora obtained were further purified. Further identification of microflora using 16S rRNA gene sequences is in progress. Biochemical characterisation of microflora from black soldier fly for hydrolytic enzymes like amylase, lipase and protease using qualitative and quantitative assays revealed that 8 isolates as positive for starch hydrolysis, 4 isolates for casein hydrolysis and 8 for cellulose hydrolysis. These isolates will be further tested for quantitative analysis.

Whole transcriptome sequencing of pink mealybug, *Maconellicoccus hirsutus*

Whole transcriptome sequencing of pink mealybug, *Maconellicoccus hirsutus* was carried out using Illumina MiSeq denovo based assembly. High quality RNA was isolated using Trizol reagent (Life Sciences Technologies, CA, USA) from the first instar nymphs

treated with Gibberellic acid (GA3) @ 500ppm and the lab-reared population which was used as control. The mealybugs were maintained on potato sprouts.

Quantity and quality of total RNA were measured by Agilent 2100 bioanalyzer (Agilent Technologies, Palo Alto, CA, USA) and NanoDrop (Thermo Fisher Scientific Inc.). 1 µg of total RNA from susceptible and resistant strain with RIN value above 7 was used for library preparation. Sequencing libraries were generated using NEBNext® UltraTM RNA Library Prep Kit for Illumina® according to the manufacturer's protocol. The quantity of cDNA libraries was assessed by Qubit 2.0 Fluorometer (Life Technologies, Carlsbad, California, USA). Clustering of the samples was performed using TruSeq PE cluster kit v3-cBot-HS on cBot (Illumina Inc. San Diego, California, USA). The samples were run (2 ×100) on Illumina HiSeq 2500 instrument using TruSeq SBS kit v3-HS (200 cycles) (Illumina Inc. San Diego, California, USA) following the manufacturer's instructions. The raw reads from the Illumina sequencing were deposited in the NCBI Sequence Read Archive (SRA) database (BioProject).

Further, raw data was processed to obtain high-quality reads. The open-source software package Trimmomatic was used to identify and to trim nucleotides falling below the established quality threshold (minimum 20 phred score) as well as to trim adapter sequences. The transcriptome *de novo* assembly was carried out using the short read assembly program called Trinity. Trinity uses the de Brujin graph to represent the overlap among the reads. The assembly was further refined using the tr2aacds pipeline in Evidential Gene package (http://arthropods.eugenes.org/EvidentialGene/) which reduced the redundancy by selecting the 'optimal set' of assembled transcripts based on their coding potential leading to final non-redundant transcriptome assembly containing a unique set of transcripts. To check the quality of assembled transcriptome, Nx matrics and coding capacity of assembly using BUSCO v 3.0.2 was analysed.

A total of six samples (3 GA3 treated, and 3 control) were subjected to Illumina based RNAseq with two replicates for each strain (MhC-1, MhC-2, MhC-3 for susceptible population and MhT-1, MhT-2, MhT-3 for treated population). The clean reads after the adapter removal and quality trimming were ranged from 33278015 to 36783352 for treated and 25957191 to 27785518 for control strains. A total of 41,824 transcripts and 37,492 unigenes were assembled with average contig length of 1292.5, GC content of 38.47%, N50 value of 2404 and ExN50 value of 3292. The BUSCO scores for the assembly are C: 93.4% [S: 82.4%, D: 11.0%], F: 1.4% (fragmented), M: 5.2% (missing), n: 1367 (total no of conserved genes). This shows 94% of the transcripts represent the complete eukaryotic BUSCO gene model and only 10 core eukaryotic genes (5.2%) were missing from the assembly. 60,330 unigenes were assembled from all the four libraries sequenced and run against different databases.

Development of mobile apps on non-chemical methods for management of important crop pests

A mobile app on management of the invasive pest, *S. frugiperda* in maize was developed (Fig. 44). This alien invasive pest gained entry into India in 2018 and has spread across all the major maize growing regions of the country. A mobile app BIPM on FAW was developed. This mobile app gives detailed information about the biology of FAW, damage symptoms in the field conditions, pest identification, management through biological control, pheromone traps and chemical control. Attempts were also made to present the content in North Eastern languages of India, so as to benefit the farmers of North-Eastern region, where maize is grown widely. This mobile app was developed in several languages viz. English, Hindi, Marathi, Tamil, Telugu, and the North-Eastern languages like Assamese, Bengali, Khasi, Manipuri, Nagamese and Sikkimese. The users can install the mobile app from Google Play Store to obtain and to disseminate information on the management of FAW. The hyperlink to download this mobile app from Google Play Store is at: https://play.google.com/store/apps/details?id=com.companyname.bipm_on_faw

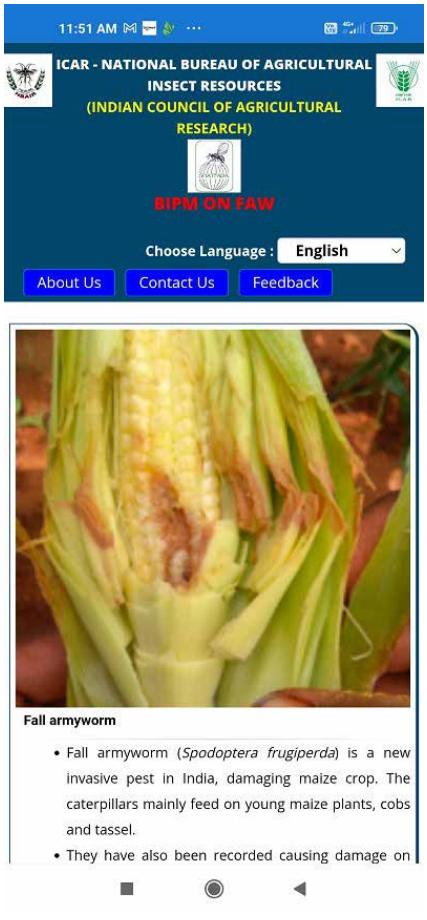


Figure 44. Screenshot of the mobile app, BIPM ON FAW

Division of Germplasm Conservation and Utilisation

Parasitisation potential of *Trichogramma chilonis* and *Telenomus remus* against fall armyworm, *Spodoptera frugiperda*

The biocontrol potential of two parasitoids, *T. chilonis*, *Telenomus remus* along with *Trichogramma pretiosum* against the fall armyworm egg was investigated in a single, simultaneous and sequential release. In a single release, the percent parasitism of *T. remus* was highest (92%) followed by *T. chilonis* (81%) and *T. pretiosum* (45%). In the simultaneous release of *T. remus* and *T. chilonis* per cent parasitism was 88.9 % and was on par with *T. remus* single release. Among all the duration-dependent treatments of sequential release, *T. chilonis* release post 24-48 hours of *T. remus* release provided the most satisfactory outcome.

Screening of indigenous trichogrammatids and geographical stains of *T. chilonis* against *Spodoptera frugiperda*

Total of 64 trichogrammatids strains belonging to 14 species were screened against *S. frugiperda* under laboratory condition to identify the potential strain. The results revealed that *T. chilonis* 184 parasitied higher percentage of eggs as compared to other species/strains. From the 64 strains, 36 geographical strains of *T. chilonis* were also evaluated against *S. frugiperda* and result showed field collected *T. chilonis* strains from fall armyworm eggs parasitised higher percentages of host eggs. Three geographical strains of *T. chilonis* 184, *T. chilonis* 204 and *T. chilonis* 186 were more potent and parasitised 81.2, 56.2 and 55.2% of *S. frugiperda* eggs, respectively. The strains of *T. chilonis* 184 and 204 were collected from Karnataka, whereas *T. chilonis* 186 was collected from Andhra Pradesh.

Field evaluation of *Trichogramma chilonis* against *Spodoptera frugiperda*

Field evaluation of *T. chilonis* was carried out at Bagalur, Karnataka against *S. frugiperda* in the naturally infested maize crop. Four releases of *T. chilonis* at weekly intervals significantly ($P < 0.05$) increased the egg mass and egg parasitism of *S. frugiperda*. After four releases of *T. chilonis*, the egg mass parasitism was 66.25% and egg parasitism was 42.15% in maize field (Figure 45). The plant damage incidence (7.0%) and leaf damage score (1.15 on 0-9 Davis scale) was significantly ($P < 0.05$) lower after four releases of *T. chilonis* in maize field.

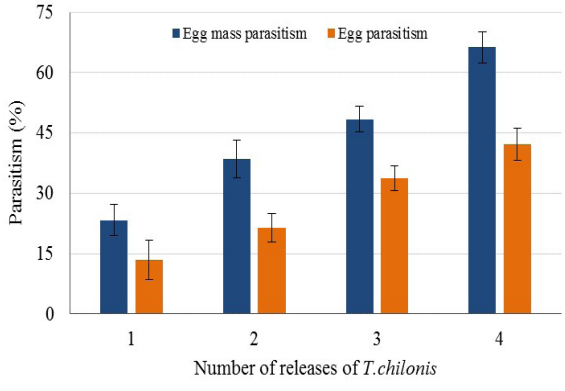


Figure 45. Percentage of *S. frugiperda* egg mass and eggs parasitised by *T. chilonis* in maize

Biology of *Bracon brevicornis* on fall armyworm

The biology of *Bracon brevicornis* was studied on different instars of fall armyworm, *S. frugiperda*. The highest fecundity (293 eggs) was observed on fifth instar larvae of *S. frugiperda*. The egg hatching percentage was lowest on the third instar larvae. However, the per cent hatching was not significantly different between fourth and fifth instar larvae. Percent pupal formation (80%) and adult emergence of this parasitoid were highest on the fifth instar larvae. Field release of this parasitoid against fall armyworm exhibited 54% reduction in infestation.

Integrated management of fall armyworm

IPM trial was conducted to manage fall armyworm at Devasthethalli, Nandi Cross, Karnataka covering 1.5 acre area (Figure 46). IPM trial viz., installing pheromone traps, two releases of *Trichogramma chilonis* and *Telenomus remus*, one spray of NBAIR BT-25, two sprays of NBAIR strain of *Bacillus albus* and one spray of ICAR-NBAIR strain Ma-35 *Metarhizium anisopliae* showed 79.23% larval population reduction of fall armyworm and 81.56% egg reduction compared to control.

Figure 46. Experimental plot of maize at Devasthethalli, Nandi Cross, Karnataka

Pentatomid predator, *Eocanthecona furcellata* for the management of lepidopteran insects

Studies on life table parameters of pentatomid predator, *Eocanthecona furcellata* on laboratory hosts *viz*., *Galleria mellonella*, rice moth *Corcyra cephalonica*, silkworms, *Samia cynthia ricini* and *Bombyx mori* showed that the life cycle of *E. furcellata* was shorter when reared on *C. cephalonica*. The mean fecundity significantly varied across the prey and higher fecundity was observed when reared on *G. mellonella* (429.69±21.08) followed by *S. cynthia ricini* (408.81±25.16) and *C. cephalonica* (330.4 ± 37.19). The net reproductive rate (R_0) was significantly higher on *S. cynthia ricini* (157.62 ± 23.85) followed by *G. mellonella* (114.00 ± 27.58) and *C. cephalonica* (101.143 ± 24.44), respectively.

Parameters like *lx, Fxj, mx* and *Vxj* values were significantly higher on *S. cynthia ricini* followed by *G. mellonella* and *C. cephalonica,* respectively. It was inferred that, best suitable host considered for mass rearing of *E. furcellata* was *S. cynthia ricini* followed by *G. mellonella* and *C. cephalonica.* The characters like higher fecundity, high survival rate and ease of group rearing of *E. furcellata* are amenable features for mass production under laboratory conditions. Mass rearing of *E. furcellata* on three hosts, *S. cynthia ricini, C. cephalonica* and *G. mellonella* can be suggested due to the ease of their host insect availability for mass rearing and low rearing costs. Augmentative release of *E. furcellata* can be integrated with other control measures for the management of lepidopteran pests.

Gall insects of different crops

Pink flowers of *Pongamia* attracted more number of gall flies compared to the white flowers. Persistence of galls on the plant was observed till adult emergence. Removal of galls on *Pongamia* just after formation reduced the gall incidence in trees by about 80%. Galls in *Syzygium cumini* was caused by *Fergusonina syzygii* (Family: Fegusoninidae). Severe incidence of blotch gall was observed in Jamun trees with around 15-20 percent of leaves infested by gall fly. The life cycle of the gall fly was completed in 25-27 days. In the newly emerged flushes in Jamun, terminal bud gall was found to be very severe that resulted in cessation of further growth of the shoot. *Syzygium* galls were found to be fed by hairy caterpillars and a weevil that reduced the gall infestation in the field.

Stem gall in bitter gourd by *Lasioptera falcata* severely infested the crop during September to November with 72-77 percent infestation of the new shoots with more than 20 flies per gall in Ramnagar and Devanahalli. The incidence of the adult flies was recorded during the month of May. Hybrid varieties of bitter gourd were heavily infested with gall flies compared to local varieties. *Insostemma indica* was found to be the major parasitoid of stem gall fly in little gourd.

Management of gall insects

Several natural extracts of essential oils were tested as an attractant for bitter gourd gall fly but none were found to attract them. Seven natural extracts of essential oils were tested as attractants for little gourd gall fly and none were found to be attractive to the fly. Azadirachtin and chlorpyriphos and beta-cyfluthrin were found to be very effective in the management of little gourd fly in farmers' fields.

Mass culturing of fall armyworm, *Spodoptera frugiperda*

The larvae of fall armyworm was successfully reared on potato dry slices. The size of the larvae was significantly better in wet potato slices but a mortality rate of 10 percent was recorded. Castor leaves supplemented with maize leaf powder and yeast powder favoured the growth of the adult moths.

Development and maintenance of iso-female colonies of insect species

Development and continuous maintenance of susceptible insects in the laboratory is a pre-requisite for undertaking studies on insecticide/biopesticide bioassays, evaluation of plant germplasm, segregation of breeding material, and also for mapping populations and transgenic plants for resistance to insects. For successful rearing of insects in the laboratory, there is a need for developing an easy and cost-effective method of rearing of insects on a semi-synthetic diet/preferred host plant/surrogate host that supports survival and development of the insect for several generations. Pest insect cultures derived from a single female (Iso-female lines) were established for cotton pink bollworm, *Pectinophora gossypiella*, brinjal shoot and fruit borer, *Leucinodes orbonalis*, tomato pin borer, *Tuta absoluta*, fall armyworm, *Spodoptera frugiperda,* legume podborer, *Maruca vitrata* and chilli broad mite, *Polyphagotarsonemus latus* (Table 4). These lines are partly inbred and serve as a good source for further development into pure inbred lines that are homozygous at every locus and the alleles at each locus are identical by descent.

Table 4. Details of iso-female colonies developed and maintained at ICAR-NBAIR

Sl. No.	Name of the insect	Place and date of collection of parental colonies	Rearing method	Date of creation of iso-female colonies and NBAIR Accession No.
1	Cotton bollworm, *Pectinophora gossypiella*	Raichur, Karnataka 23.10.2009	Semi- synthetic diet	07.05.2013 NBAII-MP-GEL-02a
2	Brinjal shoot and fruit borer, *Leucinodes orbonalis*	Bengaluru Rural, Karnataka 15.09.2012	Plant host	05.02.2013 NBAIR-IS-CRA-01a
3	Tomato pinworm, *Tuta absoluta*	Rayakottai, Tamil Nadu 10.11.2014	Plant host	15.12.2014 NBAII-MP-GEL-02a
4	Fall armyworm, *Spodoptera frugipera*	Chikkaballapur, Karnataka 01.09.2018	Semi- synthetic diet	06.10.2018 NBAIR-MP-NOC-05a
5	Legume podborer, *Maruca vitrata*	Hesaraghatta, Bengaluru, Karnataka 30.09.2020	Semi- synthetic diet	14.10.2020 NBAIR-IS-CRA-02
6	Broad mite, *Polyphagotarsonemus latus*	Ramanagara, Kanakapura, Karnataka 11.06.2020	Natural host	23.06.2021 NBAIR-GR-TAR-01 (Susceptible)
7	Broad mite, *Polyphagotarsonemus latus*	Ramanagara, Kanakapura, Karnataka 11.06.2020	Natural host	23.06.2021 NBAIR-GR-TAR-01a (Insecticide resistant)

Predatory potential of mirid bug, *Dortus primarius*

Five releases of mirid predator, *Dortus primarius* was evaluated against *Tuta absoluta* both at high density (2 pair/plant) and low density (1 pair/plant) in cages. In both the treatments, there was a reduction in population of *T. absoluta* compared to the control. However, significantly lesser number of *T. absoluta* eggs and larvae were observed in treatment with high dose of predator compared to low dose and the control.

Evaluation of *Blaptostethus pallescens* against thrips

The biocontrol potential of anthocorid predator, *B. pallescens* was evaluated against *Scirtothrips dorsalis* and *Thrips palmi* on capsicum grown in polyhouse at Doddabalapura. Weekly release of *B. pallescens* @ 20-30 per square meter (total 4-5 releases) with alternation of biopesticide *Bacillus subtilis* reduced the thrips population by 26.2%.

Evaluation of predatory mite, *Neoseiulus indicus* against phytophagous mites in capsicum

Four releases of *N. indicus* reduced the red spdier mites by 68.45% (65.27-72.63%) on top and bottom leaves (Figure 47a&b).

Figure 47a. Thrips damage in Capsicum

Figure 47b. Release of predatory bug, *Blaptostethus pallescens* against thrips in capsicum

Compatability studies of *Metarhizium anisopliae* and *Trichogramma chilonis*

The interaction between isolates of *Metarhizium anisopliae* (ICAR-NBAIR strain Ma-35) and *Trichogramma chilonis* was studied. Isolate was sprayed at 10^8 spores ml^{-1} with eggs of fall armyworm and the control group was sprayed with sterile distilled water with Tween 80 (0.01%). In pre-parasitism, the per cent adult emergence was not affected in both the treatments (Ma-35 and control). However, more number of adults emerged from control compared to eggs treated with Ma-35 in post parasitism study. Similarly, adult longevity was less in pre-parasitism study compared to post-parasitism. No variations were observed in the developmental period, sex ratio in Ma-35 treated eggs and in control. Hence, *Metarhizium anisopliae* (Ma-35) can be used in conjunction with this parasitoid for the management of fall armyworm.

Scirtothrips dorsalis – a pest of celery

Scirtothrips dorsalis, the chilli thrips, was reported for the first time as a pest of celery, *Apium graveolens* (Figure 48). Infested celery plants in a polyhouse at Kalahalli village (13°05'46.0"N, 77°47'12.2"E) in Hoskote taluk of Bengaluru Rural district, Karnataka, had light to dark brownish scars on various parts besides discoloured and distorted leaves. Association of fungal or bacterial disease was dismissed based on microscopic analysis of tissue sections. Eggs, juveniles and adults of thrips were abundant, especially on the leaves. The possible role of *S. dorsalis* as a vector of tospoviruses in celery needs to be investigated.

Figure 48. Celery crop damaged by *Scirtothrips dorsalis*

Biological control of the broad mite in mulberry

Typhlodromus (*Anthoseius*) *transvaalensis* was evaluated against the broad mite, *Polyphagotarsonemus latus*, in mulberry (cv. Victory-1) at Chakkalurdoddi, Channapatna taluk, Ramanagara district, Karnataka. The predatory mite (60 mites/plant) was compared with two concentrations (0.8% and 1%) of a laboratory-made mycelial–conidial liquid formulation of *Hirsutella thompsonii* [ICAR–NBAIR–MF(Ag)66]. Both agents on all sampling dates significantly reduced the number of broad mites on both bottom and top leaves. They outperformed the chemical (treated check: sulphur 80% at 2.5 g/litre), with the predatory mite alone reducing the pest population by 96.2% and 86.1% on bottom and top leaves, respectively.

Shatpada Treat

A simple and cost-effective mass production and application technology for *Typhlodromus* (*Anthoseius*) *transvaalensis* has been developed. *T*. (*A*.) *transvaalensis* is an effective biocontrol agent for the broad mite (*Polyphagotarsonemus latus*), spider mites (e.g., two-spotted spider mite, *Tetranychus urticae*) and thrips (*Scirtothrips dorsalis*).

Geographical and host distribution of whiteflies

Surveys were conducted in Goa, Gujarat, Karnataka, Lakshadweep, Meghalaya and Odisha West Bengal to document the new geographical and host distribution record for whiteflies viz., rugose spiralling whitefly, *Aleurodicus rugioperculatus*. Woolly whitefly, *Aleurothrixus floccosus* was recorded in Karnataka, Lakshadweep and Tamil Nadu. Bondar's nesting whitefly, *Paraleyrodes bondari* and *A. floccosus* was recorded from Andhra Pradesh, Odisha and West Bengal. Besides, 45 host plants for rugose spiralling whitefly; 21 host plants for nesting whitefly, *Paraleyrodes minei*; 9 host plants for Bondar's nesting whitefly, *P. bondari*; 13 host plants for solanum whitefly, *Aleurothrixus trachoides* and 5 host plants for palm infesting whitefly, *A. atratus* was recorded for the first time in India.

Documentation of natural enemies of whiteflies

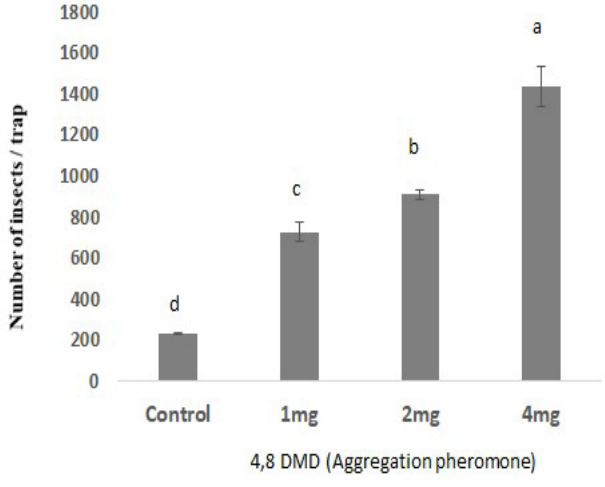
Several predators viz., *Pseudomallada astur*, *Cybochephalus indicus*, *Menochilus sexmaculatus*, *Jauravia pallidula* on *A. rugioperculatus*, *P. astur*, *C. indicus*, *C. nigrita* and *J. pallidula* on *A. atratus* and *Acletoxenus indicus*, *Scymnus utilis*, *Cryptolaemus montrouzieri* and *P. astur* on *A. floccosus* under field conditions were documented. Mass production technology for parasitoid *Encarsia guadeloupae* for the management of rugose spiraling whitefly was developed. The bio control potential of entomopathogenic fungus, *Isaria fumosorosea* for the management of invasive whiteflies was evaluated. Both the technologies were commercialised to four private and public sector organizations. A mobile app for rugose spiraling whitefly management was developed to educate the farmers and other stakeholders.

Safety evaluation of entomopathogenic fungus, *Isaria fumosorosea* on beneficial insects

Infectivity of *I. fumosorosea* on beneficial insects like mulberry silkworm (common intercrop with coconut), *Pseudomallada astur* (common predator on RSW) and *Goniozus nephantidis* (potential parasitoid of *Opisina arenosella*) was evaluated under laboratory condition. No infectivity was observed on different stages of *B. mori*, *P. astur* and *G. nephantidis*. The fungus was effective against all the developmental stages of both the species to an extent of 58-80% under field conditions. The mass production and formulation technology (talc, grain and oil based) for potential strains of *I. fumosorosea* Pfu-5 with higher bio-efficacy, persistence and longer shelf life is being developed.

Aggregation Pheromone of *Tribolium castaneum*

The pheromone of *T. castaneum* dimethyl decanal was formulated and loaded into nanomatrix. The physiological response of the neurons in the antennae of *T. castaneum* was confirmed. The efficacy of the pheromone in trapping the beetles was assessed at the Indian Institute of Food Processing Technology. Among the various concentration tested DMD at 4 mg/ lure attracted the highest number of beetles (>1400 beetles in 4 traps) (Fig.49 a).



Bars representing the same alphabet do not differ significantly (P>0.05).

Figure 49a: Efficacy of DMD in attracting the *T. castaneum*

Characterisation of biorationals against *T. castaenum*

Repellence assay

Ajowan and its constituents were evaluated to check the repellent activity against adult insects exposed to test concentrations. *T. castaneum* when exposed to *T. ammi* EO recorded highest percent repellency (83.33 %) followed by Y-terpinene (70.00%) and Thymol (63.33 %) (Fig.49b). The EO and constituents caused a good repellence but the gap is that they are highly volatile and hence have limited time to be effective.

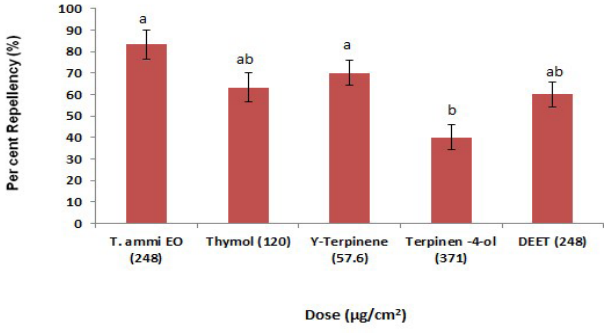


Figure 49b: Percent repellency of *T. ammi* oil and its constituents against *T. castaneum* at 5 hrs of exposure. Bars representing the same alphabet do not differ significantly (P>0.05).

Synthetic approach for preparing the sex pheromone components of *Spodoptera frugiperda*

The major component of *Spodoptera frugiperda* (J.E. Smith) was synthesized using synthetic pathway that was economical. In the first step of reaction, bromoalcohols was prepared (product A). The pure precipitated product was obtained after washing with cold benzene. In the second step, alkylation reaction was done with 1-hexyne with product A. The crude product was then be purified using silica gel flash chromatography with a hexane/ethyl acetate 6:1 eluent. In the third step, step 3 hydrogenation of alkynols was done as mentioned in Figure 50 the product obtained (Z)-11-Hexadecen-1-ol and (Z)-7-Dodecen-1-ol was used in the acetylation procedure. Acetylation of alcohols was done and residue was purified using hexane/ethyl acetate 9:1 as the eluent in flash chromatography on silica gel.

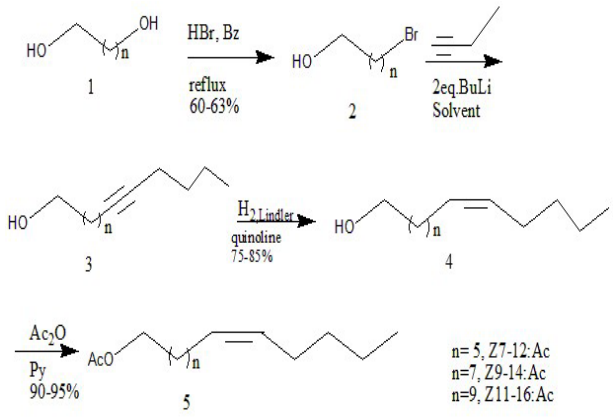


Figure 50. Synthesis of the major component of *Spodoptera frugiperpa* pheromone (Z)-9-tetradecenyl acetate.

A Wittig reaction or alkylation of an acetylene with an alkyl halide followed by selective reduction are used to make the straight chain (C_{10}–C_{16}) alcohols or acetates with a double bond present in many sex pheromones. The Wittig reaction, on the other hand, is not as stereo-selective as the alkylation approach, which normally involves protecting the bromoalcohol with tetrahydropyranyl ether, resulting in a lower overall yield. These major components of pheromones were loaded into bio polymeric chitosan alginate nanoparticles for slow-release formulations. Laboratory synthesis cost for 1 gm of compound is Rs 10000/- the cost can be reduced during the scale up of production at industrial level.

Field evaluation of entomopathogens against bhendi aphid, *Aphis gossypii* and leafhoppers, *Amrasca biguttula biguttula*

The field trial for the evaluation of entomofungal pathogens against aphid (*Aphis gossypii*) and leafhopper (*Amrasca biguttula biguttula*) in okra was carried out at ICAR-NBAIR Yelahanka, Bengaluru with various entomopathogenic fungi (*B. bassiana*, *M. anisopliae*, *L. fusisporum*). Three rounds of foliar sprays of entomofungal pathogens formulations at a spore concentration of 1×10^8 cfu/ml were applied. Minimum number of aphids and leafhoppers was recorded in Emamectin benzoate 5% SG treated plot followed by *L. fusisporum* ICAR-NBAIR-Vl8. Maximum yield recorded in Emamectin benzoate 5% SG (450.78 Kg) treated plot followed by *L. lecanii* ICAR-NBAIR-Vl 8 (411.67 Kg) (Figure 51).

Figure 51. A. Overview of bhendi experimental plot at ICAR-NBAIR, Yelahanka campus, Bengaluru. B. Bhendi harvested from entomopathogenic fungi treated plot

Management of Mulberry root rot by *Trichoderma asperellum* strain NBAIR-TATP at Magadi Taluk, Karnataka

Mulberry root rot disease caused by *Rhizoctonia bataticola* (=*Macrophomina phaseolina*) and other pathogens like *Fusarium solani, F. oxysporum, Botryodiplodia theobromae* are diseases of concern in Karnataka, and management of the disease (Figure 52) is very challenging to the mulberry farmers. Initial application of Dithane M45 and systemic fungicide Ridomil Gold @ 0.2% concentration failed to protect the mulberry plants from pathogen infection. Soil drenching with *Trichoderma asperellum* strain NBAIR-TATP @ 2% solution @ 50 ml per plant effectively suppressed the root rot disease and prevented further spread of the disease. It also further boosted the growth of the mulberry plants with healthy leaves (Figure 53). This work has been carried out of in association with Department of Sericulture.

Figure 52. A. Root rot infected mulberry plants shows typical wilting B. fungal growth symptoms in infected roots

Figure 53. A. Field view of *Trichoderma asperellum* strain NBAIR-TATP applied for the management of root rot of mulberry, and B. NBAIR-TATP application showed recovery of mulberry plants from root rot disease.

Isolation of novel entomopathogenic fungus, *Aschersonia aleyrodis* from citrus whitefly, *Dialeurodes citri* in Kinnow mandarin

Novel entomopathogenic fungus (EPF), *Aschersonia aleyrodis* (orange coloured fungal growth) was isolated from the infected nymphs and pupae of citrus whitefly, *Dialeurodes citri* on the lower leaf surface of Kinnow from the orchards of Ludhiana, Punjab. The growth of this fungus on the Sabouraud dextrose broth (SDYA) medium was fast with filamentous hyphae, white to yellowish white mycelium with a peripheral circle. The colour of the conidial mass varied from light yellowish orange to reddish orange (Figure 54). Anamorphic stroma was observed as thin pulvinate structure along with hypothallus. Conidiomata was 5-15 per stroma, conidiogenous cells arised singly or in whorls not branched, cylindrical, slightly tapering, truncate at apices. Conidial masses appeared reddish orange, orange or light yellow, thickened in the centre. Conidia were fusiform unicellular, hyaline, guttulate with acute ends (10–12x1.5–2.0 µm) (Figure 55). This fungus was confirmed by amplification and sequencing of beta tubulin gene which showed 99.40 per cent identity in NCBI and further the sequence was deposited in NCBI (Accession No. MW894659)

Figure 54. *Aschersonia aleyrodis* in culture plate

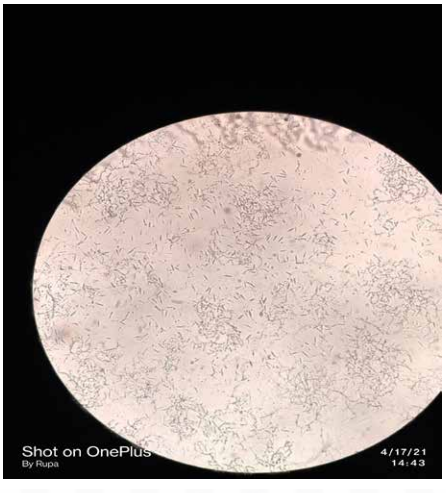


Figure 55. Conidia of *Achersonia aleyrodis*

Development of oil-based formulation of *Beauveria brongniartii* NBAIR-Bbr-1 for the management of red palm weevil, *Rhynchophorus ferrugineus*

The red palm weevil grubs cause damage to the coconut trunk or crown by feeding on soft tissues and often cause reddish brown liquid exudation from the bore holes. Severe infestation results in yellowing of the inner whorl of leaves, wilting of crown and death of palm. ICAR-NBAIR evaluated oil-based formulation of *Beauveria brongniartii* NBAIR-Bbr-1 in collaboration with ICAR-CPCRI, Kasargod (Figure 56). Under the laboratory conditions, grubs treated with all *Beauveria brongniartii* NBAIR-Bbr-1 recorded 100% mortality (Fig. 57), whereas the untreated control grubs found healthy.

Figure 56. A. Bioassay of oil-based formulation of *Beauveria brongniartii* NBAIR-Bbr-1 against red palm weevil

Figure 57. Development of fungal mycosis on red palm weevil grubs after inoculating with *Beauveria brongniartii* strain NBAIR-Bbr-1

Isolation and characterisation of nucleopolyhedrovirus from *Maruca vitrata*

Natural occurrence of nucleopolyhedrovirus (NPV) infection on legume (Dolichos) pod borer *Maruca vitrata* larvae (Figure 58) was recorded in 2021 during surveys conducted in legume fields at Krishnagiri district of Tamil Nadu. A strain of nucleopolyhedrovirus (MaviNPV NBAIR1) infecting *M. vitrata* was isolated from diseased larvae, morphological and biological characteristics were studied (Figure 59). Electron microscopic studies showed irregular shaped MaviNPV occlusion bodies (OBs) of size 0.9 to 1.4 µm (Figure 60). First instar larvae were most susceptible (LC_{50} 2.021 OBs/m2) to MaviNPV followed by second and third instars with the lethal concentrations (LC_{50}) 3.210 OBs/m^2 and 3.956 OBs/m^2, respectively (Table 5).

Figure 58. MaviNPV infected larva showing typical symptoms

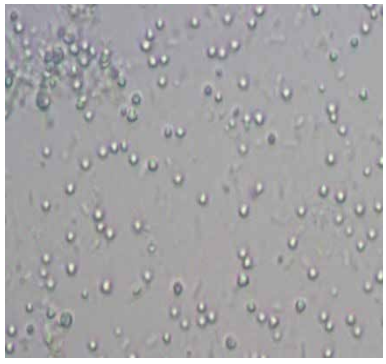


Figure 59. Light microscopy view of MaviNPV occlusion bodies

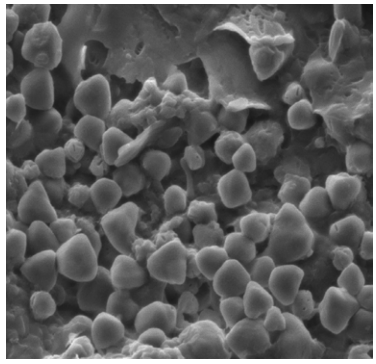


Figure 60. Electron photomicrograph of occlusion bodies of MaviNPV

Table 5. Bioassay of *Maruca vitrata* nucleopolyhedrovirus (MaviNPV) against *Maruca vitrata*

Instar	Number of larvae used	LC_{50} POBs/ mm^2 (6^{th} day)	Slope ± SE	Fiducial limits		χ^2	DF
				Lower	Upper		
1^{st} instar	50	2.021	1.11±0.12	2.132	8.211	1.27	4
2^{nd} instar	50	3.210	0.90±0.11	2.521	10.205	6.99	4

Fitness attributes of entomopathogenic nematodes (EPN)

The biocontrol potential of 40 EPN strains belonging to *Heterorhabditis bacteriophora*, *H. indica*, *Heterorhabditis* sp., *Steinernema abbasi*, *S. carpocapsae*, *S. feltiae*, *Steinernema* sp., and *S. riobrave* in terms of virulence, environmental tolerance (to heat, desiccation, and cold), host seeking ability etc.was studied. Virulence assays were carried out against 12 species of pests belonging to Coleoptera and Lepidoptera. Most isolates infected *Galleria mellonella* between 16 and 37°C with higher fecundity at 25-30°C). The biocontrol potential was variable among nematode species and the host species.

Field efficacy of EPN formulations for the management of fall armyworm in maize

Field trials were repeated to study the comparative effect of WP and novel granular formulations of *H. indica* NBAII Hi101, *S. carpocasae* NBAII Sc01 and *H. bacteriophora* NBAII Hb105 against fall armyworm, *Spodoptera frugiperda*. The results indicated that granular formulation of *H. indica* and *S. carpocapsae* were on par with respective WP formulations in reducing the populations of fall armyworm (FAW) (58-65%), however granular formulation of *H. bacteriophora* imparted only 24-28% control.

Field studies on the effect of combinations of inter (mixed) cropping of maize with pulse, fodder and flower crops and WP formulation of EPN on the fall armyworm damage in maize

Field studies during rabi (2020-2021) on the effect of WP formulation of *H. indica* NBAII Hi101 in combination with intercropping (1:1) maize with red gram, fodder dhaincha and marigold on the incidence of FAW and crop damage was conducted. The results of during kharif 2020-2021corroborated that intercropping with redgram, fodder dhaincha and marigold significantly reduced the incidence of FAW over control and saved on the application of EPN dose.

Evaluation of entomopathogenic nematode, *Heterorhabditis indica* against *Holotrichia* sp.

A total of 250 soil samples were collected randomly from maize, grape coconut, arecanut and tomato growing regions of Kolar, Chikkballapur, Udupi, Karnataka. A soil sample drawn from coconut rhizosphere of Udupi, Karnataka. *Steninernema* sp. NBAIR S58 a new species from India and this nematode can be used for the management of insect pests. During 2020-2021 two field demonstrations were carried out at Bagalakote district of Karnataka to evaluate the efficacy of two species of entomopathogenic nematodes (EPN), *Steinernema carpocapsae* and *Heterorhabditis indica*, along with a commonly used insecticide (chlorpyrifos) against *Holotrichia* species. Field trial data showed that the reduction in *Holotrichia* grub population was significantly higher in field treated with *H. indica* at rate of 2.5×10^9 IJ ha^{-1} than *S. carpocapsae* and chlorpyrifos application. Chlorpyrifos application was more efficient in reducing the grub population than both nematode species at the lower application rate (1.25×10^9 IJ ha^{-1}) (Figure 61). These experiments suggest *H. indica* to be a promising biocontrol agent against *Holotrichia* species.

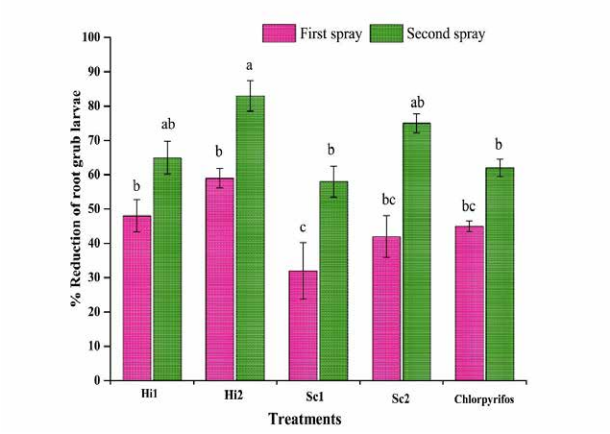


Figure 61. Percent reduction of second instar grubs of *Holotrichia* species, at 2 and 4 weeks after different treatments in in farmer's field at Bagalkote, Karnataka, India. Different letters on the top of error indicate statistically different values for different nematode concentrations at ($P < 0.05$) using Tukey's test. Bars = standard error. Sc, *Steinernema carpocapsae*; Hi, *Heterorhabditis indica*; 1 = 1.25 × 10^9 IJ ha^{-1}, 2 = 2.5 × 10^9 IJ ha^{-1}. Chlorpyrifos was used at the rate of 4,500 ml ha^{-1} as drench application.

Diversity of bee pollinators in niger

The diversity of bees in niger were documented. Six different species of bees viz., *Apis florea* (3.0 / flower/10 minutes), *Apis cerana indica* (2.75 bees/ flower/10 minutes), *Amegilla* sp (1.0 bee/flower/10 minutes), *Ceratina binghami* (0.75 bee/flower/10 minutes), *C. hieroglyphica* (1.75 bees/flower/10 minutes) and *Nomia* sp (0.75 bee/flower/10 minutes). We have observed the flower-visiting by calliphorid fly and some ant species also (Figures 62-63).

Figure 62. Calliphorid fly visiting niger flower

Figure 63. Ants in niger flower

Pollinator exclusion studies in niger

There was significant increase in the seed weight of niger in the bee pollinated flowers (3.62 g/100 seeds) compared to wind pollinated flowers (2.38 g/100 seeds) (Figure 64).

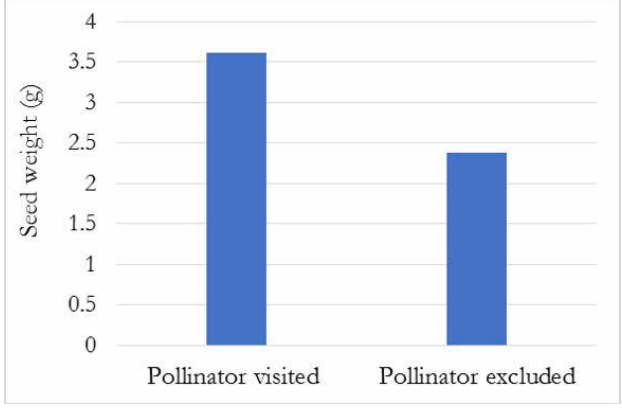


Figure 64. Effect of pollinator visitation on seed weight (g) of niger

Colony division of stingless bees, *Tetragonula iridipennis*

Strong colony of *Tetragonula iridipennis* divided with queen cells recorded 80% establishment with new cells and storage pots constructed in 39.75±2.50 and 44.25±5.18 days respectively. The number of days taken for first oviposition in the established nest was 79.25±9.5 days. Highest number of pollen pots (30.07±6.24) and honey pots (101.20 ±2.63) per hive was recorded during the month of February to March.

Coconut shell traps to attract swarms of stingless bees, *Tetragonula iridipennis*

Coconut shell traps were found to be effectively trap the swarming bees with a trap occupancy rate of 44.87% in a time period of 13.40±4.38 days. The brood cells were constructed 89.50±6.07 days after acceptance of the shell traps with an average of 67.70±20.83 brood cells per trap. The foragers preferred foraging for nectar, resin and pollen during the 15, 30 and 45 days after acceptance of the coconut shells for nesting. Significantly higher number of filled honey pots and pollen pots were recorded during the months of February-May and December to March.

Development of mealworm, *Tenebrio molitor* and superworm, *Zophobas morio* in different media

Mealworm, *Tenebrio molitor* and *Zophobas morio* cultures were maintained and mass cultured in the laboratory in bran-based media. The egg to adult duration of *T. molitor* and *Z. morio* were 129.83±9.62 and 168.41±2.68 days respectively. Rice bran + vegetable supplemented diet recorded the lowest larval development period (50.40 days) of *T. molitor*. Highest individual larval weight of *T. molitor* (143.27 mg) was recorded in rice bran. Rice bran recorded the lowest larval development period (119.80 days) of *Z. morio* with highest individual larval weight (195.40 mg) and lowest feed conversion ratio (0.80).

All India Coordinated Research Project on Biological Control of Crop Pests

Biological suppression of plant diseases

Three bioagents viz., *Bacillus amyloliquefaciens* (BS-5), *Bacillus subtilis* (BS-6), *Bacillus cereus* (BS-39) were identified as the effective bioagents against soil borne diseases of rice (NRRI).

Soil application, seedling root dip and foliar application of *Trichoderma harzianum* AAU BC Th1 and *Pseudomonas fluorescens* ICAR PFDWD pfu in combination effectively reduced the incidence of early blight disease in tomato (57%) (AAU-A).

Biological suppression of cotton pests

BIPM module with release of *Trichogrammatoidea bactrae* @2cc/acre + pheromone traps reduced the pink bollworm damage to 6.0% compared to 14% damage recorded in control (TNAU).

BIPM treatment recorded higher numbers of good opened bolls/plant (0.47), least numbers of bad opened bolls (1.57/plant) which was on par with farmers' practices. Farmers practices recorded 0.23 good bolls/plant, 0.39% bad opened bolls/plant, lesser number of parasitised larvae/plant (0.67) and least boll infestation (32.22%). Yield in farmers plot was 4.76 q/acre, while control plot recorded the least yield (1.23 q/acre) with maximum boll infestation 69.09% (PJTSAU).

Biological suppression of sugarcane pests

Egg parasitoid, *Tetrastychus pyrillae* and nymphal and adult parasitoid, *Fulgoraecia melanoleuca* were recorded to parasitise *Pyrilla perpusilla* on sugarcane with peak activity in month of September (PAU).

Three sprays of endophytic entomopathogenic fungal strains NBAIR-Ma35, NBAIR Bb23 (5g/l) were found effective in the management of sugarcane early shoot borer with 8.9 and 10.3% dead hearts compared to chlorantraniliprole sprays (6.9% dead heart) (ANGRAU).

Soil application of wettable powder formulation of entomopathogenic nematode, *Heterorhabditis indica* NBAIR Hi101 @ 22.50 kg/ha was found superior in controlling sugarcane white grubs and recorded 3.11 per cent lesser mean clump mortality as compared to control (11.31%) (MPKV).

Six releases of *Trichogramma chilonis* @ 50,000 parasitoids/ha at weekly intervals starting from 40 days after emergence of shoots found superior to untreated control in reducing early shoot borer infestation from 18.67 to 6.95 % dead hearts while the chemical, chloropyriphos reduced the early shoot borer infestation from 17.16 to 8.54 %. The net benefit of Rs. 9,874/ha was obtained by considering the additional cost of Chlorpyriphos (Rs. 750/ha) (MPKV).

Biological suppression of maize pests

The incidence of fall armyworm in the plots treated with *Trichogramma chilonis* + *Metarhizium anisopliae* Ma 35 was 14% followed by 15% incidence recorded in *T. chilonis* + NBAIR *Bt* 2% (15%) treated

plots compared to control (45%) (ANGRAU, IIMR, SKUAST, TNAU, UAS-R).

Release of egg parasitoid, *T. chilonis* @ 1,00,000 per ha (two releases at 10 and 17 days old crop) at farmer's fields reduced the incidence of stem borer, *Chilo partellus* by 50-55 per cent over control (PAU).

Four sprays of liquid formulations of NBAIR strain *Trichoderma asperellum* recorded low incidence (17%) of maize *Turcicum* leaf blight which was equally effective as chemical fungicide carbendazim (SKUAST).

Biological suppression of ragi pests

Application of talc formulation of *Metarhizium anisopliae* Ma 35 @ 10gm/lit at 30 & 45 Days of crop emergence reduced the damage caused by pink borer, *Sesamia inferens* on finger millet resulting in 34 and 63.1 per cent reduction in dead hearts and white ear heads, respectively over the untreated control. There was 33.0% increase in yield over the untreated control and the yield realized in insecticide check was on par with use of the bio-control agent (IIMR).

Biological suppression of pests of pulses

Chitin enriched oil formulation of *Lecanicillium saksenae* (10^7 spores ml/l) @10 ml/l was found effective in managing pod bugs in cowpea with a mean population of 0.5 bugs per plot. There was a yield increase of 10 per cent in *L. saksenae* treated plots, compared to other biocontrol agents and chemical Thiamethoxam spray (KAU, Vellayani).

Three sprays of HearNPV in chick pea was found effective in reduced the pod borer damage with 20% increase in yield at Raichur (UAS-R).

Natural infection of Nucleopolyhedrovirus (NPV) infecting cowpea pod borer, *Maruca vitrata* was documented in Anand district, Gujarat (AAU-A).

Biological suppression of pests of tropical fruit crops

Larval parasitoid, *Bracon hebetor* recorded 62.50% parasitisation of mango leaf webber under filed conditions. Three sprays of entomopathogenic fungus *Metarhizium anisopliae* NBAIR Ma4 @5 g/l at ~~at~~ 7 days interval reduced the incidence of mango thrips to 49.4% (CISH).

Application of CISH strain *Purpureocillium lilacinum* and CISH strain *Bacillus* spp along with vermicompost reduced the wilt and root knot nematode incidence in guava with low root knot index of 1.88 compared to the control root knot index of 3.19 (CISH).

Spraying of *Metarhizium anisopliae* (NBAIR-Ma-4), *Beauveria bassiana* (NBAIR-Bb-5a) and Azadirachtin @ 10000 ppm effectively reduced the mealybug populations in guava and aonla (SKUAST).

Biological suppression of pests of temperate fruit crops

Three weekly sprays of combination of Azadirachtin 1500 ppm and NBAIR strain *Lecanicilium lecanii* @ 5.0 ml/l reduced the incidence of green apple aphid and mites by 73.28% and 44.66% (SKUAST).

Three sprays of Azadirachtin 10000 ppm @ 2.0 ml/l followed by spraying of *Metarhizium anisopliae* NBAIR Ma4 (5g/l) and NBAIR *Lecanicilium lecanii* Vl8 (5g/l) resulted in 85.0% reduction of apple woolly aphid (SKUAST).

Application of entomopathogenic nematode, *Heterorhabditis bacteriophora* (5000IJs/gallery) was found the most effective resulting in 67 per cent mortality of apple leopard moth, *Zeuzera multistrigata* (YSPUHF).

Two weekly releases of anthocorid bug, *Blaptostethus pallescens* @ 400 bugs/ plant resulted in 25.27 and 35.91% reduction in European red mite and two spotted spider mite infestation on apple respectively over untreated control (SKUAST).

Biological suppression of pests in plantation crops

Sustained release of CPCRI strain *Metarhizium majus* in breeding sites could reduce coconut rhinoceros beetle damage by 70% (CPCRI).

Application of NBAIR strain *Isaria fumosorosea* @5gm/l at 15 days interval effectively reduced the percent of egg spirals and nymphs of coconut rugose spiralling whitefly by 66.45% and 74.97% (HRS).

Conservation biological control using the aphelinid parasitoid, *Encarsia guadeloupae* and sooty mould scavenger beetle, *Leiochrinus nilgirianus* reduced the coconut rugose spiralling whitefly population to more than 80% in five months period (CPCRI).

Soil and foliar application of PGPR KAU consortium @ 2% in black pepper nursery was found to be effective against *Phytophthora* disease. This treatment recorded 62.5 per cent survival of plants as against 41.67 per cent in control (KAU-T).

Biological suppression of pests in vegetables

Brinjal: BIPM module comprising of *Trichogramma chilonis*, *Bacillus thuringiensis Bt*1 and EPN *Steinernema* sp AAU Strain 8 was found equally effective as chemical module for the management of brinjal shoot and fruit borer, *Leucinodes orbonalis*. The BIPM module recorded 3–4% infestation as compared to 8–12% infestation in the untreated control (AAU-A).

Large scale demonstration of biointensive IPM modules (BIPM)

Large scale demonstration (50 ha at Rajabahar, Colaghat and Jorhat) of biocontrol based IPM package in rice on variety 'Ranjit' recorded the maximum yield of 4963.5 kg/ha in biocontrol based IPM package treated plots which was significantly higher compared to farmer's practice plot with 4637.5 kg/ha. The net returns over control in bio intensive integrated pest management package was Rs. 56,291.90 as compared to Rs. 44,967.50 in farmers practice plot (AAU-J).

Large-scale demonstration (100 ha all districts of Punjab) on bio-intensive pest management in organic basmati rice using *Trichogramma chilonis* and *T. japonicum* @ 1,00,000 per ha (5–6 releases) at farmers' fields resulted in 55–60 and 50 per cent reduction in incidence of leaf folder, *Cnaphalocrocis medinalis* and yellow stem borer, *Scirpophaga incertulas*, respectively (PAU).

Large scale field demonstration of biocontrol product PBAT-3 (*Trichoderma harzianum* Th14 + *Pseudomonas fluorescens* Psf 173) as soil treatment, seed biopriming, seedling treatment and foliar spray in rice against soil borne diseases was conducted in 200 ha at Nainital district of Uttarakhand. Treatment of bioagents increased the yield and reduced the fungicide application (GBPUAT).

Large-scale demonstrations (550 ha at Gandhinagar, Narmada, Navasari, Surendranagar districts of Gujarat) BIPM modules in okra, cabbage, mango have witnessed 30–40% reduction in chemical pesticide usage (AAU-A).

Large-scale demonstrations of proven biocontrol technology using *Trichogramma chilonis* @ 50,000 per ha (10–12 releases at 10 days interval from July to October 2021) against sugarcane stalk borer, *Chilo auricilius* conducted at farmers' fields in collaboration with sugar mills resulted in 50–60 per cent reduction in borer incidence over control (PAU).

4. GENBANK / BOLD ACCESSIONS

S. No.	ORGANISM	ACCESSION NUMBER
	COLEOPTERA (*COI*)	
1.	*Adoretus ovalis*	MZ836004
2.	*Anomala communis*	OL377861
3.	*Anomala dorsalis*	OK605086
4.	*Anomala ruficapilla*	OL377737
5.	*Anomala* sp.	OK642161
6.	*Apomycena* sp.	OL343524
7.	*Brahmina coriacea*	OL317648
8.	*Euplatypus parallelus*	MT662118
9.	*Holotrichia fissa*	MN850439
10.	*Holotrichia serrata*	OK465395
11.	*Holotrichia sikkimensis*	OL321135
12.	*Hybosorus orientalis*	MW075516
13.	*Miridiba excisa*	MT764775
14.	*Myllocerus subfasciatus*	MW376481
15.	*Xylosandrus compactus*	MT178811
	DIPTERA (*COI*)	
16.	*Actinoptera reticulata*	MZ462182
17.	*Coelotrypes luteifasciatus*	MW621500
18.	*Coelotrypes merremiae*	MW621148
19.	*Euphranta cassiae*	MW596412
20.	*Euphranta crux*	MW622002
21.	*Exorista sorbillans*	OM368623
22.	Gastrozonini	MZ503643
23.	*Rhabdochaeta* sp.	MZ472615
24.	*Rhabdochaeta* sp.	MZ172755
25.	*Senometopia quarta*	OM371064
26.	*Senometopia* sp.	MZ014029
27.	*Sundaresta malaisei*	MZ473245
28.	*Tabanus diversifrons*	MT786796
29.	*Xanthorrachis annandalei*	MZ462183

S. No.	ORGANISM	ACCESSION NUMBER
	HEMIPTERA (*COI*)	
30.	*Agonoscelis nubilis*	OK413643
31.	*Aleurodicus dispersus*	MT913392
32.	*Aleurodicus dispersus*	MT679149
33.	*Aleurodicus dispersus*	MT936904
34.	*Aleurodicus dispersus*	MT920112
35.	*Aleurodicus dispersus*	MW027005
36.	*Aleurodicus rugioperculatus*	MT542036
37.	*Aleurodicus rugioperculatus*	MT676410
38.	*Bemisia tabaci* Abohar, Fazilka, Punjab	MW602291
39.	*Bemisia tabaci* Anand, Gujarat	MW620991
40.	*Bemisia tabaci* Arsikere, Hassan, Karnataka	MT679547
41.	*Bemisia tabaci* Beeranakere, Shimoga, Karnataka	MW030184
42.	*Bemisia tabaci* Bharuch, Gujarat	MW621869
43.	*Bemisia tabaci* Champaner, Gujarat	MW626009
44.	*Bemisia tabaci* Channarayapatna, Hassan, Karnataka	MT810378
45.	*Bemisia tabaci* Fatehabad, Haryana	MW621498
46.	*Bemisia tabaci* Hassan, Karnataka	MT926003
47.	*Bemisia tabaci* Honnali, Davangere, Karnataka	MW013167
48.	*Bemisia tabaci* Hulikatte, Ramanagara, Karnataka	MW012618
49.	*Bemisia tabaci* Jeenahalli, Davangere, Karnataka	MT541159
50.	*Bemisia tabaci* Kadur, Chikmagalur, Karnataka	MT924263
51.	*Bemisia tabaci* Karnal, Haryana	MW621000
52.	*Bemisia tabaci* Keshopur, Gurdaspur, Punjab	MW602288
53.	*Bemisia tabaci* Kolar, Karnataka	MW012612
54.	*Bemisia tabaci* Mallekan, Sirsa, Haryana	MW602292
55.	*Bemisia tabaci* Mandi Dabwali, Sirsa, Haryana	MW498977
56.	*Bemisia tabaci* Nagpur, Maharashtra	MW602290
57.	*Bemisia tabaci* Seegehadlu, Chikmagalur, Karnataka	MT991017
58.	*Bemisia tabaci* Soratur, Gadag, Karnataka	MW020439
59.	*Bemisia tabaci* Sugatur, Kolar, Karnataka	MT920109
60.	*Bemisia tabaci* Surtia, Sirsa, Haryana	MW514236
61.	*Bemisia tabaci* Tamatadahalli, Chikmagalur, Karnataka	MT541160

S. No.	ORGANISM	ACCESSION NUMBER
62.	*Bemisia tabaci* Yaraganal, Davanagere, Karnataka	MW030983
63.	*Bemisia tabaci* Yarahalli, Mysore, Karnataka	MW020430
64.	*Cappaea taprobanensis*	OK413639
65.	*Cappaea taprobanensis*	OK413640
66.	*Dalpada oculata*	OK413642
67.	*Halyomorpha picus*	OK413641
68.	*Halys sulcatus*	OK413637
69.	*Halys sulcatus*	OK413638
70.	*Hermolaus rolstoni*	OK413645
71.	*Menida versicolor*	OK413648
72.	*Patchiella reaumuri*	MT796073
73.	*Phenacoccus manihoti*	MW039322
74.	*Phenacoccus manihoti* Jedarpalayam, Namakkal, Tamil Nadu	OK174324
75.	*Phenacoccus manihoti* Kallakurichi, Tamil Nadu	OK173048
76.	*Phenacoccus manihoti* Koranampatti, Salem, Tamil Nadu	OK172561
77.	*Phenacoccus manihoti* Thoppapatti, Namakkal, Tamil Nadu	OK172562
78.	*Phenacoccus manihoti* Vellarivalli, Salem, Tamil Nadu	OK172179
79.	*Phenacoccus manihoti* Yethapur, Salem, Tamil Nadu	OK172342
80.	*Phricodus hystrix*	MZ540897
81.	*Plautia crossota*	OK413646
82.	*Starioides* sp.	OK413644
83.	*Starioides* sp.	OK413647
	HYMENOPTERA (*COI*)	
84.	*Anagyrus lopezi*	OK85480
85.	*Anisopteromalus calandrae*	OM349564
86.	*Anisopteromalus calandrae*	OM368669
87.	*Bracon brevicornis*	MW039394
88.	*Braunsapis mixta*	MW135190
89.	*Braunsapis mixta*	MZ619047
90.	*Braunsapis mixta*	MZ619048
91.	*Braunsapis mixta*	MZ619049
92.	*Braunsapis picitarsis*	MW135303
93.	*Chelonus* sp.	MT680656

S. No.	ORGANISM	ACCESSION NUMBER
94.	*Cotesia* sp.	MW048913
95.	*Diaeretiella rapae*	MT682672
96.	Eulophidae	MW048911
97.	Eulophidae	MW078432
98.	*Eurytoma* sp.	MT740707
99.	*Goniozus nephantidis*	MW048912
100.	*Habrobracon* sp.	MW035917
101.	Mesochorinae	MW048914
102.	*Mesochorus* sp.	MW039393
103.	Ophioninae	MW048910
104.	*Parapanteles* sp.	MW078433
105.	*Podagrion* sp.	MW017535
106.	Tetrastichinae	MW035916
107.	*Trichogramma chilonis*	OL913800
108.	*Trichogramma chilonis*	OL913900
109.	*Trichogramma chilonis*	OL913974
110.	*Trichogramma chilonis*	OL958541
111.	*Trichogramma chilonis*	OL958558
LEPIDOPTERA (*COI*)		
112.	*Citripestis eutraphera*	MZ165364
113.	*Dudua aprobola*	MZ165365
114.	*Penicillaria jocosatrix*	MZ165363
115.	*Spodoptera frugiperda* Bari Brahmana, Samba, Jammu & Kashmir	MZ674205
116.	*Spodoptera frugiperda* Ludhiana, Punjab	MW624694
117.	*Spodoptera frugiperda* Ludhiana, Punjab	MW624695
118.	*Spodoptera frugiperda* Ludhiana, Punjab	MW624696
119.	*Spodoptera frugiperda* Ludhiana, Punjab	MW624697
120.	*Spodoptera frugiperda* Parbhani, Maharashtra	MW561312
121.	*Spodoptera frugiperda* Parbhani, Maharashtra	MW561313
122.	*Spodoptera frugiperda* Parbhani, Maharashtra	MW561314
123.	*Spodoptera frugiperda* Parbhani, Maharashtra	MW561315
124.	*Spodoptera frugiperda* Parbhani, Maharashtra	MW561316
125.	*Spodoptera frugiperda* Parbhani, Maharashtra	MW561317

S. No.	ORGANISM	ACCESSION NUMBER
126.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW561292
127.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW561293
128.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW561294
129.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW561295
130.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW561296
131.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW561297
132.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW561298
133.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW561299
134.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW561300
135.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW561301
136.	*Spodoptera frugiperda* Raichur, Karnataka	MW561302
137.	*Spodoptera frugiperda* Raichur, Karnataka	MW561303
138.	*Spodoptera frugiperda* Raichur, Karnataka	MW561304
139.	*Spodoptera frugiperda* Raichur, Karnataka	MW561305
140.	*Spodoptera frugiperda* Raichur, Karnataka	MW561306
141.	*Spodoptera frugiperda* Raichur, Karnataka	MW561307
142.	*Spodoptera frugiperda* Raichur, Karnataka	MW561308
143.	*Spodoptera frugiperda* Raichur, Karnataka	MW561309
144.	*Spodoptera frugiperda* Raichur, Karnataka	MW561310
145.	*Spodoptera frugiperda* Raichur, Karnataka	MW561311
146.	*Spodoptera frugiperda* Udhampur, Jammu & Kashmir	MZ676673
LEPIDOPTERA (*COI B*)		
147.	*Spodoptera frugiperda* Chhattisgarh	OL979468
148.	*Spodoptera frugiperda* Chikkaballapur, Karnataka	OL774673
149.	*Spodoptera frugiperda* Chikkaballapur, Karnataka	OL782595
150.	*Spodoptera frugiperda* Doddaballapur, Bangalore Rural, Karnataka	OL839203
151.	*Spodoptera frugiperda* Gauribidanur, Chikkaballapur, Karnataka	OL979475
152.	*Spodoptera frugiperda* Jolarpettai, Tirupattur, Tamil Nadu	OL979469
153.	*Spodoptera frugiperda* Namakkal, Tamil Nadu	OL979476
154.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW564033
155.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW564034
156.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW564035
157.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW564036

S. No.	ORGANISM	ACCESSION NUMBER
158.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW564037
159.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW564038
160.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW564039
161.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW564040
162.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW564041
163.	*Spodoptera frugiperda* Pennagaram, Dharmapuri, Tamil Nadu	MW564042
164.	*Spodoptera frugiperda* Punjab	OL774682
165.	*Spodoptera frugiperda* Raichur, Karnataka	MW584913
166.	*Spodoptera frugiperda* Raichur, Karnataka	MW584914
167.	*Spodoptera frugiperda* Raichur, Karnataka	MW564043
168.	*Spodoptera frugiperda* Raichur, Karnataka	MW564044
169.	*Spodoptera frugiperda* Raichur, Karnataka	MW564045
170.	*Spodoptera frugiperda* Raichur, Karnataka	MW564046
171.	*Spodoptera frugiperda* West Bengal	OL839204
	LEPIDOPTERA (*TPI*)	
172.	*Spodoptera frugiperda* Anantapur, Andhra Pradesh	MW493657
173.	*Spodoptera frugiperda* Attur, Bengaluru, Karnataka	MW493658
174.	*Spodoptera frugiperda* Chhattisgarh	OL999572
175.	*Spodoptera frugiperda* Chikkaballapur, Karnataka	OM069380
176.	*Spodoptera frugiperda* Chikkaballapur, Karnataka	MW493655
177.	*Spodoptera frugiperda* Dharmapuri, Tamil Nadu	MW493656
178.	*Spodoptera frugiperda* Doddaballapur, Bangalore Rural, Karnataka	OM069379
179.	*Spodoptera frugiperda* Gauribidanur, Chikkaballapur, Karnataka	OM069378
180.	*Spodoptera frugiperda* Gauribidanur, Chikkaballapur, Karnataka	MW493659
181.	*Spodoptera frugiperda* Jolarpettai, Tirupattur, Tamil Nadu	OM069377
182.	*Spodoptera frugiperda* Jolarpettai, Tirupattur, Tamil Nadu	MW493650
183.	*Spodoptera frugiperda* Ludhiana, Punjab	MW493660
184.	*Spodoptera frugiperda* Ludhiana, Punjab	MW493661
185.	*Spodoptera frugiperda* Ludhiana, Punjab	MW493662
186.	*Spodoptera frugiperda* Ludhiana, Punjab	MW493663
187.	*Spodoptera frugiperda* Ludhiana, Punjab	OL999569
188.	*Spodoptera frugiperda* Manipur	MW493653
189.	*Spodoptera frugiperda* Mizoram	MW493654

S. No.	ORGANISM	ACCESSION NUMBER
190.	*Spodoptera frugiperda* Namakkal, Tamil Nadu	OM069376
191.	*Spodoptera frugiperda* Punjab	OL999568
192.	*Spodoptera frugiperda* Sathanur, Perambalur, Tamil Nadu	MW493649
193.	*Spodoptera frugiperda* Tripura	OL999570
194.	*Spodoptera frugiperda* Tripura	MW493651
195.	*Spodoptera frugiperda* Visakhapatnam, Andhra Pradesh	OM069375
196.	*Spodoptera frugiperda* West Bengal	OL999571
THYSANOPTERA (*COI*)		
197.	*Euphysothrips minozzii*	MW914652
198.	*Thrips parvispinus*	OM095426
199.	*Thrips parvispinus*	OM095429
200.	*Thrips parvispinus*	OM085663
201.	*Thrips parvispinus*	OM085664
202.	*Thrips parvispinus*	OM078497
203.	*Thrips parvispinus*	MW883374
GENOME SEQUENCING AND TRANSCRIPTOME SEQUENCING		
204.	*Amrasca biguttula biguttula* Denovo Whole Genome Sequencing	SRX6943562 to SRX6943571
205.	*Amrasca biguttula biguttula* Stage-specific Denovo Transcriptome Sequencing	SRX6464084 to SRX6464091

5. IDENTIFICATION SERVICES

Dr Sunil Joshi

Sl. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	*Aphis gossypii, Greeni deapsidii*	Aphididae	Shivaji University, Kolhapur
2.	*Aphis* (*Toxoptera*) *aurantii, Aphis craccivora* (2), *A. gossypii, Brevicoryne brassicae, Greenidea* sp., *Greenidea* (*Trichosiphum*) *psidii* (2), *Myzus persicae*	Aphididae	Assam Agricultural University, Assam
	Coccus viridis	Coccidae	
	Paracoccus marginatus	Pseudococcidae	
3.	*Ferrisia virgata, Paracoccus marginatus, Phenacoccus manihoti, Pseudococcus jackbeardsleyi*	Pseudococcidae	Tirunelveli, Tamil Nadu
4.	*Melanaphis sacchari*	Aphididae	Acharya Ranga Agricultural University, Agricultural Research Station, Perumallapalle
5.	*Perissopneumon tamarindus*	Monophlebidae	ICAR-Central Agroforestry Research Institute, Jhansi, Uttar Pradesh
6.	*Ceroplastes* sp., *Saissetia oleae*	Coccidae	Central Horticultural Experiment Station, Bhubaneswar
	Rastrococcus iceryoides	Pseudococcidae	
	Perissopneumon tamatindus	Monophlebidae	
7.	*Pseudococcus longispinus*	Pseudococcidae	Regional Plant Quarantine Station, Hebbal, Bengaluru
8.	*Ceroplastes ceriferus, C. cirripediformis*	Coccidae	College of Horticulture, Kerala Agricultural University, Thrissur
	Icerya sp. (4), *Icerya purchasi*	Monophlebidae	
	Ferrisia virgata (67), *Paracoccus marginatus* (85), *Phenacoccus manihot* (76), *P. solenopsis* (2), *Pseudococcus jackbeardsleyi* (20), *P. longispinus, Rastrococcus iceryoides*	Pseudococcidae	
9.	*Aphis craccivora* (2)	Aphididae	ICAR-Indian Institute of Natural Resins and Gums, Namkum, Ranchi
	Coccus hesperidum (2), *C. longulus, Hemilecanium imbricans, Trijuba oculata*	Coccidae	
	Aonidiella orientalis	Diaspididae	
10.	*Parasaissetia nigra*	Coccidae	Institute of Wood Science and Technology, Bengaluru
	Nipaecoccus viridis	Pseudococcidae	
11.	*Aonidiella orientalis*	Diaspididae	Date Palm Research Station, S.D. Agricultural University, Gujarat
12.	*Planococcus citri, Pseudococcus* sp., *P. jackbeardsleyi, Sphilococcus* sp.	Pseudococcidae	Paresh Suri, Pune, Mumbai

13.	*Aphis craccivora* (3), *A. gossypii* (3), *A. nerii, A. spiraecola, Lipaphis erysimi, L. pseudobrassicae, Macrosiphoniella sanborni, Rhopalosiphum maidis* (4)	Aphididae	Anand Agricultural University, Anand, Gujarat
14.	*Aphis craccivora, A. spiraecola* (2), *Aphis sp.* (2), *Hysteroneura setariae* (2), *Uroleucon compositae*	Aphididae	University of Agricultural Sciences, Dharwad, College of Agriculture, Vijayapur, Karnataka
15.	*Ceroplastes* sp., *C. rusci, Drepanococcus chiton*	Coccidae	Punjab Agricultural University, Punjab
	Aonidiella aurantii, Aulacaspis tubercularis	Diaspididae	
	Ferrisia virgata, Nipaecoccus viridis	Pseudococcidae	
16.	*Aphis* (*Toxoptera*) *odinae*	Aphididae	ICAR-Directorate of Cashew Research, Dakshina Kannada, Puttur, Karnataka
	Ceroplastes sp.	Coccidae	
17.	*Geoica lucifuga, Tetraneura ? nigriabdominalis*	Aphididae	ICAR-Krishi Vigyan Kendra, Belagavi, Karnataka
	Saccharicoccus sacchari	Pseudococcidae	
18.	*Ceroplastes cirripediformis*	Coccidae	ICAR-Indian Institute of Horticultural Research, Bengaluru
	Rastrococcus iceryoides	Pseudococcidae	
19.	*Icerya* sp., *I. purchasi* (2)	Monophlebidae	Dr Reena, Jammu
20.	*Paracoccus marginatus* (2), *Phenacoccus solenopsis* (2)	Pseudococcidae	Navsari Agricultural University, Gujarat
21.	*Aphis spiraecola, Hydaphis coriandri*	Aphididae	University of Agricultural Sciences, Dharwad, Karnataka
22.	*Cerataphis brasiliensis*	Aphididae	ICAR - Central Plantation Crops Research Institute, Regional Station, Vittal, Karnataka
	Icerya aegyptiaca	Monophlebidae	
23.	*Aphis craccivora* (3), *A. gossypii* (14), *A. nerii, A. spiraecola, Macrosiphum euphorbiae, Melanaphis sacchari, Myzus persicae* (4), *Phorodon cannabis* (3), *Rhopalosiphum maidis, R. rufiabdominale*	Aphididae	Central Institute of Medicinal and Aromatic Plants, Lucknow
	Antecerococcus indicus, Ceroplastes cirripediformis, Coccus longulus, Pulvinaria polygonata, P. psidii, Saissetia oleae	Coccidae	
	Lindinga spisrosii	Diaspididae	
	Icerya pilosa, I. purchasi (3)	Monophlebidae	
	Coccidohystrix insolita (2), *Dysmicoccus carens, Ferrisia virgata, Nipaecoccus viridis, Paracoccus marginatus* (2), *Rastrococcus iceryoides*	Pseudococcidae	
24.	*Paracoccus marginatus*	Pseudococcidae	ICAR-Central Tuber Crops Research Institute, Sreekariyam, Thiruvananthapuram, Kerala

25.	*Aphis gossypii*	Aphididae	University of Horticultural Sciences, Shivamogga, Karnataka
	Dysmicoccus brevipes	Pseudococcidae	
26.	*Rhopalosiphum rufiabdominale*	Aphididae	University of Agricultural Science, Bengaluru (GKVK)
	Insignorthezia insignis	Coccidae	
27.	*Paracoccus marginatus, Pseudococcus jackbeardsleyi*	Pseudococcidae	ICAR- National Bureau of Agriultural Insect Resources, Bengaluru
28.	*Coccido hystrixinsolita*	Pseudococcidae	ICAR-Indian Institute of Pulses Research, Kanpur, Uttar Pradesh
29.	*Ceroplastes* sp.	Coccidae	Karmaveer Bhurao Patil Mahavidyalaya, Pandharpur, Maharashtra
30.	*Schoutedenia emblica*	Aphididae	University of Agricultural and Horticultural Sciences, Bagalkot
	Insignorthezia insignis	Coccidae	
	Duplaspidiotus sp.	Diaspididae	
	Nipaecoccus viridis	Pseudococcidae	
31.	*Uroleucon compositae*	Aphididae	University of Agriultural Sciences, Raichur
32.	*Ceroplastes* sp. (2), *Coccus longulus, C. viridis, Insignorthezia insignis, Parasaissetia nigra, Trijuba oculata, Vinsonia stellifera*	Coccidae	Indian Institute of Science, Bengaluru
	Aulacaspis crawii	Diaspididae	
	Drosicha sp. (2), *Icerya seychellarum, Labioproctus poleii*	Monophlebidae	
	Antonina graminis, Nipaecoccus viridis (2), *Paracoccus marginatus* (2), *Planococcus* sp. (2), *Rastrococcus iceryoides, Phenacoccus solenopsis*	Pseudococcidae	
33.	*Coccus longulus, Kilifia acuminata, Pulvinaria* sp. (4), *Saisetia* sp.	Coccidae	Andaman & Nicobar Regional Centre, Zoological Survey of India, Port Blair
	Duplaspidiotus sp.	Diaspididae	
	Icerya seychellarum	Monophlebidae	
	Nipaecoccus viridis	Pseudococcidae	
34.	*Drepanococcus* sp.	Coccidae	Regional Agricultural Research Station, Nandyal
35.	*Aphis gossypii* (3), *Aphis spiraecola, Hydaphis coriandri* (4)	Aphididae	National Research Centre on Seed Spices, Ajmer, Rajasthan
36.	*Ferrisia virgata, Kiritshenkella sacchari, Paracoccus marginatus, Planococcus citri* (2), *Phenacoccus solenopsis* (2)	Pseudococcidae	Govind Ballabh Pant University Of Agriculture And Technology, Pantnagar, Uttarkhand

37.	*Megapulvinaria maxima*	Coccidae	ICAR-Directorate of Medicinal and Aromatic Plant Research, Boriavi, Anand, Gujarat
38.	*Phenacoccus manihoti* (30)	Pseudococcidae	Farmers fields from Tirupur & Dharmapuri, Tamil Nadu
39.	*Dactylopius ceylonicus, Rastrococcus iceryoides*	Pseudococcidae	Vathalmalai, Tamil Nadu
40.	*Kiritshenkella lingnanai, Phenacoccus saccharifolii*	Pseudococcidae	ICAR-Sugarcane Breeding Institute, Veerakeralam, Coimbatore
41.	*Coccus longulus, Saissetia oleae*	Coccidae	ICAR – Krishi Vigyan Kendra, Chintamani, Karnataka
42.	*Aphis gossypii, A. spiraecola*	Aphididae	St. Joseph's College, Bengaluru, Karnataka
	Antecerococcus indicus, Ceroplastes sp., *Coccus* sp., *C. hesperidum, Saissetia coffeae*	Coccidae	
	Antonina sp., *Nipaecoccus viridis, Paracoccus marginatus* (2), *Phenacoccus solenopsis, Pseudococcus longispinus* (2)	Pseudococcidae	

Dr K. Sreedevi

SI. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	*Aulacophora* sp.	Chrysomelidae	Regional Agricultural Research Station, Anakapalle
	Hydrophilid beetle	Hydrophilidae	
	Adoretus duvauceli, A. lasiopygus, Apogonia sp., *Maladera rufocuprea, Schizonycha fuscescens*	Scarabaeidae	
2.	*Celosterna scabrator, Stromatium barbatum*	Cerambycidae	College of Agriculture, Vijayapura, Karnataka
3.	*Adoretus* sp., *A. simplex, Anomala* sp., *A. bengalensis, A. cantor, Digitonthophagous gazelle, Heteronychus* sp., *Holotrichia nagpurensis, Idionycha excise, Onitis* sp., *Penotodon* sp., *Schizonycha ruficollis*	Scarabaeidae	Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarkhand
4.	*Anomala* sp., *Brahmina* sp., *Hetreronychus* sp., *Holotrichia sikkimensis, Maladera* sp., *Oryctes* sp.	Scarabaeidae	Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Shalimar, Kashmir
5.	*Sternocera chrysis*	Buprestidae	Punjab Agricultural University, Ludhiana
	Pterostichus sp.	Carabidae	
	Elaterid larva	Elateridae	
	Lucanid beetle	Lucanidae	
6.	*Megalodacne* sp.	Erotylidae	ICAR-National Research Centre for Orchids, Pakyong, Sikkim
	Aethina tumida	Nitidulidae	

7.	Ground beetle	Carabidae	Regional Agricultural Research Station, Anakapalle
	Aulacophora sp.	Chrysomelidae	
	Bugs	Pentatomidae	
	Adoretus sp., *A. bicaudatus, A. duvauceli, A. lasiopygus*, *Heteronychus* sp., *Hybosorus* sp., *Maladera rufocuprea*, *Schizonycha fuscescens*	Scarabaeidae	
8.	*Anomala varicolor, Holotrichia consanguinea, H. nagpurensis, H. serrata*, *Schizonycha ruficollis*	Scarabaeideae	Farmer, Ghaziabad
9.	*Acanthoscelis* sp.?	Carabidae	Krishi Vigyan Kendra, Tavanur, Malappuram
	Popillia complanata	Scarabaeideae	
10.	Bugs	Plataspidae	ICAR-Indian Institute of Natural Resins and Gums, Ranchi
	Adoretus sp., *A. versutus, Apogonia* sp., *Holotrichia* sp. 1, *Holotrichia* sp. 2, *H. rufoflava, Idionycha excisa, Schizonycha ruficollis*	Scarabaeidae	
11.	*Popillia* sp., *P. complanata*	Scarabaeidae	College of Agriculture, Vellanikkara, Thrissur
12.	*Oryzaephilus surinamensis*	Silvanidae	ICAR- National Research Centre for Grapes, Pune
13.	*Holotrichia serrata*	Scarabaeidae	Krishi Vigyan Kendra, Chintamani, Karnataka
14.	*Adoretus* sp. 1, *Adoretus* sp. 2, *A. versutus, Anomala bengalensis, A. dorsalis, Holotrichia* sp., *Schizonycha fuscescens*	Scarabaeidae	ICAR-Central Agroforestry Research Institute, Jhansi
15.	*Brahmina coriacea, B. flavosericea, Holotrichia longipennis, Maladera* sp., *Melolontha cuprescens, Mimela* sp.	Scarabaeidae	ICAR-Central Potato Research Institute, Shimla
16.	*Chrysochus* sp.	Chrysomelidae	ICAR-Indian Institute of Horticultural Research, Bengaluru

Dr G. Mahendiran

SI. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	*Sitophilus oryzae*	Curculionidae	Government College of Pharmacy, Bengaluru, Karnataka
2.	*Hypera postica*	Curculionidae	ICAR-National Research Centre on Seed Spices, Ajmer, Rajasthan
3.	*Lepidospyris demssia, Rhynchaenus mangiferae*	Curculionidae	Punjab Agricultural University, Ludhiana, Punjab
4.	*Lepidospyris demssia, Rhynchaenus mangiferae*	Curculionidae	Punjab Agricultural University, Ludhiana, Punjab
5.	*Sitophila* (subtribe)	Curculionidae	University of Horticultural Sciences, Bagalkot, Karnataka
6.	*Sitophilus oryzae*	Curculionidae	University of Agricultural Sciences, Dharwad, Karnataka
7.	*Barioscapus cordiae*	Curculionidae	ICAR-Central Agroforestry Research Institute, Jhansi, Uttar Pradesh
8.	*Callosobruchus maculatus*	Chrysomelidae	ICAR-National Bureau of Agricultural Insect Resources, Bengaluru

Dr Ankita Gupta

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	*Charops bicolor*	Ichneumonidae	United States of America
2.	*Campoletis chlorideae*	Ichneumonidae	Shivaji University, Kolhapur
	Cotesia ruficrus	Braconidae	
	Eurytoma sp.	Eurytomidae	
3.	*Chelonus* sp.	Braconidae	College of Agriculture Navsari Agriculture University, Gujarat
4.	*Halticoptera* sp.	Pteromalidae	ICAR-Indian Grassland and Fodder Research Institute, Dharwad, Karnataka
	? *Ephedrus* sp.	Braconidae:	
5.	*Aenasius arizonensis*, *Anagyrus dactylopii*, *Homalotylus turkmenicus*, *Prochiloneurus* sp1., *Prochiloneurus* sp2., *Pseudleptomastix mexicana*	Encyrtidae	ICAR – Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh
	Chartocerus sp.	Signiphoridae	
	Marietta leopardina	Aphelinidae	
	Aprostocetus sp.	Eulophidae	
6.	*Diaeretiella rapae*	Braconidae	ICAR – Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh
7.	*Eriborus trochanteratus*	Ichneumonidae	All India Coordinated Research Project on Biocontrol, University of Agricultural Sciences, Raichur, Karnataka
8.	*Cotesia ruficrus*, *Rogas* sp.	Braconidae	All India Coordinated Research Project on Biocontrol, University of Agricultural Sciences, Raichur, Karnataka
	Brachymeria sp.	Chalcididae	
	Eurytoma sp.	Eurytomidae	
9.	*Trathala flavoorbitalis*	Ichneumonidae	Assam Agricultural University, Jorhat, Assam
10.	*Allotrapa* sp.	Platygastridae	ICAR-Indian Agricultural Research Institute, New Delhi
11.	*Glyptapanteles obliquae*	Braconidae	ICAR –Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat

Dr Salini S.

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	*Oxycarenus laetus*	Oxycarenidae	Nunhems Seeds
2.	*Halyomorpha picus*	Pentatomidae	Institute of Wood Science and Technology, Bengaluru
3.	*Andrallus spinidens*	Pentatomidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
4.	*Bagrada hilaris*	Pentatomidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
5.	*Perillus bioculatus*	Pentatomidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
6.	*Dolycoris indicus*	Pentatomidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
7.	*Eysarcoris montivagus*	Pentatomidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
8.	*Agonoscelis nubilis*	Pentatomidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
9.	*Nezara vitridula* var. *smaragdula, N. viridula*	Pentatomidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
10.	*Acrosternum gramineum*	Pentatomidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
11.	*Agaeus tessellatus*	Pentatomidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
12.	*Cantao ocellatus*	Scutelleridae	Central Institute of Medicinal and Aromatic Plants, Lucknow
13.	*Plautia crossota*	Pentatomidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
14.	*Hermolaus rolstoni*	Pentatomidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
15.	*Cletus* sp.	Coreidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
16.	*Coridius chinensis*	Dinidoridae	Central Institute of Medicinal and Aromatic Plants, Lucknow
17.	*Graptostethus servus*	Lygaeidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
18.	*Spilostethus pandurus*	Lygaeidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
19.	*Lygaeus* sp.	Lygaeidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
20.	*Leptocorisa oratorius*	Alydidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
21.	*Riptortus pedestris*	Alydidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
22.	*Clavigralla gibbosa*	Coreidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
23.	*Acanthaspis siva*	Reduviidae	Central Institute of Medicinal and Aromatic Plants, Lucknow

24.	*Amyotea malabarica*	Pentatomidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
25.	*Perillus bioculatus*	Pentatomidae	Magadh University, Bodhgaya, Bihar
26.	*Bagrada hilaris*	Pentatomidae	Magadh University, Bodhgaya, Bihar
27.	*Geotomus pygmaeus*	Cydnidae	ICAR-Central Tobacco Research Institute, Rajahmudry, Andhra Pradesh
28.	*Pentatoma punctipes*	Pentatomidae	Central Agricultural University, Pasighat, Arunachal Pradesh
29.	*Ectatops* sp.	Pyrrhocoridae	Central Agricultural University, Pasighat, Arunachal Pradesh
30.	*Cletus trigonus*	Coreidae	Central Agricultural University, Pasighat, Arunachal Pradesh
31.	*Eysarcoris montivagus* Distant	Pentatomidae	Central Agricultural University, Pasighat, Arunachal Pradesh
32.	*Euagoras* sp.	Reduviidae	Central Agricultural University, Pasighat, Arunachal Pradesh

Dr K.J. David

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	*Dideopsis aegrota*, *Eristalinus arvorum*, *Eristalinus* sp.	Tephritidae	ICAR-Indian Institute of Horticultural Research, Bengaluru
	Chrysomya bezziana, *Stomorrhina* spp.	Calliphoridae	
2.	*Bactrocera dorsalis*	Tephritidae	Navsari Agricultural University, Gujarat
3.	*Bactrocera dorsalis, B. nigrofemoralis, B. zonata, Zeugodacus cucurbitae, Z. scutellaris, Z. tau*	Tephritidae	ICAR-Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora
4.	*Haematobia* spp., *Stomoxys* sp.	Muscidae	Kerala Agricultural University, Thrissur
	Atylotus sp.	Tabanidae	
5.	*Anatrichus* sp., *Merochlorops* sp.	Chloropidae	University of Agricultural Sciences, Raichur
	Sepedon ferruginosa	Sciomyzidae	
6.	*Bactrocera correcta, B. dorsalis*	Tephritidae	St. Joseph's College, Bangalore
7.	*Episyrphus balteatus*, *E. viridaureus*, *Ischiodon scutellaris*, *Melanostoma* sp.	Syrphidae	Punjab Agriculture University, Ludhiana
	Atylotus sp.	Tabanidae	
8.	*Bactrocera dorsalis, Zeugodacus cucurbitae*	Tephritidae	Agriculture College and Research Institute, Madurai
9.	*Cryptochaetum* sp.	Cryptochaetidae	University of Agricultural and Horticultural Sciences, Shivamogga
	Cacoxenus sp.	Drosophilidae	
	Leucopis sp.	Chamaemyiidae	
	Megaselia sp.	Phoridae	
	Paragus sp.	Syrphidae	
10.	*Batrocera caryeae, B. dorsalis*	Tephritidae	College of Agriculture, Vellayani

11.	*Bactrocera caryeae, B. correcta, B. dorsalis, Dietheria fasciata Zeuodacus caudatus, Z. cucurbitae, Z. diversus, Z. trileantus, Z. tau*	Tephritidae	Agrinos India Pvt. Ltd., Bengaluru
12.	*Bactrocera dorsalis, Zeugodacus cucurbitae, Z. diversus, Z. tau*	Tephritidae	PI industries, Davanagere

Dr K. Selvaraj

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	*Rabdostigma myrtacei*	Aleyrodidae	Sri Konda Laxman Telangana State Horticultural University, Sangareddy, Telangana
2.	*Aleurodicus rugioperculatus*	Aleyrodidae	Central Agricultural University, Pasighat, Arunachal Pradesh
3.	*Aleurolobus barodensis*	Aleyrodidae	Mekalsuta sugars Pvt. Ltd., Badwani, Madhya Pradesh
4.	*Aleurodicus rugioperculatus, Aleurotrachelus atratus, Paraleyrodes bondari, P. minei*	Aleyrodidae	Vishweshwaraiah Canal Farm, Mandya, Karnataka
5.	*Aleurodicus dispersus, Bemisia tabaci*	Aleyrodidae	ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala
6.	*Aleurodicus dispersus*	Aleyrodidae	ICAR- Research Complex for NEH Region, Manipur
7.	*Aleurodicus rugioperculatus*	Aleyrodidae	Central Horticultural Experiment Station, ICAR- Indian Institute of Horticultural Research, Chettalli, Kodagu
8.	*Aleurodicus rugioperculatus, Paraleyrodes minei*	Aleyrodidae	University of Agricultural Sciences, Dharwad
9.	*Aleurodicus dispersus*	Aleyrodidae	Magadh University, Bodh Gaya, Bihar
10.	*Aleurodicus rugiopercultus*	Aleyrodidae	Forest Entomology Department, Uttarakhand
11.	*Acaudaleyrodes rachipora, Crescentaleyrodes semilunaris, Rhachisphora ixorae, Tetraleurodes acaceae*	Aleyrodidae	University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka

Dr Rachana R.R.

S. No.	Taxon/taxa identified	Group /family	Service provided to
1.	*Thrips palmi* (2)	Thripidae	University of Agricultural Sciences, Dharwad
	Scirtothrips dorsalis (2)	Thripidae	
2.	*Thrips palmi* (4)	Thripidae	Punjab Agricultural University, Ludhiana
	Scirtothrips dorsalis (2)	Thripidae	
	Thrips tabaci	Thripidae	
	Frankliniella schultzei	Thripidae	
3.	*Thrips tabaci* (3)	Thripidae	University of Horticultural Sciences, Bagalkot
	Thrips hawaiiensis	Thripidae	

4.	*Scirtothrips dorsalis*	Thripidae	University of Agricultural Sciences, Dharwad
5.	*Microcephalothrips abdominalis*	Thripidae	Punjab Agricultural University, Ludhiana
6.	*Anaphothrips sudanensis*	Thripidae	BASF Pvt. Ltd., Pune
7.	*Thrips parvispinus* (6)	Thripidae	University of Agricultural Sciences, Raichur
	Thrips hawaiiensis (3)	Thripidae	
8.	*Gynaikothrips uzeli*	Phlaeothripidae	Punjab Agricultural University, Ludhiana
9.	*Thrips parvispinus* (56)	Thripidae	ICAR-Indian Institute of Hortiultural Research, Bengaluru
10.	*Thrips parvispinus* (78)	Thripidae	ICAR-Indian Institute of Hortiultural Research, Bengaluru
11.	*Thrips parvispinus* (2)	Thripidae	Directorate of Plant Protection Quarantine and Storage, Bengaluru
	Thrips hawaiiensis	Thripidae	
	Thrips palmi	Thripidae	
12.	*Thrips parvispinus*	Thripidae	Directorate of Plant Protection Quarantine and Storage, Telangana
13.	*Thrips parvispinus* (2)	Thripidae	Krishi Vigyan Kendra, Rajendranagar
14.	*Thrips parvispinus* (2)	Thripidae	College of Horticulture, Mojerla
	Thrips palmi (2)	Thripidae	
15.	*Thrips parvispinus*	Thripidae	University of Horticultural Sciences, Bagalkot
	Thrips hawaiiensis	Thripidae	
16.	*Thrips parvispinus* (2)	Thripidae	Directorate of Plant Protection Quarantine and Storage, Andhra Pradesh
17.	*Thrips parvispinus* (2)	Thripidae	Vegetable Research Station, Rajendranagar
	Thrips hawaiiensis (2)	Thripidae	
	Thrips florum	Thripidae	
18.	*Thrips parvispinus* (2)	Thripidae	Syngenta Pvt. Ltd., Aurangabad
	Thrips hawaiiensis	Thripidae	
19.	*Thrips parvispinus*	Thripidae	Coverta agriscience Pvt Ltd., Telangana
	Thrips hawaiiensis	Thripidae	
	Frankliniella occidentalis	Thripidae	
	Frankliniella schultzei	Thripidae	
20.	*Thrips palmi* (2)	Thripidae	Coverta agriscience Pvt Ltd., Telangana
	Frankliniella schultzei	Thripidae	
	Microcephalothrips abdominalis	Thripidae	
	Thrips atactus	Thripidae	

21.	*Rhipiphorothrips cruentatus*	Thripidae	ICAR-Indian Institute of Natural Resins and Gums, Ranchi
	Rhipiphorothrips pulchellus	Thripidae	
	Scirtothrips dorsalis	Thripidae	
	Megalurothrips usitatus	Thripidae	
22.	*Scolothrips rhagebianus*	Thripidae	ICAR-National Bureau of Agricultural Insect Resources, Bengaluru
23.	*Thrips palmi*	Thripidae	University of Horticultural Sciences, Shivamogga
24.	*Pseudodendrothrips bhattii* (2)	Thripidae	Central Silk Board, Bengaluru
	Pseudodendrothrips mori (2)	Thripidae	
	Bathrips melanicornis	Thripidae	
25.	*Thrips parvispinus*		BASF Pvt. Ltd., Pune
	Thrips hawaiiensis		
26.	*Scirtothrips dorsalis* (3)	Thripidae	Central Institute of Medicinal and Aromatic Plants, Bengaluru
	Thrips palmi	Thripidae	
	Microcephalothrips abdominalis	Thripidae	
27.	*Thrips parvispinus* (9)	Thripidae	HM Clause Pvt Ltd., Bengaluru
	Scirtothrips dorsalis (3)	Thripidae	
	Haplothrips (*Haplothrips*) *gowdeyi*	Phlaeothripidae	
	Thrips hawaiiensis	Thripidae	
	Franklinothrips vespiformis (2)	Aeolothripidae	
	Frankliniella schultzei	Thripidae	
28.	*Megalurothrips usitatus* (3)	Thripidae	ICAR-Indian Institute of Pulses Research, Kanpur
	Megalurothrips distalis (3)	Thripidae	
	Scirtothrips dorsalis	Thripidae	
29.	*Thrips palmi* (4)	Thripidae	HM Clause Pvt Ltd., Bengaluru
	Thrips hawaiiensis	Thripidae	
30.	*Thrips florum*	Thripidae	ICAR-National Bureau of Agricultural Insect Resources, Bengaluru
	Thrips hawaiiensis	Thripidae	
	Scirtothrips dorsalis	Thripidae	
31.	*Indothrips bhushani*	Aeolothripidae	University of Agricultural Sciences, Raichur
	Scirtothrips dorsalis	Thripidae	
32.	*Thrips florum*	Thripidae	University of Agricultural Sciences, Bengaluru
	Thrips hawaiiensis	Thripidae	
	Scirtothrips dorsalis	Thripidae	
	Megalurothrips sp.	Thripidae	

33.	*Scirtothrips dorsalis* (2)	Thripidae	Punjab Agricultural University, Ludhiana
	Thrips palmi	Thripidae	
	Thrips tabaci	Thripidae	
34.	*Thrips florum* (2)	Thripidae	University of Horticultural Sciences, Shivamogga
	Thrips hawaiiensis (2)	Thripidae	
	Thrips orientalis	Thripidae	
35.	*Frankliniella schultzei*	Thripidae	ICAR-National Research Centre on Seed Spices, Ajmer
	Anascirtothrips arorai (2)	Thripidae	
	Thrips palmi (2)	Thripidae	
	Thrips tabaci	Thripidae	
	Scirtothrips dorsalis	Thripidae	
	Scirtothrips dorsalis	Thripidae	
36.	*Scirtothrips dorsalis* (2)	Thripidae	Coverta agriscience Pvt Ltd., Telangana
	Frankliniella schultzei	Thripidae	
	Thrips palmi (2)	Thripidae	
	Thrips hawaiiensis	Thripidae	
37.	*Thrips palmi* (9)	Thripidae	Coverta agriscience Pvt Ltd., Telangana
	Scirtothrips dorsalis (10)	Thripidae	
	Frankliniella schultzei (3)	Thripidae	
	Frankliniella occidentalis (2)	Thripidae	
	Haplothrips (*Haplothrips*) *gowdeyi*	Phlaeothripidae	
	Thrips florum (2)	Thripidae	
	Thrips hawaiiensis (2)	Thripidae	
38.	*Thrips florum* (9)	Thripidae	Krishi Vigyan Kendra, Guntur
	Thrips hawaiiensis (8)	Thripidae	
39.	*Thrips palmi*	Thripidae	University of Agricultural Sciences, Raichur
	Scirtothrips dorsalis (3)	Thripidae	
	Frankliniella schultzei	Thripidae	
40.	*Frankliniella schultzei*	Thripidae	Krishi Vigyan Kendra, Guntur
	Thrips palmi	Thripidae	
41.	*Thrips florum*	Thripidae	ICAR-Indian Institute of Hortiultural Research, Bengaluru
	Thrips hawaiiensis	Thripidae	
42.	*Scirtothrips dorsalis* (4)	Thripidae	ICAR-Indian Institute of Hortiultural Research, Bengaluru
	Thrips palmi	Thripidae	
	Diarthrothrips nimbus	Thripidae	
43.	*Thrips florum* (3)	Thripidae	ICAR-Indian Institute of Hortiultural Research, Bengaluru
	Thrips hawaiiensis (3)	Thripidae	

Dr Omprakash Navik

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	*Trichogramma chilonis* (2)	Trichogrammatidae	Anand Agricultural University, Anand, Gujarat
2.	*Trichogramma chilonis* (8)	Trichogrammatidae	Odisha University of Agriculture & Technology, Bhubaneswar, Odisha
3.	*Trichogramma chilonis*	Trichogrammatidae	University of Agricultural and Horticultural Sciences, Shimoga, Karnataka
4.	*Trichogramma chilonis T. chilotrae* (6)	Trichogrammatidae	Central Institute of Medicinal and Aromatic Plants, Lucknow
5.	*Trichogramma chilonis* (2)	Trichogrammatidae	ICAR-Indian Agricultural Research Institute, New Delhi

Dr R.S. Ramya

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	*Senometopia quarta*	Tachinidae	Directorate of Cashew Research, Puttur
2.	*Senometopia illota*	Tachinidae	ICAR-Indian Agricultural Research Institute, New Delhi
3.	*Senometopia* sp.	Tachinidae	University of Calicut
4.	*Thecocarcelia* sp.	Tachinidae	University of Calicut
5.	*Argyrophylax* sp.	Tachinidae	University of Calicut

Dr M. Sampath Kumar

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	*Neoscona theisi* (2)	Araneidae	Punjab Agricultural University, Ludhiana
	Oxyopes hindostanicus (2), *Oxyopes* sp. (3)	Oxyopidae	
	Bianor angulosus (2), *Bianor* sp.	Salticidae	
	Leucauge sp. (2), *Tetragnatha nitens*	Tetragnathidae	
2.	*Pardosa* sp. (4)	Lycosidae	University of Agricultural Sciences, Raichur
	Bianor balius, *Langona* sp. (4)	Salticidae	

3.	*Neoscona* sp. (4)	Araneidae	University of Agricultural Sciences, Bengaluru
	Cheiracanthium approximatum (2), *Cheiracanthium* sp. (10)	Cheiracanthiidae	
	Draposa lyrivulva (2), *Draposa* sp. (2), *Lycosa* sp. (4), *Pardosa* sp. (20),	Lycosidae	
	Oxyopes hindostanicus (5), *O. naliniae* (2), *O.* ? *pankaji*, *Oxyopes* sp. (6), *Peucetia* sp. (2)	Oxyopidae	
	Myrmarachne sp. (3), *Phintella* sp. (2), *Rhen flavigera* (5)	Salticidae	
	Indoxysticus minutes, Runcinia sp. (3), *Thomisus* sp. (2)	Thomisidae	
4.	*Araneus* sp., *Neoscona* sp.	Araneidae	University of Agricultural Sciences, Raichur
	Cheiracanthium sp.	Cheiracanthiidae	
	Runcinia sp.	Thomisidae	
5.	*Oxyopes* sp.	Oxyopidae	ICAR - Directorate of Floricultural Research, Pune
	? *Stenaelurillus* sp.	Salticidae	
	Thomisus ? *spectabilis, Thomisus* sp.	Thomisidae	
6.	*Olios ? lamarcki*	Sparassidae	University of Agricultural and Horticultural Sciences, Shimoga
7.	*Argiope* sp., *Gasteracantha* sp., *Neoscona* sp.	Araneidae	University of Agricultural Sciences, Dharwad

6. EXTENSION ACTIVITIES

ICAR-NBAIR organized demonstration on biological control of rugose spiralling whitefly using *Isaria fumosorosea*

Demonstration on biological control of rugose spiralling whitefly using *Isaria fumosorosea* ICAR-NBAIR conducted an awareness-cum demonstration on biological control of invasive rugose spiralling whitefly in the coconut gardens of Ramanagara District, Karnataka on 30 January 2021. Mr R. Shanker, Honourable Minister of Horticulture and Sericulture, Government of Karnataka reviewed the status of whitefly infestation in coconut gardens in the district and interacted with farmers and stakeholders. He showed keen interest on the initiatives taken jointly by Department of Horticulture and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru to contain the pest. The importance of augmentation and conservation of the parasitoid, *Encarsia guadeloupae* and foliar application of entomopathogenic fungus, *Isaria fumosorosea* for the management of rugose spiralling whitefly was demonstrated to farmers. The programme was jointly organised by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru and Department of Horticulture, Government of Karnataka.

ICAR-NBAIR promoted biological control among the tribal farmers in Yelagiri hills, Tamil Nadu

NBAIR in association with KVK, Vellore organized a farmers' awareness programme on biological control-cum-distribution of inputs/kits under tribal sub-plan on 15 February 2021 at Yelagiri, Thirupathur district, Tamil Nadu. The importance of biological control and use of macrobials and microbials for insect pest management without using harmful insecticides to preserve the fragile hill ecosystem was explained. A total of 50 farm families from the tribal settlements belong to the villages, Yelagiri and Mangalam benefitted from this programme. The bioagents, viz. *Trichoderma*, *Pseudomonas*, *Bacillus* spp., *Pochonia chlamydosporia*, *Metarhizium anisopliae*, *Beauveria bassiana*, EPN, predators and parasitoids and kits comprising of traps with insect lures, battery-operated sprayers, solar insect light traps with single stand and adjustable stand, mega solar insect light traps and electrical insect light traps were distributed to the farmers.

ICAR-NBAIR organised an awareness programme on cassava mealybug and fall armyworm to the farmers of Tamil Nadu

ICAR-NBAIR organised an awareness programme on cassava mealybug and management of fall armyworm (FAW) to the farmers belonged to Dharmapuri district, Tamil Nadu on 3 September 2021 at NBAIR Hebbal campus. As a part of Tamil Nadu state programme under Department of Horticulture and Plantation crops, a total of 25 farmers along with two staff were visited NBAIR. The morphology of cassava mealybug, its mode of dispersal, damage symptoms, life stages of the invasive pest and available management options were explained to the farmers. The biocontrol-based

module for management of fall armyworm was also explained to the farmers in detail. The technical folders and advisories on cassava mealybug and fall armyworm brought by this bureau in regional languages was distributed to the farmers. The various issues raised by the farmers on the management of cassava mealybug and fall armyworm were addressed by the scientists. HRD cell of the bureau coordinated this awareness programme.

Large scale field demonstration of "WP formulation of *Heterorhabditis indica* NBAII H38" was taken up for the management of fall army worm in maize at Chikaballapura and Kolar, Karnataka.

ICAR-NBAIR & ICAR-Central Inland Fisheries Research Institute, Barrackpore jointly organised Demonstration meeting on 'Mass Production of Black soldier fly for utilisation as fish feed' at Peechi, Kerala

ICAR-National Bureau of Agricultural Insect Resources, Bengaluru and ICAR-Central Inland Fisheries Research Institute, Regional centre Bengaluru jointly organised a one day Discussion cum Demonstration meeting on 'Mass Production of Black soldier fly for utilisation as fish feed' at Government Fish Seed Hatchery at Peechi, Thrissur district, Kerala. Around 35 participants from State Department of Fisheries, Private fish hatcheries and farmers participated in the programme. The global scenario of using insect protein in aquacultural diets and progress made in use of BSF as a protein supplement in fish feed was explained. The mass production of black soldier fly for utilization as fish feed' was explained. The life cycle of the insect, potential of different waste substrates that favours quicker multiplication of the insect was deliberated. The factors affecting the culture establishment of the insect was also explained. Few participants who were involved in mass culturing of black soldier fly interacted during the programme and expressed their problems associated with the breeding. The problems related to rearing of black soldier fly like breeding of other flies in the waste bins and methods to overcome the same was discussed. The event was covered in the local daily print and electronic media for the benefit of the stakeholders.

7. AWARDS AND RECOGNITIONS

Dr T.M. Shivalingaswamy

Chaired a technical session on 'Role of Pollinators in Agriculture' during the 'National Conference on Priorities in Crop Protection for Sustainable Agriculture' organised by Central Agricultural University, Imphal, 17 March 2021.

Dr T. Venkatesan

Elected as Fellow of National Academy of Agricultural Sciences by National Academy of Agricultural Sciences, New Delhi.

Vice-President, Society for Biocontrol Advancement, Bengaluru.

Vice-President, Association for Advancement in Horticultural Ecosystems, Bengaluru.

Served as panelist for the Brainstorming session on 'Classical and molecular taxonomy - Standalone or Complimentary', ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 18 November 2021.

Recognized as Reviewer for BMC Genomics 2021.

Reviewer as International Journal of Pest Management.

Reviewer for Indian Journal of Entomology.

Dr K. Srinivasamurthy

Received 'Achiever Award-2020' from Society for Advancement of Human and Nature (SADHNA) Dr Y. S. Parmar University of Horticulture & Forestry, Nauni, Solan.

Received 'Excellence in Research Award 2021' from Agro Environmental Developmental Society, Rampur, Uttar Pradesh.

Received 'Outstanding Achievement Award 2021' in the International Conference on Research Initiatives for Agriculture, Biotechnology and Allied Sciences, New Age Mobilisation, New Delhi, 23 April 2021.

Received 'Outstanding Agricultural Scientist Award 2021' from Dr. B. Vasantharaj David Foundation, Chennai.

Dr P. Sreerama Kumar

Received membership through the President's Circle Program, Entomological Society of America, USA, for the year 2021.

Editor, SIP Newsletter, Society for Invertebrate Pathology, USA, for 2021.

Member, Publications Committee, Society for Invertebrate Pathology, USA, for the year 2021.

Invited Speaker, Brainstorming Meeting on Integrated Management of Sap-Sucking Pests (Thrips and Mites) of Mulberry – Current Status and Future Prospects, organised by the Karnataka State Sericulture Research and Development Institute, Thalaghattapura, Bengaluru, 23 February 2021.

Served as co-chairman for the Technical Session III: Biological control of Plant Diseases (04 March 2021) for the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR– National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Served as convenor for the 'National Webinar on Plant Diseases in Eastern and Northeastern India: Current dynamics and proposed action plan for their Management' organised by Department of Plant Pathology, College of Agriculture (CAT), Lembucherra, Tripura in collaboration with the All-India Coordinated Research Project on Pigeonpea (Tripura Centre, CAT) and in association with the ICAR–National Bureau of Agricultural Insect Resources (Bengaluru), 24–25 June 2021.

Served as Lead speaker for the 'National Webinar on Validation of IPM Strategies for Sustainable Agriculture in Present Indian Context' organised by Department of Agricultural Entomology, College of Agriculture, Tripura, in collaboration with Department of Botany, Rabindranath Thakur Mahavidyalaya, Sepahijala, Tripura, 10–11 August 2021.

Served as nodal officer for the Limited Departmental Competitive Examination for the promotion of one

Upper Division Clerk (UDC0 to Assistant, ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 20–21 September 2021.

Served as guest speaker for the 'Webinar on Biological Control of Insect Pests and Mites on Commercial Flower Crops' organised by ICAR–Directorate of Floricultural Research, Pune, 27 September 2021.

Served as Guest Lecturer/ Expert for the 'Virtual Workshop on Mites and Thrips Management in Mulberry' organised by Central Sericultural Research and Training Institute, Mysuru, 5 October 2021.

Served as Chairman, Departmental Promotion Committee for promotion of Skilled Supporting Staff to Technician, 16 October 2021.

Served as Member, Ph.D. Advisory Committee for Ms Aaliya Afroz of Indira Gandhi Krishi Vishwavidyalaya, Raipur.

Dr R. Rangeshwaran

Delivered invited talk on "Entrepreneurship development through production of *Bacillus thuringiensis*" in training programme on "Entrepreneurship Development in Pest Management for Youth" organised by College of Agriculture, Central Agricultural University, Imphal under IDP-NAHEP, 30 June 2020.

Dr K. Subaharan

Delivered a talk on 'Pest management in Kitchen Garden' to Anganwadi workers and development workers at National Institute of Public Cooperation and Child Development (NIPPCID), 2 March 2021.

Delivered a talk on 'Pest management in Kitchen Garden' to Anganwadi workers and development workers at National Institute of Public Cooperation and Child Development (NIPPCID), 9 March 2021.

Delivered a lead talk on 'Controlled release pheromone driven technology for pest management' in Technical session XI on Biocompatible approaches in pest management during the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Delivered a lead talk on 'Attractants and repellents for Agricultural and Veterinary Pests' during the 'National Conference on Priorities in Crop Protection for Sustainable Agriculture' organised by Central Agricultural University, Imphal, 17 March 2021.

Delivered an invited talk on 'Clean and green pest management' in connection with Celebration of Science Day organised by Sree Parasakthi College, Courtallam, 1 March 2021.

Delivered an invited talk on 'Harnessing the Space technology for Pest Management' as a part of Atal Faculty Development Programme organised by CMR Institute of Technology, Bengaluru, 7 September 2021.

Delivered a talk during the farmers scientist interface meeting during October 2021.

Delivered an invited talk on 'Integrated Pest Management (IPM) approaches for Invasive pest management', 27–28 August 2021.

Delivered a talk on 'Integrated Pest Management of coconut for the Southern States to Scientists from KVK' organised by ICAR–Agricultural Technology Application Research Institute (ATARI), Bengaluru and ICAR–National Centre for Integrated Pest Management, New Delhi, 23 October 2021.

Delivered an invited talk on 'Chemoecological approaches in pest management' organised by BIPA on 29 October 2021.

Served as a committee member for preparation of impact analysis document of ICAR–National Bureau of Agricultural Insect Resources, Bengaluru to Indian Council of Agricultural Research, New Delhi.

Served as an expert for screening the Department of Biotechnology- Biotechnology Industry Research Assistance Council (BIRAC) Gandhian Young Technological Innovation (GYTI) proposals (10 Nos) submitted through Indian Institute of Technology, Kanpur Incubation Centre.

Served as an expert for Screening the Department of Biotechnology- Biotechnology Industry Research Assistance Council (BIRAC) BIG Grant 17 proposal submitted through ICAR–National Academy of Agricultural Research and Management, Idea

Incubation Centre.

Served as a member for regularization of Young Professional I and II at ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 27 March 2021.

Served as a committee member for a qualifying examination of Mr Nidhosh, Ph.D. Entomology scholar at University of Agricultural Sciences, Bengaluru, 16 February 2021.

Served as an external examiner for the evaluation of M.Sc. thesis of Ms Shashi Bala, Biotechnology Division at University of Agricultural Sciences, Dharwad, 7 February 2021.

Invited to serve as an expert for selecting the Research Associates at Indian Council of Medical Research–National Institute of Malaria Research (NIMR) Field Unit, 30 April 2021.

Served as an external examiner to conduct the qualifying examination for M.Sc. (Agrl. Entomology) students at Pandit Jawaharlal Nehru College of Agriculture and Research Institute (PAJANCOA) and Pondicherry University, 28 September 2021.

Served as Co-chair for a National seminar at ICAR–Central Plantation Crops Research Institute Regional Station Kayamkulam, 23 August 2021.

Served as a Judge for technical presentations during the National seminar at ICAR–Central Plantation Crops Research Institute Regional Station Kayamkulam, 23 August 2021.

Served as an Associate Editor for International Journal for Tropical Insect Science.

Served as an Associate Editor and reviewer for the Indian Journal of Entomology.

Served as a reviewer for Scientific Reports.

Served as a reviewer for Entomon.

Served as a reviewer for Current Science.

Served as verification officer for Agricultural Knowledge Management Unit (AKMU) of ICAR–National Bureau of Agricultural Insect Resources, Bengaluru.

Served as external examiner for M.Sc. (Agrl. Entomology) thesis at Tamil Nadu Agricultural University, Coimbatore, 13 December 2021.

Served as a selection committee member for recruiting the Senior Research Fellow under the Consortium Research Platform of Genomics project at ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3 December 2021.

Served as a member of DPC for promotion of Lower Division Clerk at ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 30 June 2021.

Served as an external expert member for selection of Young Professional I and II at ICAR– Agricultural Technology Application Research Institute (ATARI) Bengaluru Zone, 19–20 July 2021.

Served as a resource person for Farmers Scientist Interface meeting, held at ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 28 September 2021.

Served as nodal officer for ICAR–National Academy of Agricultural Research Management drive dashboard and National Science and technology survey for 2020–2021.

Served as external examiner for Jain University, 17 December 2021.

Received Dr M. Swamiappan award for outstanding contribution in Biointensive IPM (BIPM). from Society for Biocontrol Advancement (SBA), Bengaluru during Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Received Best Poster Presentation award for the paper entitled "Toxicity and repellence of geranium oil against Whitefly *Bemisia tabaci*" at Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Best Oral Presentation award for the paper entitled "Larvicidal activity of sweet basil, *Ocimum basilicum* nanoemulsion against dengue vector *Aedes aegypti* (Diptera: Culicidae)" at Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR– National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Dr G. Sivakumar

Delivered a Lead talk "Current research on entomopathogens of recent invasive insect pests in India' in the 'Second International Congress of Biological Control' organised by International Organization for Biological Control (IOBC), Davos, Switzerland, 26–30 April 2021.

Served as panel speaker in the technical session entitled "Management of invasive pest by South-South co-operation" in the 'Second International Congress of Biological Control' organised by International Organization for Biological Control (IOBC), Davos, Switzerland, 26–30 April 2021.

Delivered a talk on "Biological control of crop pests and diseases" in the Farmers seminar, Salem, Tamil Nadu, 17 July 2021.

Delivered a talk on "Microbial biopesticides for crop pests and disease management" in the Tribal Farmers Seminar organized by Regional Agricultural Research Station, Acharya N. G. Ranga Agricultural University (ANGRAU), Anakapalle at Killoguda village, Araku valley, Andhra Pradesh, 27 August 2021.

Dr M. Mohan

Nominated as Department of Biotechnology nominee for the Institute Biosafety Committee of University of Agricultural Sciences, Bengaluru.

Dr Mahesh Yandigeri

Received Best service worker award for the year 2021 during 28th Foundation Day celebrations of ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 19 October 2021.

Recognised as Post Graduate teacher for University of Horticultural Sciences, Udyanagiri, Navanagar, Bagalkot.

Recognised as Post Graduate teacher for University of Agricultural Sciences, Bengaluru.

Dr A. Kandan

Acted as resource person in National Training-cum-webinar "On farm and mass production protocols of bioagents and microbial agents for Fall armyworm management" under FAO project TCP/IND/3709 (E) "Time–critical measures to support early warning and monitoring and sustainable management of the Fall Armyworm in India", 29 September 2021.

Received appreciation certificate as a Panel List member for valuable contribution during International Conference on "Management of basal stem rot in oil palm and other tree species: Present status and future strategies" organised by ICAR–Indian Institute of Oil Palm Research, Pedavegi, 9–11 November 2021.

Dr Deepa Bhagat

Received Best service worker award for the year 2021 during 28th Foundation Day celebrations of ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 19 October 2021.

Delivered a talk on "Nanotechnology applications for pest management" in a training program on "Integrated pests and disease management in nurseries, plantation and forest" organised by Institute of Wood Science and Technology, Malleshwaram, Bengaluru, 16 December 2021.

Delivered a lecture on "Fruit-fly Awareness Day" as Guest of Honour conducted on virtual mode by Association for Advancement in Plant Protection in Horticultural Ecosystems, Bengaluru, 8 August 2021.

Delivered online lecture on "Nanotechnology in agricultural pest management" to MSc students of Biotechnology, Microbiology and Biochemistry organised by School of Sciences, JAIN (Deemed to be University), Bengaluru, 2 September 2021.

Delivered a lecture on "Paper based virus sensor for the detection of Nuclear polyhedrosis virus

biopesticides (HaNPV)" during the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Delivered a lecture on "Nano-formulation of pheromones for pest management" in the Workshop on "Biological control of insect-pests of crops in north-east region of India", organised jointly by Central Agricultural University (CAU) and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 9–10 March 2021.

Delivered a lecture as Lead speaker on the topic entitled "Nano formulations of pheromones and their application in insect pest management" in the 'National Conference on Priorities in Crop Protection for Sustainable Agriculture' organised by Central Agricultural University (CAU), Imphal in collaboration with ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 16–18 March 2021.

Dr K. Sreedevi

Attended the State Level Technical Programme (SLTP) of Entomology discipline at Acharya N G Ranga Agricultural University (ANGRAU), Guntur, Andhra Pradesh as Expert Member, 24–27 May 2021.

Attended the State Level Technical Programme (SLTP) of Entomology discipline at Dr. YSR Horticultural University (Dr. YSRHU), Venkataramannagudem, Andhra Pradesh as Expert Member, 2–3 August 2021.

Received Fellow Award from Society for Biocontrol Advancement, Bengaluru for the year 2020.

Delivered an invited lecture on "Root grubs - hidden enemies of crops and their management" in the National Webinar on "Validation of IPM strategies for sustainable agriculture in present Indian context" organized by College of Agriculture, Tripura, 10–11 August 2021.

Delivered an invited lecture on "Gonnehula jeevana chakra mathu jaivika niyantrana" in a Farmer's meet organised by Sugarcane Farmers Association, Belagavi, Karnataka, 8 August 2021.

Delivered an invited lecture on "Molecular Taxonomy–Prospects and challenge" to the Post graduate students of Punjab Agricultural University, Ludhiana, 20 March 2021.

Delivered an invited lecture on "Identification of important parasitoids and predators of agricultural pests" at a Workshop on "Biocontrol of invasive crop pests and utilization of insects as food in North-East Region of India" organised by Central Agricultural University, Imphal held at College of Agricultural Engineering and Post-harvest Technology, Ranipool, Sikkim, 11–12 February 2021.

Received "Dr. B. Vasantharaj David Award" for the year 2021 from Applied Zoologists Research Association, Bhubaneswar, Odisha.

Dr R. Gandhi Gracy

Received Best Oral presentation award for the paper entitled "DNA Barcoding and Molecular Phylogeny of Indian Sphecidae (sensu lato)" during the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Dr Ankita Gupta

Received Best Oral presentation award for the paper entitled "Successful attempts and challenges in reviving larval taxonomy and rearing of Indian owlflies (Neuroptera: Myrmeleontidae) after a century with special reference to *Ascalaphus* congeners" during the Sixth National Conference on Biological Control: Innovative Approaches for Green India, orga nised online and offline by the Society for Biocont rol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Received Best service worker award for the year 2021 during 28th Foundation Day celebrations of ICAR–National Bu reau of Agricultural Insect Resources, Bengaluru, 19 October 2021.

Served as a n invited speaker in "Hymathon 2021" organ ised by the International Society of Hymenopteri sts - the Australasia Session, 7 May 2021.

Served as Judge of the students' completion/ presentations in "Hymathon 2021" organised by the International Society of Hymenopterists - the Australasia Session, 7 May 2021.

Delivered an invited lecture on "Beneficial Insects' to the students of VIT School of Agricultural Innovations and Advanced Learning (VAIAL), Vellore Institute of Technology (VIT), Vellore, Tamil Nadu. 25 May 2021.

Served as committee member for the verification of the documents submitted by the candidates for the post of Assistant Director General/Director/ Joint Director (ASRB vacancy notification-Advt. No. 01/2021 dated: 05.11.2021) and screened five applications from ICAR–National Bureau of Agricultural Insect Resources, Bengaluru.

Served as moderator for the Brainstorming session on 'Classical and molecular taxonomy - Standalone or complimentary' conducted on virtual mode by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 18 November 2021.

Served as member of selection committee for the interview for Senior Research Fellow under AMAAS project entitled "Exploitation of endosymbionts of insect pests for pest management", 29 November 2021.

Served as member of Departmental Promotion Committee of Ms Nazia Anjum, Upper Division Clerk to Assistant, 28 September 2021.

Served as an external expert and attended online Advisory Committee meeting of Mr Darshan R. Ph.D. (Agril. Entomology), College of Agriculture, Shivamogga, 28 September 2021.

Served as external expert for the online oral comprehensive examination of Mr. K. Gupta, Ph.D. (Agril. Entomology), Indira Gandhi Krishi Vishwavidyalaya, Raipur, 29 September 2021.

Completed PhD thesis evaluation of Mr. J.M. Samraj, ID No. 52765, Ph.D. (Entomology), GBPUAT, Pantnagar on 11/12/2021.

Served as an invited participant to attend the virtual meeting on 'International biodiversity project to study the impact of modern agriculture on wasp biodiversity' organised by Dr F. Javier Peris-Felipo from Spain, world expert on Braconidae (Alysiinae and Opiinae), 15 October 2021.

Dr K.J. David

Received Best service worker award for the year 2021 during 28th Foundation Day celebrations of ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 19 October 2021.

Received Best Oral presentation award for the paper entitled "Fruit flies as weed biocontrol agents-an Indian Perspective" in the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Delivered two invited lectures on "Identification of economically important fruit flies of India" on virtual mode as a part of regular training program on fruit flies entitled "Fruit fly Surveillance and Management" organised by National Institute on Plant Health Management, Hyderabad, 21 April 2021 and 1 September 2021.

Dr S. Salini

Received Best service worker award for the year 2021 during 28th Foundation Day celebrations of ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 19 October 2021.

Received Best Oral presentation award for the paper entitled "A review of predatory stink bugs of India and their use as biological agents" in the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Delivered a guest lecture (in virtual mode) on "Order Hemiptera -Taxonomy and Classification" to the students of Vellore Institute of Technology, School of Agricultural Innovations and Advanced Learning, 14 June 2021.

Participated and delivered lecture on "Black soldier fly breeding spots: Collection & Recognition" in

the Field Day at Thalahalli, Chikkaballapura as part of Swachh Bharat Abhiyan organised by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 26 October 2021.

Dr Jagadeesh Patil

Delivered an invited talk on "Biological control potential of entomopathogenic nematodes for management of insect pests" in National Conference on Priorities in Crop Protection for Sustainable Agriculture, organised by Central Agricultural University and ICAR- National Bureau of Agricultural Insect Resources, Bengaluru, Karnataka, 16–18 March 2021.

Delivered an invited talk on "Entomopathogenic nematodes for FAW management in India" in the Joint Training and Geo-zone meeting on IPM of the FAW in South Asia and Northeast Asia, FAO Asia Pacific, 18 October 2021.

Delivered an invited talk on "On farm production protocols of the EPN for the management of FAW" in the National Training-cum-webinar on "On farm and mass production protocols of bioagents and microbial agents for fall armyworm management", 29 September 2021.

Delivered an invited talk on "On farm production protocols of the EPN for the management of FAW" in the FFS - Fall armyworm management in Maize-National Training-cum-webinar "On-farm and mass production protocols of bioagents and microbial agents for Fall armyworm management" under (TCP/IND/3709 (E) "Time-critical measures to support early warning and monitoring and sustainable management of the Fall Armyworm in India" FAO India, 7 October 2021.

Delivered an invited talk on "On farm production protocols of the EPN for the management of FAW" in the FFS - Fall armyworm management in Maize-National Training-cum-webinar "On-farm and mass production protocols of bioagents and microbial agents for Fall armyworm management" from 25-27 October 2021 under (TCP/IND/3709 (E)"Time-critical measures to support early warning and monitoring and sustainable management of the Fall Armyworm in India" FAO India), 26 October, 2021.

Delivered an invited talk on "On farm production protocols of the EPN for the management of FAW" in the FFS - Fall armyworm management in Maize-National Training-cum-webinar "On-farm and mass production protocols of bioagents and microbial agents for Fall armyworm management" from 15-17 November 2021 under (TCP/IND/3709 (E)"Time-critical measures to support early warning and monitoring and sustainable management of the Fall Armyworm in India" FAO India), 17 November, 2021.

Delivered an invited talk on "On farm production protocols of the EPN for the management of FAW" in FFS - Fall armyworm management in Maize, National Training-cum-webinar on"On-farm and mass production protocols of bioagents and microbial agents for Fall armyworm management" for North-eastern hill region, 23–25 November 2021.

Dr M. Sampath Kumar

Acted as a co-major advisor and guided Mr. Biswamitra Reang, M.Sc Entomology student from Indira Gandhi Krishi Vishwavidyalaya, Raipur for the completion of thesis dissertation entitled 'Diversity and systematic studies of rice Tetragnathid spiders from Tamil Nadu.'

Served as one of the organizing secretaries and conducted the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Served as convener and coordinated the Technical session II on 'Biological Control of Insect pests' Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Served as an executive member in the National Conference on priorities in Crop Protection for Sustainable Agriculture at College of Agriculture, Iroisemba, Central Agricultural University, Imphal, Manipur, March 16–18 2021.

Served as one of the course coordinators in organising the workshop on 'Biocontrol of Invasive Crop Pests and Utilization of Insects as Food in North-East Region of India' Central Agricultural University, Imphal and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru at College of Agricultural Engineering & Post Harvest Technology, Ranipool, Sikkim, February 11–12, 2021.

Served as one of the course coordinators in organising the student READY training programme, ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 15 March–3 April 2021.

Served as Treasurer, Society for Biocontrol advancement (SBA), Bengaluru.

Received Best Oral presentation award for the paper entitled "Severe occurrence of a new invasive cassava mealybug, *Phenacoccus manihoti* Matile-Ferrero (Pseudococcidae: Hemiptera) on cassava and its classical biological control opportunities in India" in the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Received Best Poster presentation award for the paper entitled "New record of long-jawed orb-weaver, *Tetragnatha nitens* Audouin (Araneae: Tetragnathidae) from India" in the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Received Best Poster presentation award for the paper entitled "Diversity and Seasonal Distribution of Spiders (Arachnida: Araneae) in Horticultural Ecosystem at Karaikal, U. T. of Pudhucherry" in the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Delivered an invited lecture on "Identification, distribution, management and quarantine issues of invasive pests (FAW and others)" at College of Horticulture & Forestry (CAU), Pasighat, Arunachal Pradesh for the Krishi Vigyan Kendra- East Siang, 8 February 2021.

Delivered an invited lecture on "Overview of biological control for NEH region" at College of Food Technology, Central Agricultural University, Lamphelpat, Imphal, Meghalaya, 9 March 2021.

Delivered a talk on "Biological agents for parthenium management" to celebrate "Parthenium awareness week 2020" in the webinar jointly organised by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru and Krishi Vigyan Kendra, Needamangalam, 21 August 2021.

Delivered a invited talk on "Control and management of cassava mealybug" on virtual mode to 200 farmers, under National Horticultural Mission 2020-21 organised by Department of Horticulture and Plantation crops, Dharmapuri district, Tamil Nadu, 31 December 2021.

Served as a reviewer for Indian Journal of Entomology.

Served as a reviewer for Entomon.

Served as reviewer for Journal of Biological control.

Dr K. Selvaraj

Received appreciation certificate for the training, demonstration, popularization, dissemination of technologies on the biological control of RSW in coconut using innovative extension methodologies from Erode District Collector, Tamil Nadu, 18 January 2021.

Dr U. Amala

Received Best Oral Presentation award for the paper entitled, "Trap nesting – a viable approach for conservation of solitary bees in pigeon pea" in the National web symposium on Recent Advances in Beneficial Insects, Natural Resins and Gums, ICAR-Indian Institute of Natural Resins and Gums, Ranchi, 25–26 February 2021.

Delivered an invited lecture on 'Utilization of insects as feed' in the Workshop on "Biocontrol of Invasive Crop Pests and Utilization of Insects as Food in North-East Region of India" organised by Central

Agricultural University, Imphal and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru at College of Agricultural Engineering & Post Harvest Technology, Ranipool, Sikkim, 11–12 February, 2021.

Served as one of the organizing secretary for Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Delivered an invited lecture on 'Potential application of remote sensing tools in bee pollination studies' under ATAL Faculty Development Programme on 'Hyperspectral Remote Sensing and Its Applications' organised by CMR Institute of Technology, Bengaluru, 7 September 2021.

Delivered a talk on 'Utilization of Black soldier fly as fish feed' at Field Day organized by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru at Thalahalli under Swachh Bharat Abhiyan programme, 26 October 2021.

Delivered a talk on 'Utilization of Black soldier fly as fish feed' at 'Discussion cum action plan meeting with Krishi Vigyan Kendra Personnel' held at ICAR-Agricultural Technology Application Research Institute (ATARI), Karnataka, 18 September 2021.

Organized a Demonstration cum Discussion meeting on 'Mass production of black soldier fly for utilization as fish feed' along with ICAR-Central Inland Fisheries Research Institute Regional Centre Bengaluru at Government Fish Seed Hatchery, Peechi, Kerala, 16 December 2021.

Delivered an invited lecture on "Applications of Sensor-based tools in Pollination studies" in the faculty development programme organized by Department of Electronics and Communication, Brindavan College of Engineering, Bengaluru, 23 December 2021.

Received Best Oral Presentation award for the paper entitled "Coconut shell traps – a viable way to attract the swarms of stingless bees, *Tetragonula iridipennis* Smith" in the Fifth National Symposium on Plant Protection in Horticulture (NSPPH-2021) organized by Association for Advancement of Pest Management in Horticultural Ecosystems, ICAR–Indian Institute of Horticultural Research, Bengaluru, 29 December 2021.

Served as reviewer for International Journal of Tropical Insect Science.

Dr Richa Varshney

Delivered an invited talk on "Mass production and utilization of bicontrol agents" in Workshop on "Biocontrol of Invasive Crop Pests and Utilization of Insects as Food in North-East Region of India" jointly organised by Central Agricultural University, Imphal and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru at Krishi Vigyan Kendra, East Siang, College of Horticulture & Forestry (CAU), Pasighat, East Siang, Arunachal Pradesh, 8–9 February 2021.

Delivered an invited talk on "Production of Bio-control agents for pest control in Sericulture" in the Training Program on "Promotion of Entrepreneurship in Sericulture Sector" organised by Andhra Pradesh State Sericulture Research and Development Institute, Hindupur and National Institute of Agricultural Extension Management (MANAGE) Hyderabad, 21 January 2021.

Delivered an invited talk on "Results from Native Natural Enemy Survey India" in the First Webinar on Regional Exchange on FAW jointly organized by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, Bangladesh Agricultural Research Institute and Centre for Agriculture and Bioscience International (CABI), 22 February 2021.

Elected Fellow of Society for Biocontrol Advancement, Bengaluru.

Received Best Oral Presentation award for the paper entitled "Diversity and occurrence of native egg parasitoids of invasive fall armyworm *Spodoptera frugiperda* (J. E. Smith) in India" in the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Received Best Oral Presentation award for the paper entitled "Influence of storage of *Corcyra cephalonica* (Stainton) eggs on production of *Trichogramma chilonis* Ishii" in the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Dr R.R. Rachana

Received University of Agricultural Sciences Gold Medal for securing the highest OGPA in Ph.D. (Agricultural Entomology).

Recognised as an expert member for thrips identification in the team of scientists formed to investigate the emerging thrips menace on Chilli in the states of Andhra Pradesh and Telangana.

Recognised as Post Graduate Teacher in the department of Entomology at University of Agricultural and Horticultural Sciences, Shivamogga.

Received Best Poster Presentation award for the paper entitled "Biodiversity of thrips on vegetables in Karnataka" in the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Received Best Oral Presentation award for the paper entitled "Invasive thrips species, *Thrips parvispinus* (Karny): an emerging pest on chilli" in the Fifth National Symposium on Plant Protection in Horticulture (NSPPH-2021) organized by Association for Advancement of Pest Management in Horticultural Ecosystems, ICAR–Indian Institute of Horticultural Research, Bengaluru, 29 December 2021.

Dr Navik Omprakash Samodhi

Recognized as Co-guide for M.Sc. student Mr. Vijji Venkatesh, Department of Entomology, Indira Gandhi Agricultural University, Raipur, Chhattisgarh.

Delivered an invited talk on "Beneficial Insects: Awareness Meet" for farmers organized by KISAN, Pune, 1 August 2021.

Received Best Oral Presentation award for the paper entitled "Diversity and occurrence of native egg parasitoids of invasive fall armyworm *Spodoptera frugiperda* (J.E. Smith) in the Sixth National Conference on Biological Control: Innovative Approaches for Green India, organised online and offline by the Society for Biocontrol Advancement and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 3–5 March 2021.

Dr R.S. Ramya

Received the Best Oral Presentation award for the paper entitled "Phosphine as an alternative to methyl bromide for management of coffee berry borer, *Hypothenemus hampei* (Ferrari, 1867)" in the National Conference on Priorities in Crop Protection for Sustainable Agriculture, organized by Central Agricultural University (CAU), Imphal in collaboration with ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 16–18 March 2021.

Recognised as reviewer for Crop Protection, Phytoparasitica, International Journal of Tropical Insect Science and Uttar Pradesh Journal of Zoology.

Served as Executive Member and Member of Publication Committee of the National Conference on Priorities in Crop Protection for Sustainable Agriculture, organized by Central Agricultural University (CAU), Imphal in collaboration with ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 16–18 March 2021.

8. AICRP COORDINATION UNIT AND CENTRES

The biocontrol technologies developed at NBAIR are field tested, validated and demonstrated on a large scale under the All-India Coordinated Research Project on Biological Control of Crops Pests and Diseases by selected ICAR institutes and State Agricultural Universities.

Coordination Unit

• ICAR–National Bureau of Agricultural Insect Resources, Bengaluru	Basic Research

State Agricultural University-based centres

• Acharya N. G. Ranga Agricultural University, Hyderabad	Sugarcane, Maize
• Anand Agricultural University, Anand	Cotton, pulses, oilseeds, vegetables, weeds
• Assam Agricultural University, Jorhat	Sugarcane, pulses, rice, weeds
• Central Agricultural University, Pasighat	Rice, vegetables
• Dr Y. S. Parmer University of Horticulture and Forestry, Solan	Fruits, vegetables, weeds
• Gobind Ballabh Pant University of Agriculture and Technology, Pantnagar	Plant disease antagonists
• Kerala Agricultural University, Thrissur	Rice, coconut, weeds, fruits
• Maharana Pratap University of Agriculture & Technology, Udaipur	Vegetables, whitegrubs, termites
• Mahatma Phule Krishi Vidyapeeth, Pune	Sugarcane, cotton, soybean, guava
• Orissa University of Agriculture & Technology, Bhubaneswar	Rice, vegetables
• Pandit Jayashankar Telangana State Agricultural University, Hyderabad	Cotton, pulses, oilseeds, sugarcane
• Punjab Agricultural University, Ludhiana	Sugarcane, cotton, oilseeds, rice, tomato, weeds
• Sher-e-Kashmir University of Agriculture Science & Technology, Srinagar	Temperate fruits, vegetables
• Tamil Nadu Agricultural University, Coimbatore	Sugarcane, cotton, pulses, tomato
• University of Agricultural Science, Raichur	Oilseeds, pulses

ICAR Institute-based centres

• ICAR–Central Plantation Crops Research Institute, Kayangulam	Coconut
• ICAR–Indian Institute of Horticulture Research, Bengaluru	Fruits and vegetables
• ICAR–Indian Institute of Rice Research, Hyderabad	Rice
• ICAR–Indian Institute of Vegetable Research, Varanasi	Vegetables
• ICAR–National Centre for Integrated Pest Management, New Delhi	Biocontrol in IPM
• ICAR–Central Institute for Subtropical Horticulture, Lucknow	Tropical fruits
• ICAR–Indian Institute of Millets Research, Hyderabad	Maize, sorghum and other millets

Voluntary centres

- Dr YSR Horticultural University, Ambajipeta
- Sun Agro Biotech, Chennai
- Indira Gandhi Krishi Viswavidhyalaya, Raipur
- KAU-Regional Agricultural Research Station, Kumarakom
- Kerala Agricultural University, Vellayani
- Uttar Banga Krishi Vishwavidyalaya, Pundibari
- SKUAST–Jammu, Rakh Dhiansar
- Nagaland University, Medziphema
- National Institute of Plant Health Management, Hyderabad

9. ONGOING RESEARCH PROJECTS

A. Institute projects

DIVISION OF GERMPLASM COLLECTION AND CHARACTERISATION

I. Biosystematics of agriculturally important insects and associated fauna

1. Taxonomy of Pseudococcidae, Coccidae and Diaspididae (Hemiptera Coccoidea (01.04.2017 to 31.03.2022) – Dr Sunil Joshi
2. Biosystematics studies on Scarabaeidae and Cerambycidae of Coleoptera (22.06.2017 to 31.03.2022) – Dr K. Sreedevi
3. Taxonomic studies on Indian Curculionidae (Coleoptera) with emphasis on Entiminae (01.07.2016 to 31.03.2022) – Dr G. Mahendiran
4. Digitisation of type specimens and cataloguing of voucher specimens in ICAR-NBAIR reference collections (01.04.2018 to 31.03.2023) – Dr Ankita Gupta
5. Taxonomic studies on Braconidae with special reference to Cheloninae, Microgastrinae and Braconinae with emphasis on host-parasitoid association in India (01.04.2021 to 31.03.2026) – Dr Ankita Gupta
6. Taxonomy and biocontrol potential of entomopathogenic nematodes in Deccan Plateau of India (01.04.2017 to 31.03.2022) – Dr Jagadeesh Patil
7. Taxonomic studies on Tephritoidea (Diptera) of India with special reference to Tephritidae, Platystomatidae, Ulidiidae and Pyrgotidae (01.04.2020 to 31.03.2025) – Dr K.J. David
8. Taxonomy of Pentatomoidea (Hemiptera: Heteroptera) of India with special reference to Pentatomidae and Tessaratomidae (01.04.2020 - 31.03.2025) – Dr S. Salini
9. Taxonomy of Indian jumping spiders (Salticidae: Araneae) with reference to crop agroecosystem (01.04.2016 to 31.03.2026) – Dr M. Sampath Kumar
10. Taxonomy and diversity of Indian Thysanoptera with special reference to Terebrantia (01.10.2015 to 31.03.2024) – Dr R.R. Rachana
11. Taxonomy of Indian Trichogrammatidae (Chalcidoidea: Hymenoptera) and evaluation of potential species (01.09.2016 to 31.03.2022) – Dr Navik Omprakash Samodhi

DIVISION OF GENOMIC RESOURCES

II. Molecular characterisation, genomics and bioinformatics of agriculturally important insects, entomopathogenic nematodes and associated microorganisms

1. Studies on molecular and functional diversity of EPN-EPB-insect tritrophism and their utilisation against soil pests (08.07.2016 to 30.06.2022) – Dr M. Nagesh
2. Biological characterisation of agriculturally important insects through DNA barcodes (01.04.2020 to 31.03.2025) – Dr T. Venkatesan
3. Molecular characterisation of economically important plant bugs and their diversity (01.04.2020 to 31.03.2024) – Dr K. Srinivasa Murthy
4. *Bacillus thuringiensis* – Fermentation and formulation strategies for enhanced toxicity against insect pests (01.04.2017 to 31.03.2022) – Dr R. Rangeshwaran
5. Population genetic diversity in selected insect borer of economic importance (01.04.2018 to 31.03.2022) – Dr M. Mohan

6. Development of mobile apps for the biological control of important crop pests (01.04.2017 to 31.03.2022) – Dr M. Pratheepa
7. Studies on black soldier fly and associated microorganisms for their utilisation (01.04.2020 to 31.03.2025) – Dr Mahesh Yandigeri
8. Exploration of induced hormesis for the possible role in enhanced efficacy of biocontrol agent (01.09.2017 to 31.03.2022) – Dr G. Gandhi Gracy
9. Identification and molecular characterisation of Indian Tachinids (01.04.2020 to 31.03.2023) –Dr. R.S. Ramya
10. Molecular studies on virulence of *Bacillus thuringiensis* against fall armyworm and root grubs (21.01.2021-31.03.2026) – Dr C. Manjunatha

DIVISION OF GERMPLASM CONSERVATION AND UTILISATION

III. Biodiversity conservation, behavioural studies and maintenance and utilisation of arthropod germplasm

1. Ecological studies on the establishment and management of invasive insects fall armyworm, *Spodoptera frugiperda* and cassava mealybug, *Phenacoccus manihoti* in India (01.10.2020 to 31.03.2023) – Dr A. N. Shylesha
2. Non bee insect pollinators of important crops (01.04.2021 to 31.03.2024) – Dr T.M. Shivalingaswamy
3. Documenting agriculturally important mites establishing an authentic collection and utilising natural enemies in the field (01.04.2014 to 31.03.2022) – Dr P. Sreerama Kumar
4. Exploiting the olfactory cues for management of key stored product pests (01.04.2019 to 31.03. 2022) – Dr K. Subaharan
5. Characterisation of viruses with special reference to *Lepidoptera* & *Coleoptera* (24.11.2015 to 31.03.2022) – Dr G. Sivakumar
6. Developing Controlled release formulations for major pests (03.10.2018 to 02.10.2022) – Dr Deepa Bhagat
7. Development of suitable formulation for entomopathogenic fungi and under exploited entomogeneous bacteria for the management of major lepidopteran and coleopteran pests - (01.10.2020 to 31.03.2025) – Dr A. Kandan
8. Climate change effect on the diversity and bioecology of some important sucking pests (01.04.2014 to 31.03.2022) – Dr K. Selvaraj
9. Studies on whiteflies and associated natural enemies for their management (19.09.2016 to 31.03.2022) – Dr K. Selvaraj
10. Mass culturing and utilisation of stingless bee *Tetragonula iridipennis* Smith (Hymenoptera: Apidae) for pollination of selected crops (01.10.2020 to 31.03.2024) – Dr U. Amala
11. Development of mass production protocols of selected insects of industrial importance (01.10.2020 to 31.03.2024) – Dr U. Amala
12. Investigation on interactions between the entomopathogenic fungi and natural enemies (01.10.2020 to 31.03.2024) – Dr Richa Varshney
13. Characterisation and diversity of Megachilidae (31.04.2019 to 31.03.2024) – Dr Veeresh Kumar

B. List of external funded projects

DIVISION OF GERMPLASM COLLECTION AND CHARACTERISATION

1. CABI: Insect Biodiversity documentation in Sikkim region including research into the potential for biological control of *Hedychium* species using Indian natural enemies (01.04.2018 to 30.06.2022) – Dr Ankita Gupta
2. CABI: Insect and fungal pathogen biodiversity documentation in the Indian Himalayan region (Himachal Pradesh) and the Nilgiri Mountains (Tamil Nadu) including research into the potential for biological control of *Rubus ellipticus* and *R. niveus* using Indian natural enemies (01.03.2018 to 30.06.2022) – Dr Ankita Gupta
3. Bioversity International: Biodiversity of insect pests and natural enemies in organically grown land races of rice (01.10.2020 to 30.10.2021) – Dr M. Sampath Kumar
4. DBT: Multifaceted exploration of edible molluscs of North East India (18.07.2018 to 17.01.2022) – Dr K. Sreedevi
5. DST: Biogeography, systematics and molecular characterisation of white grub fauna (Coleoptera: Scarabaeidae) of South India (19.11.2018 to 18.11.2021) – Dr K. Sreedevi
6. DST: Systematic studies on fruit flies of subfamily Tephritinae (Diptera: Tephritidae) from south India with special reference to Western Ghats (30.03.2019 to 29.03.2022) – Dr K.J. David
7. DST -SERB: Systematic studies on Pentatominae (Hemiptera: Heteroptea: Pentatomidae) from North East India (03.01.2020 to 03.01.2023) – Dr S. Salini
8. DST: Taxonomic studies on species complexes in selected parasitoids (Braconidae: Hymenoptera (10.02.2022 to 09.02.2025) – Dr Ankita Gupta
9. DST: Biodiversity and Systematic studies on Weevils (Curculionidae: Coleoptera) with special reference to Eastern Ghats of India (10.02.2022 to 09.02.2025) – Dr G. Mahendiran
10. DST: Taxonomy and diversity of Terebrantian thrips (Thysanoptera: Terebrantia) from south India with special reference to Western Ghats (10.02.2022 to 09.02.2025) – Dr R. Rachana

DIVISION OF GENOMIC RESOURCES

11. ICAR under CRP Genomics mode: Insect Genomics - Whole genome and transcriptome sequencing (01.04.2020 to 31.03.2026) – Dr M. Mohan
12. NASF: Identification and validation of newer approaches for the management of whitefly *Bemisia tabaci* (Hemiptera: Aleyrodidae) (01.08.2020 to 31.07.2023) – Dr T. Venkatesan
13. DST-INSPIRE: Baculovirus mediated modulation of small RNA's and its implications in pathogenicity of lepidopteran hosts (01.05.2018 to 31.04.2023) – Dr T. Venkatesan
14. DST Women Scientist-A: Identification and characterisation of baculovirus encoded miRNAs and evaluating their expression in plant to control predation by *Helicoverpa armigera* (20.05.2019 to 20.05.2022) – Dr T. Venkatesan
15. CABin Network: Genome Manipulation for the management of important agricultural insect pests (01.04.2020 to 31.03 2025) – Dr T. Venkatesan
16. NAIF: Strengthening of the institutional mechanism to protect/manage innovations/intellectual properties (IPs) generated at ICAR-NBAIR (01.04.2020 to 31.03.2025) – Dr T. Venkatesan
17. National Bee Board-DAC: Exploration of gut microbiome & quality bee products for sustainable bee keeping in India (2021-2023) – Dr T. Venkatesan

18. AMAAS: Exploitation of endosymbionts of insect pests for pest management (01.04.2017 to 31.09.2021) – Dr Mahesh S. Yandigeri

DIVISION OF GERMPLASM CONSERVATION AND UTILISATION

19. NASF: Development of sustainable management tools for the invasive pest, FAW, *Spodoptera frugiperda* (J. E. Smith) in maize (01.11.2019 to 31.10.2022) – Dr K. Subaharan
20. ICFRE-IFGTB: Development of volatile based lure for key insect pests of commercial tree species *Ailanthus* (*Ailanthus excelsa*) and Teak (*Tectona grandis*) (01.08.2019 to 30.10.2021) – Dr K. Subaharan
21. DBT: Controlled release of olfactory cues for management of lesser grain weevil, *Sitophilus oryzae* a stored product pest of rice – Dr K. Subaharan
22. DST: Signalling mechanism in the tri-trophic interaction between Brassicacious plants and their insect pest and parasitoid of the pest (01.11.2018 to 31.03.2022) – Dr K. Subaharan
23. Corteva Agriscience India Pvt Ltd: To evaluate the bio-efficacy of Picoxystrobin 7.05% +Propiconazole11.71% w/w SC (Galileo way) against foliar diseases (*Cercospora* leaf spot, *Alternaria* leaf spot and Grey mildew) in Cotton and phytotoxicity and natural enemies (01.10.2021 to 30.12. 2023) – Dr G. Sivakumar
24. DST under ASEAN - India collaborative programme: Collection, characterisation of *Spodoptera frugiperda* nucleopolyhedrovirus (SpfrNPV) isolates of India, Vietnam and Thailand against maize fall armyworm (FAW) (29.06.2020 to 28.06.2022) – Dr G. Sivakumar
25. Agrinos India Pvt Ltd: Studies on Agrinos HYT products for Nematode Management (01.08.2021 to 31.05.2022) – Dr G. Sivakumar
26. FAO: Review study on impacts of agro-ecological approaches, innovations on biological control, immediate recommendations for the management of FAW in India (24.07.2020 to 31.09.2021) – Dr A. Kandan
27. AMAAS: Development of formulations of *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium* spp. for the management of sucking pests in vegetable crops (01.04.2017 to 31.09.2021) – Dr A Kandan
28. KSHM: Demonstration of IPM technology for cultivation of capsicum, tomato and European cucumber in farmers' fields (01.11.2018 to 30.10. 2021) – Dr A. Kandan
29. DBT: Efficacious management of wood borers in protected areas of forest by pheromone loaded organogel (12.03.2019 to 11.03.2022) – Dr Deepa Bhagat
30. BIRAC: Drone assisted pheromone detection and remediation for pests (10.12.2018 to 31.12.2020) – Dr Deepa Bhagat
31. CDB: Exploration of entomopathogenic fungus *Isaria fumosorosea* Wize for the management of emerging invasive whiteflies in coconut (21.10.2019 to 12.02.2022) – Dr K. Selvaraj
32. CDB: Development and validation of biointensive integrated pest management strategies for coconut invasive whiteflies in Karnataka (17.12.2020 to 28.05.2023) – Dr K. Selvaraj
33. DST: Enhancing the pollination in fennel (*Foeniculum vulgare* Mill.) by Syrphid fly, *Ishchiodon scutellaris* Fabricius (10.02.2022 to 09.02.2025) – Dr U. Amala

10. PUBLICATIONS

Peer-reviewed articles

Abhishek MS, Hanumanthaswamy BC, Venkatesan T, Selvaraj K. 2021. Field evaluation of biopesticides against whitefly, *Bemisia tabaci* (Homoptera: Aleyrodidae) in tomato. *J Biol Control*. 35(1): 12–18.

Amala U, Shylesha AN, Shivalingaswamy TM. 2021. Coconut shell traps: easiest and economic way to attract stingless bees (*Tetragonula iridipennis*) Smith. *Sociobiol*. 68(4): e7220.

Arunkumara CG, Jagadish KS, Mohan M, Venkatesan T, Narayanaswamy KC, Peter A. 2021. Biochemical basis of insecticides resistance in cotton leafhopper, *Amrasca biguttula biguttula* (Ishida) (Hemiptera: Cicadellidae). *Int J Chem Stud*. 8(6): 2298–2301.

Ashwini M, Mohan M, Sivakumar G, Venkatesan T. 2021. Enhanced insecticide-resistance spectrum in green lacewing predator, *Chrysoperla zastrowi sillemi* (strain PTS-8) and its potential role in the management of sucking pests of cotton. *Current Sci*. 120(2): 423–428.

Ballal CR, Verghese A, Pratheepa M, Sreedevi, K. 2021. Interspecific association of solanum whitefly, *Aleurothrixus trachoides* (Back), coccinellid predator, *Axinoscymnus puttarudriahi* Kapur and Munshi and ant *Tapinoma melanocephalum* (Fabricius) in *Capsicum*. *Int J Trop Insect Sci*. DOI: 10.1007/s42690-021-00701-6

Biswakarma D, Dey N, Bhagat D, Bhattacharya S. 2021. Switchable luminescent probe for trace-level detection of the *Spodoptera litura* nuclear polyhedrosis virus via a color-changing response. *ACS Agric Sci Technol*. 1(4): 322–328.

Chandel RS, Verma KS, Baloda AS, Sreedevi K. 2021. White grubs in India. *Indian J Entomol*. DOI: 10.5958/0974-8172.2021.00010.9

Chandra K, Ahrens D, Bhunia D, Sreedevi K, Gupta D. 2021. New species and records of Sericini from India (Coleoptera: Scarabaeidae: Melolonthinae). *Zootaxa*. 4951(3): 492–510.

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 Environ*. 24: 280–282.

David KJ, Hancock DL, Han HY, Gracy RG, Sachin K, Swathi RS. 2021. A new genus in the tribe Acidoxanthini (Diptera: Tephritidae: Trypetinae) from India with a discussion of its phylogenetic relationships. *J Asia Pac Entomol*. 24: 1194–1201.

David KJ, Hancock DL, Sachin K, Mahendiran G. 2021. A new species, new postabdominal descriptions and a new synonymy in *Euphranta* Loew (Diptera: Tephritidae: Trypetinae: Adramini). *Zootaxa*. 5057(1): 87–98.

David KJ, Hancock DL, Sachin K, Ramya RS, Ramani S. 2021. Taxonomic notes on the genus *Elaphromyia* Bigot (Diptera: Tephritidae: Tephritinae: Pliomelaenini) in India, with description of a new species. *Zootaxa*. 5023(2): 251–262.

Devanda M, Jayashankar M, Sreedevi K. 2021. Incidence of white grub, *Holotrichia consanguinea* (Blanchard) in Cheetwari village of Jaipur district, Rajasthan. *Insect Environ*. 24(3): 15–16.

Dhanapal R, Singh RN, 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.

Dubey VK, Kalleshwarswamy CM, Joshi S, Shivanna BK. 2021. Diversity and diagnostics of sternorrhynchan insect pests infesting arecanut. *Indian J Entomol*. DOI: 10.5958/IJE.2021.56

Elangovan AV, Amala U, Saravanakumar M, Awachat VB, Mohan M, Mahesh SY, Selvaraj K, Anjumoni M, Nageswara Rao SB, Giridhar K, Bhatta R. 2021. Effect of black soldier fly, *Hermetia illucens* (Linnaeus) prepupae meal on growth performance and gut development in broiler chicken. *Int J Trop Insect Sci*. 41: 2077–2082.

Enakshi G, Varshney R, Radhika V. 2021. Performance of larval parasitoid, *Bracon brevicornis* on two *Spodoptera* hosts: implication in bio-control of FAW. *J Pest Sci*. 95: 435–446.

Gupta A, David KJ. 2021. A new species of the genus *Asobara* Foerster (Hymenoptera: Braconidae) parasitic on *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae) infesting tomato in India. *Zootaxa*. 5048: 444–450.

Gupta A, Sampathkumar M, Mohan M, Shylesha AN, Venkatesan T, Shashank PR, Dhanyakumar O,

Ramkumar P, Sakthivel N, Geetha B. 2021. Assessing adverse impact of the native biological control disruptors in the colonies of the recent invasive pest *Phenacoccus manihoti* Matile-Ferrero (Hemiptera: Pseudococcidae) in India. *Glob Ecol Conserv*. 32: e01878.

Gupta A. 2021. A new species of the genus *Parahormius* Nixon (Hymenoptera: Braconidae: Hormiinae) parasitic on host pupae of Lyonetiidae (Lepidoptera) from India. *Zootaxa*. 5052: 292–296.

Gupta M, Kaur R, Gupta A, Raychoudhury R. 2021. Are ecological communities the seat of endosymbiont horizontal transfer and diversification? A case study with soil arthropod community. *Ecol Evol*. 11: 14490–14508.

Joshi S, Bhaskar H, Poon VSA, Jayanthi Mala BR, Kamala Jayanthi PD, Pai SG, Thite SV, Sood AK, Kedar SC, Sridhar V, Deepthy KB, Navik O, Rachana RR. 2021. Occurrence and spread of *Ceroplastes cirripediformis* Comstock (Hemiptera: Coccomorpha: Coccidae) in India. *Zootaxa*, 5039(4): 561-570.

Joshi S, Bindu JK, Gullan PJ, Sajeev TV, Anoop EV. 2021. A new species of mealybug (Hemiptera: Coccomorpha: Pseudococcidae) from *Tectona grandis* L.f. Lamiaceae) in southern India. *Zootaxa*. 4718(3): 391–400.

Joshi S, Dubey AK. 2020. Re-description and first occurrence of a scale of quarantine importance, *Parlatoria ziziphi* (Lucas) (Hemiptera: Diaspididae) in the Andaman and Nicobar Islands. *Biosystematica*. 11(1&2): 5–11.

Joshi S, Navik O, Veereshkumar. 2021. A new species of *Icerya* Signoret (Hemiptera: Coccomorpha: Monophlebidae) and a key to species of the genus found in India. *Zootaxa*. 4920 (2): 200–210.

Kannan M, Geetha N, Elango K, Mohan M. 2021. Characterization of granulosis viruses of sugarcane early shoot borer, *Chilo infuscatellus* (Snell.) and internode borer, *Chilo sacchariphagus indicus* (Kapur). *Currrent Sci*. 121(4): 570–573.

Kaur K, Sharma S., Gupta R, Vinay Kumar TM, Chandel M, Ahamed M, Singhal NK, Bakthavatsalam N, Gorantla M, Eswaramoorthy M, Subaharan K, Vijayakumar S. 2021. Nanomaze Lure: Pheromone Sandwich in Graphene Oxide Interlayers for Sustainable Targeted Pest Control. *ACS Appl Mat Interfaces* 13(41): 48349–48357 DOI: 10.1021/acsami.1c09118.

Kment P, Salini S, Redei D, Rider D. 2021. *Halyomorpha halys* fixed as the type species of the genus *Halyomorpha* (Hemiptera: Heteroptera: Pentatomidae). *Acta Entomol. Nat. Prague* 61(2): 615–630.

Kariyanna B, Prabhuraj A, Asokan R, Agrawal A, Gandhi GR, Jyoti P, Venkatesan T, Bheemanna M, Kalmath B, Diwan JR, Pampanna Y, Mohan M. 2021. Genome mining and expression analysis of carboxylesterase and glutathione-s-transferase genes involved in insecticide resistance in eggplant shoot and fruit borer, *Leucinodes orbonalis* (Lepidoptera: Crambidae). *Front Physiol*. DOI: 10.3389/fphys.2020.594845

Kment P, Salini S, Ahmed Z. 2021. *Halyomorpha picus* (Hemiptera: Heteroptera: Pentatomidae) first confirmed record from Pakistan and two new junior synonyms. *Zootaxa*. 5060(3): 429–438.

Kumar M, Pandey AK, Sreedevi K. 2021. New distributional record of *Holotrichia nagpurensis* Khan and Ghai 1982 and adult beetle host range in Terai region of Uttarakhand. *Indian J Ecol*. 48(5): 1438–1441.

Lalitha N, Chatterjee H, Gandhi GR, Anthakumar MV. 2021. Molecular phylogeny of *Scymnus latifolius*, a predator species of mealy bug shows divergent evolution among *Scymnus* species. *Currrent Sci*. 120(5): 763–765.

Manjunatha C, Sharma S, Kulshreshtha D, Singh K, Bhardwaj SC, Murugasamy S, Sindhu A, Vikas VK, Aggarwal R. 2021. Transcriptome profiling and differential gene expression analysis provides insights into Lr24-based resistance in wheat against *Puccinia triticina*. *3 Biotech*. 11: 455.

Navik O, Shylesha AN, Patil J, Venkatesan T, Lalitha Y, Ashika TR. 2021. Damage, distribution and natural enemies of invasive fall armyworm *Spodoptera frugiperda* (JE smith) under rainfed maize in Karnataka, India. *Crop Prot*. 143: 105536.

Nayyar N, Gracy RG, Ashika TR, Mohan G, Swathi RS, Mohan M, Chaudhary M, Bakthavatsalam N, Venkatesan T. 2021. Population structure and genetic diversity of invasive fall armyworm after 2 years of introduction in India. *Sci Rep*. 11: 7760.

Pandey AK, Deka B, Varshney R, Cheramgoi EC, Azariah BA. 2021. Do the beneficial fungi manage

phytosanitary problems in the tea agro-ecosystem? *Biocontrol*. 66: 445–462.

Poorani J, Booth RG, Gracy RG, Anuraha C, Swathi RS. 2021. Immature stages, host plants and natural enemies of *Henosepilachna implicata* (Mulsant) (Coleoptera: Coccinelliadae) with DNA sequence data and a new synonym and notes on some Indian species of Epilachnini. *Zootaxa*. 4970(3): 533546.

Pradhan SK, Shylesha AN, Selvaraj K, Sumalatha BV. 2021. Distribution, host range and status of invasive rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) in Karnataka. *Agric Res*. DOI: 10.1007/s40003-021-00593-5

Rachana RR. 2021. A new species of *Neohydatothrips* (Thysanoptera: Thripidae) from India. *Zootaxa*. 4920(2): 297–300.

Rachana RR. 2021. *Frankliniella occidentalis* (Pergande) (Thripidae: Thysanoptera) – the silent intruder? *Insect Environ*. 24: 18–20.

Ramanujam B, Kandan A, Poornesha B, Shylesha AN, Gandhi G, Mohan M. 2021. Pathogenicity of *Beauveria bassiana* and *Metarhizium anisopliae* on Aak grasshopper, *Poekilocerus pictus* Fabr. (Orthoptera: Acrididea). *Int J Trop Insect Sci*. DOI: 10.1007/s42690-021-00686-2

Ramanujam B, Poornesha B, Kandan A, Mohan M, Sivakumar G. 2021. Natural occurrence of entomopathogenic fungus *Beauveria felina* (DC.) J.W. Carmich on fall armyworm, *Spodoptera frugiperda* (J. E. Smith). *J Entomol Zool Stud*. 9(3): 140–143.

Rami Reddy PV, Sreedevi K. 2021. Woodpecker's holes on mango trees: A wound worth bearing. *Insect Environ*. 24(3): 25.

Ramya RS, Ganesh Kumar M, Ranjith M, Bajya DR. 2021. Arthropod diversity indices in floricultural ecosystems: which fares better? *Indian J Agric Sci*. 91(3): 340–343.

Ranjith M, Ramya RS, Boopathi T, Pardeep K, Prabhakaran N, Raja M, Bajya DR. 2021. First report of the fungus *Actinomucor elegans* Benjamin & Hesseltine belonging to *Odontotermes obesus* (Rambur) (Isoptera: Termitidae) in India. *Crop Prot*. 145: 105622.

Roselin P, Kuldeep S, Rachana RR. 2021. Diversity of floral thrips from Western Ghats of Karnataka. *Indian J Entomol*. 83(3): 407–410.

Roselin P, Kuldeep S, Rachana RR. 2021. Efficacy of some insecticides against leaf invading thrips *Gynaikothrips bengalensis*. *Indian J Entomol*. 83(4): 308–310.

Sagar D, Suroshe SS, Keerthi MC, Poorani J, Gupta A, Chandel RK. 2021. Native parasitoid complex of invasive fall armyworm, *Spodoptera frugiperda* (J. E. Smith) from Northern India. *Int J Trop Insect Sci*. (Accepted).

Salini S, David KJ, Pratheepa M. 2021. Does India have the invasive brown marmorated stink bug, *Halyomorpha halys* (Stål). *Curr Sci*. 120(2): 268–269.

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 MK, Amala U, Mahendiran G. 2021. First record of the genus *Lodosocoris* Ahmad & Afzal (Hemiptera: Heteroptera: Pentatomidae: Halyini) from India with description of a new species. *Zootaxa*. 5072(1): 53–62.

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

Salini S, Rabbani MK, Gracy RG, David KJ, Sachin K. 2021. A bizarre Pentatomid, *Phricodus hystrix* (Germer, 1838) (Hemiptera: Pentatomidae) on *Ocimum* spp. *Indian Entomologist*. 2(2): 27–38.

Salini S, Rabbani MK, Singh S. 2021. Taxonomic notes on *Sarju* Ghauri, 1977 (Hemiptera: Heteroptera: Pentatomidae) with description of a new species from India. *Zootaxa*. 4951(2): 283–303.

Salini S, Roca-Cusachs M. 2021. Review of the Oriental species of the genus *Brachycerocoris* Costa, 1863 (Hemiptera: Pentatomoidea: Pentatomidae: Podopinae s.l.) with description of two new species. *Zootaxa*. 5040 (4): 507–527.

Selvaraj K, Gotyal BS, Bhattacharya N, Satpathy S, Ramesh BV. 2021. Effect of bast fibre crops and their biochemicals on nutritional indices of *Spilosoma obliqua* (Walker). *Indian J Entomol*. 83(3): 350–354.

Selvaraj K, Sumalatha BV, Sundararaj R. 2021. New distributional record of invasive Neotropical coconut whitefly *Aleurotrachelus atratus* (Hemiptera:

Aleyrodidae) in Tamil Nadu, India. *Insect Environ*. 24(2): 230–235.

Senthoorraja R, Subaharan K, Sowmya M, Pragadessh VS, Bakthavatsalam N, Mohan M, Senthil-Nathan S, Basavarajappa S. 2021. Electrophysiological, behavioural and biochemical effect of *Ocimum basilicum* oil and its constituents methyl chavicol and linalool on *Musca domestica* L. *Environ Sci Pollut Res*. 28: 50565–50578.

Sharanabasava H, Pramesha D, Prasannakumar MK, Chidanandappa E, Yadav MK, Ngangkhama U, Parivallal B, Raghavendra BT, Manjunatha C, Sharma SK, Karthikh N. 2021. Morpho-molecular and mating-type locus diversity of Ustilaginoidea virens, an incitant of false smut of rice from Southern parts of India. *J. Appl. Microbiol*. DOI: 10.1111/JAM.15087

Shivakumara KT, Keerthi MC, Polaiah AC, Yogeesh KJ, Venkatesan T, Suthara MK, Sarana PL. 2021. First report of Bihar hairy caterpillar, *Spilarctia obliqua* Walker (Lepidoptera: Erebidae), infesting sweet basil in India. *Int J Pest Manag.* DOI: 10.1080/09670874.2021.2014078.

Shivakumara KT, Venkatesan T, Keerthi MC, Shashank PR, Pradeeksha N, Polaiah AC, Reddy PN, Saran PL, Manivel P. 2021. Occurrence of *Pyrausta panopealis* on sweet basil *Ocimum basilicum* in India. *J Environ Biol.* 42: 265–270.

Singh K, Aggarwal R, Sharma S, Gurjar MS, Manjunatha C, Choudhary M. 2021. Molecular and phenotypic analysis reveals cross infection of *Bipolaris* species in wheat and rice. *Indian Phytopathol*. 74: 929–938.

Singh K, Aggarwal R, Verma PK, Verma S, Sharma S, Manjunatha C, Choudhary M, Kulshreshtha D, Rawat K. 2021. Functional analysis of *SCD1* gene involved in pathogenicity of spot blotch disease of wheat causing fungus *Bipolaris sorokiniana*. *Indian Phytopathol*. DOI: 10.1007/s42360-021-00436-x

Sivakumar G, Mohan M, Kannan M, Elango K, Ram Kumar P, Venkatesan T, Rangeshwaran R, Mahesh, Y, Dhanyakumar O. 2021. Natural occurrence of entomopathogens on the invasive fall armyworm, *Spodoptera frugiperda* (J.E. Smith) in South India, *Currrent Sci*. 120(4): 619–621.

Sreedevi K, Veena NV, Joshi S, Mohan M, Sampath Kumar M, Mahendiran G, Venkatesan T, Shylesha AN. 2021. Record of coccinellid predator, *Hyperaspis maindroni* Sicard (Coleoptera: Coccinellidae) on invasive cassava mealybug, *Phenacoccus manihoti* Matile-Ferrero (Hemiptera: Pseudococcidae). *J Biol Control*. 34(4): 303–307.

Sreerama Kumar P, Gupta SK. 2021. First report on the occurrence of *Typhlodromus* (*Anthoseius*) *transvaalensis* (Nesbitt) (Acari: Phytoseiidae) in India with a redescription of the species. *Acarol*. 61(1): 55–61.

Sreerama Kumar P, Rachana RR. 2021. *Scirtothrips dorsalis* (Thysanoptera: Thripidae) is a pest of celery, *Apium graveolens* (Apiales: Apiaceae): first report and diagnostic characters. *J Integr Pest Manag.* 12(1): 46; 1–5.

Sreerama Kumar P. 2021. First report of *Richardia scabra* as a symptomatic host of '*Candidatus* Phytoplasma trifolii' (16SrVI-A Subgroup) from Bengaluru, India. *Plant Dis.* 105: 1187.

Sridhar J, Nagesh M *et al*. 2022. Species composition and distribution of the vector aphids of PVY and PLRV in India. *Potato Res*. (Accepted).

Subaharan K, Senthoorraja R, Manjunath S, Thimmegowda GG, Pragadheesh VS, Bakthavatsalam N, Mohan M, Senthil-Nathan S, David KJ, Basavarajappa S, Ballal CR. 2021. Toxicity, behavioural and biochemical effect of *Piper betle* L. essential oil and its constituents against housefly, *Musca domestica* L. *Pestic Biochem Phys*. 174: 104804.

Sundararaj R, Selvaraj K, Sumalatha BV. 2021. Invasion and expansion of exotic whiteflies (Hemiptera: Aleyrodidae) in India and their economic importance. *Phytoparasitica*, 49: 851–863.

Veenakumari K, Sreedevi K, Mohanraj P, Khan RF. 2021. Revision of Indian species of Phanuromyia Dodd, 1914 (Platygastroidea: Scelionidae) with descriptions of new species. *Dtsch Entomol Z*. 68(2): 309–339.

Velavan V, Rageshwaran R, Sivakumar G, Sasidharan TO, Sundararaj R, Kandan A. 2021. Occurrence of *Metarhizium* spp. isolated from forest samples in South India and their potential in biological control of banana stem weevil *Odoiporus longicollis* Oliver. *Egypt J Biol Pest Control.* 31: 131.

Visalakshi M, Selvaraj K, Poornesha B, Sumalatha BV. 2021. Biological control of invasive pest, rugose spiralling whitefly in coconut and impact on environment. *J Entomol Zool Stud*. 9(1): 1215–1218.

Yadav K, Ali SA, Mohanty AK Eshwarmoorthy M, Subaharan K, Kaul G. 2021. MSN, MWCNT and ZnO nanoparticle-induced CHO-K1 cell polarisation is linked to cytoskeleton ablation. *J Nanobiotechnol* 19, 45. DOI:10.1186/s12951-021-00779-7.

Books/book chapters

Awasthi DP, De B, Das P, Debbarma D, Sreerama Kumar P. 2021. Book of Abstracts, National Webinar on plant diseases in Eastern and Northeastern India: current dynamics and proposed action plan for their management. Tripura: College of Agriculture, Lembucherra, Tripura.

Bhagat D, Shylesha AN, Bakthavatsalam N. 2021. Nano formulations of pheromones and their application in insect pest management, pp. 133–143. In: Haldhar SM, Saha RK, Nagesh M, Bakthavatsalam N, Sinha B. (eds) *Souvenir cum Abstract Book, National Conference on Priorities in Crop Protection for Sustainable Agriculture*, Central Agricultural University, Imphal, Manipur, 16–18 March 2021.

Bhagat D. 2021. Nanotechnology for agricultural pest management – make in India: aunique approach. In: Ganguly P, Siddiqui MW, Goswami TN, Ansar M, Sharma SK, Anwer MA, Prakash N, Vishwakarma R, Ghatak (eds). *Souvenir cum Abstract Book, International Web Conference on Ensuring Food Safety, Security and Sustainability through Crop Protection*, Bihar Agricultural University, Sabour, Bhagalpur, 5–6 August 2020.

Ballal CR, Kandan A, Varshney R, Gupta A, Shylesha AN, Navik O, Venkatesan T, Gracy G, Ramanujam B, Rangeshwaran R, Sivakumar G, Nagesh M, Patil J, Amala U, Shivalingaswamy TM, Subaharan K, Bakthavatsalam N, Lalitha Y, Poornesha B, Apoorva V, Ashika TR, Nayyar N. 2021. Biological control for fall armyworm management in Asia. of major fruit crops. In: Dutta P, Chakraborty A, editors. Current trends in plant health management. Biotica Publishers.

Rangeshwaran R, Visalakshi M, Patro B, Raghunandan B, Apoorva V. 2021. *Bacillus thuringiensis* as a microbial biocontrol agent for the management of fall armyworm. In: Ballal CR, Kandan A, Varshney R, Subaharan K, editors. Attempts to rub the paw marks of FAW sans chemicals. Bengaluru: ICAR–NBAIR.

Sampathkumar M, Rangeshwaran R, Shylesha AN, Nagesh M, Subaharan K, Kandan A, David, KJ, Salini S, Mahendiran G, Patil J, Selvaraj K, Amala U, Varshney R, Navik O, Veereshkumar, Ballal CR. 2021. Awareness and training programmes on fall armyworm management organised by ICAR-NBAIR. In: Ballal CR, Kandan A, Varshney R, Subaharan K, editors. Attempts to rub the paw marks of FAW sans chemicals. Bengaluru: ICAR–NBAIR.

Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. 2021. Abstract Book, Sixth National Conference on Biological Control – Innovative Approaches for Green India. Bengaluru: Society for Biocontrol Advancement.

Sivakumar, G, Mohan M, Kannan M, Venkatesan T, Rangeshwaran R, Yandigeri M, Raveendran P, Ballal CR, Shyam Prasad G, Nelson J. 2021. Isolation and characterization of a novel indigenous isolate of Nucleopolyhedrovirus (SpfrNPV NBAIR01) and its utilization against the invasive fall armyworm. In: Ballal CR, Kandan A, Varshney R, Subaharan K, editors. Attempts to rub the paw marks of FAW sans chemicals. Bengaluru: ICAR–NBAIR.

Varatharajan R, Maisnam S, Th J, Rachana RR. 2021. Gall inducing thrips (Insecta: Thsanoptera) of North East India. In: Jacob JP, editor. Gall inducing arthropods on forest trees. Scientific Publishers.

Varshney R, Gupta A, Navik O, Shylesha AN, Lalitha Y, Raghunandan BL, Prasad S, Visalakshi M, Galande S. 2021. Parasitoids and predators of fall armyworm and their utilization for FAW management. In: Ballal CR, Kandan A, Varshney R, Subaharan K, editors. Attempts to rub the paw marks of FAW sans chemicals. Bengaluru: ICAR–NBAIR.

Venkatesan T, Ashika TR, Nayyar N, Gracy RG. 2021. Molecular characterization and strainal variations in Indian FAW populations. In: Ballal CR, Kandan A, Varshney R, Subaharan K, editors. Attempts to rub the paw marks of FAW sans chemicals. Bengaluru: ICAR–NBAIR.

Yandigeri MS. 2021. Role of actinomycetes in insect pest and plant disease management. In: Rajeshwari R, Appanna V, editors. Biopesticides in Horticultural Crops. New Delhi: Jaya Publishing House.

Technical bulletins/folders/training manuals/ popular articles

David KJ, Gupta A. 2021. Identification of Cecidomyiidae and its parasitoids. ICAR–NBAIR, Bengaluru, 34 pp.

Rachana RR, Shylesha AN. 2021. Invasive thrips, *Thrips parvispinus* (Karny) threatening chilli cultivation in India. ICAR–NBAIR, Bengaluru.

Sampathkumar M, Mohan M, Shylesha AN, Joshi S, Gupta A. 2021. Trainer's training manual on 'Mass Production and release techniques of *Anagyrus lopezi* for the classical biological control of cassava mealybug in India'. ICAR–NBAIR, Bengaluru, 64 pp.

Selvaraj K, Sumalatha BV, Sundararaj R, Venkatesan T, Shylesha AN. 2021. Guide on diagnosis of invasive whiteflies and their natural enemies. Technical Bulletin No. 01/2021, ICAR–NBAIR, Bengaluru, 52 pp.

Selvaraj K, Sumalatha BV, Venkatesan T, Ramanujam B, Shylesha AN, Kandan A, Chalapathi Rao NBV, Visalakshi M. 2021. Biological control of invasive rugose spiralling whitefly *Aleurodicus rugioperculatus* on coconut and oil palm. Technical Bulletin No. 02/2021, ICAR–NBAIR, Bengaluru, 52 pp.

Selvaraj K, Venkatesan T, Sundararaj R, Kumar S. 2021. Management of rugose spiralling whitefly in coconut (Tamil), Coconut Development Board, Kochi, 6 pp.

Reports

Amala U, Sampathkumar M, Sivakumar G, Bakthavatsalam N. (eds) 2021. *Crop Pest Report & Media Coverage 2020–21*. AICRP–BC, ICAR–NBAIR, Bengaluru, 36 pp.

Sivakumar G, Venkatesan T, Varshney R, Amala U, Sampath Kumar M, Selvaraj K, Kandan A, Patil J, Mahendiran G, Mohan M, Subaharan K, Navik O, Ramkumar P, Joshi S, Bakthavatsalam N. (eds). *AICRP–BC Annual Progress Report 2020–2021*, ICAR–NBAIR, Bengaluru, 406 pp.

Sreerama Kumar P, Amala U, Rachana RR, Ramya RS, Gupta A, Sreedevi K, Bakthavatsalam N. (eds) 2021. *Annual Report 2020*, English version, ICAR–NBAIR, Bengaluru, vi + 96 pp.

Newsletters

Amala U, Ramya RS, Rachana RR, Subaharan K, Bakthavatsalam N. (eds) 2021. *NBAIR Newsletter*, XIII(2), June 2021, 8 pp.

Sreerama Kumar P, Amala U, Rachana RR, Ramya RS, Bakthavatsalam N. (eds) 2020. *NBAIR Newsletter*, XII(4), December 2020, 8 pp.

Sreerama Kumar P. (ed.) 2021. *Society for Invertebrate Pathology Newsletter*, 54(1), February 2021, 14 pp.

Sreerama Kumar P. (ed.) 2021. *Society for Invertebrate Pathology Newsletter*, 54(2), June 2021, 12 pp.

Sreerama Kumar P. (ed.) 2021. *Society for Invertebrate Pathology Newsletter*, 54(3), November 2021, 14 pp.

Subaharan K, Amala U, Rachana RR, Ramya RS, Bakthavatsalam N. (eds) 2021. *NBAIR Newsletter*, XIII(1), March 2021, 8 pp.

Newspaper articles

Gupta A. 2021. Crawl of the wild: Inside the National Insect Museum in Bengaluru. *Hindustan Times,* 13 November 2021

Selvaraj K. Awareness about the management of whitefly and compensation for the infected palms. *Prajavani*, 30 January 2021.

Selvaraj K. How to control rugose spiralling whitefly infesting coconut? *Dinamalar*, 11 October 2021.

Selvaraj K. How whiteflies came, saw and conquered India's crops. *The Hindu*, 23 May 2021.

Selvaraj K. Inspection and awareness cum demonstration programme for the management of rugose spiralling whitefly. *Prajavani*, 30 January 2021.

Selvaraj K. Management strategies for the rugose spiralling whitefly in coconut – demonstration for the farmers. *Dinakaran*, 13 October 2021.

11. TECHNOLOGIES, PRODUCTS AND PATENTS

Technologies developed

1. Shatpada MIT-TRI: Multiple insecticide tolerant strain of egg parasitoid, *Trichogramma chilonis.*
2. High Shatpada Tricho-Kill: High temperature tolerant strain of egg parasitoid *Trichogramma chilonis.*
3. Pesticide Shatpada Chrys-Kill: Pesticide tolerant strain of aphid lion *Chrysoperla zastrowi sillemi,* an important predator of sucking pests.
4. Novel insecticidal WP formulations of *Heterorhabditis indica* for the biological control of white grubs & other soil insect pests.
5. Novel wettable powder formulation of *Pochonia chlamydosporia* as bionematicide against plant parasitic nematodes.
6. Shatpada Terminator - Liquid formulation of *Bacillus thuringiensis* isolates against lepidopteran pests.
7. Powder based formulation of *Pseudomonas fluorescens* (NBAIR-PFDWD), an antimicrobial 2,4-diacetylphloroglucinol (DAPG) producing biotic and abiotic stress tolerant strain for *Thrips* species management.
8. Shatpada: A dispenser for monitoring of eucalyptus gall wasp, *Leptocybe invasa.*
9. Shatpada Salinator - Bioformulation of salinity tolerant isolate of *Trichoderma harzianum* for biological management of plant diseases.
10. Shatpada Carbenderma - Bioformulation of carbendazim tolerant *Trichoderma harzianum* for biological management of plant diseases.
11. Wettable Powder based formulation of *Bacillus megaterium* NBAII 63 for the growth promoting ability in brinjal and tomato.
12. Shatpada: A plant volatile-based attractant for enhanced attraction of fruit fly.
13. Shatpada Plant Growth Booster - Plant growth promoting strain of *Bacillus megaterium* for vegetable crops.
14. Shatpada: Protocol for designing lure for impregnating parapheromone 4[4-acetoxy) phenyl-butanone to attract male flies of *Bactrocera* spp attacking cucurbit crops for mass trapping and monitoring its population thereof.
15. Shatpada: Controlled release dispenser for delivery of semiochemicals.
16. Shatpada: Herbal based Repellant for Termites on woody trees-REPTER.
17. Shatpada: Herbal swabber for the management of white stem borer *Xylotrechus quadripes* in Coffee (organic) B. Booster for boosting plant health in coffee (not for certified organic coffee).
18. Shatpada: Adsorption and delivery of molecules using nanoporous materials' for use in effective management of fall army worm, *Spodoptera frugiperda.*
19. Shatpada: Shatpada Dorsa-Delta, an efficient trap for mango fruit fly.
20. Shatpada: A Technique for the rearing of housefly parasitoid *Spalangia cameronensis.*
21. Shatpada: A Technique for the rearing of housefly parasitoid *Nasonia vitripennis* (Pteromalidae).
22. Shatpada-Organic waste bio-converter - Waste to wealth: Technology on Black Soldier Fly mediated bioconversion of farm and kitchen wastes.
23. Shatpada: Insect repellent formulation and methods thereof.
24. Shatpada Novel Device: Novel Device for Field Release of Parasitoids.
25. Shatpada Grubicide- *Metarhizium anisopliae* NBAIR Ma4 for management of white grubs infesting Sugarcane.
26. Shatpada Larvicide - *Metarhizium anisopliae* NBAIR Ma35 for management of Fall armyworm *Spodoptera frugiperda* in Maize.
27. Shatpada Armour – Liquid formulation of *Bacillus thuringiensis* for the management of fall army worm (*Spodoptera frugiperda*).

28. Aqueous formulation of *Spodoptera frugiperda* nucleopolyhedrovirus (SpfrNPV) NBAIR 1 strain for the management of FAW.

29. Bioformulation of *Bacillus subtilis* strain NBAIR BS1 for growth promotion in Biotic stressed Tea plantation.

30. Shatpada Rugose Whitefly kill - *Isaria fumosorosea* NBAIR Pfu5 for management of rugose spiralling whitefly *Aleurodicus rugioperculatus* in coconut and oil palm.

31. Shatpada Aleuro-Kill - Mass production technology for parasitoid *Encarsia guadeloupae* for the suppression of rugose spiralling whitefly.

32. Shatpada: A volatile attractant for trapping uzi fly, *Exorista bombycis*, parasitoid pest on mulberry silkworm Bombyx mori based on pheromonal compounds.

33. Shatpada: A technique for the rearing of parasitoid *Nesolynx thymus* (Girault) and their use in the housefly, *Musca domestica* management.

34. Development and maintenance of isofemale and inbred lines of susceptible insect pest.

35. A simple technique of rearing brinjal shoot and fruit borer, *Leucinodes orbonalis.*

36. Shatpada Treat - Production and use of the predatory mite *Typhlodromus* (*Anthoseius*) *transvaalensis* to control mites and thrips in Mulberry.

37. Shatpada Fish Feed - Black soldier fly -based protein rich aquacultural feed: a viable replacement to fish meal.

Technologies commercialized

1. A volatile attractant for trapping uzi fly, *Exorista bombycis*, parasitiod pest on mulberry silkworm *Bombyx mori* based on pheromonal compounds.

2. Protocol for designing lure for impregnating parapheromone 4[4-acetoxy) phenyl-butanone to attract male flies of *Bactrocera* spp attacking cucurbit crops for mass trapping and monitoring its population thereof and Bisexual attractant.

3. *Metarhizium anisopliae* ICAR-NBAIR Ma 4 for management of white grubs in sugarcane.

4. A technique for rearing of parasitoid *Nesolyx thymus* (Girault) and their use in housefly, *Musca domestica* management.

5. Potential entomopathogenic fungus *Isaria fumosorosea* (Strain ICAR-NBAIR- Pfu-5) for management of rugose spiraling whitefly *Aleurodicus rugioperculatus* in coconut and oil palm.

6. Powder based formulation of *Pseudomonas fluorescens* (NBAIR-PFDWD), an antimicrobial 2,4-diacetylphloroglucinol (DAPG) producing biotic and abiotic stress tolerant strain for diseases and thrips management.

7. Wettable Powder based formulation of *Bacillus megaterium* NBAII 63 for the growth promoting ability in brinjal and tomato.

8. Liquid formulation of indigenous *Bacillus thuringiensis khurstaki* (Btk) isolates against lepidopteran pests.

9. Novel mass production technology for parasitoid, *Encarsia guadeloupae* for the suppression of rugose spiralling whitefly.

10. Waste to wealth: Technology on Black Soldier Fly mediated bioconversion of farm and kitchen wastes.

11. Novel insecticidal WP formulations of *Heterorhabditis indica* for the biological control of white grubs & other soil insect pests.

Achievements of ITMU under National Agriculture Innovation Fund Project

- Total technologies ready for commercialisation: 37
- Number of technologies commercialized: 11
- Number of licensees that purchased technologies from NBAIR: 18

Patents granted

1. A simple and novel Design for small-scale solid state mass production unit for Antagonistic fungi.
2. Amorphous formulation of *Pochonia chlamydosporia* as bionematicide anda method of preparing the same.
3. Amorphous formulation of Entomopathogenic nematodes as biopesticide.
4. Invert-emulsion formulation of a fungal antagonist for biological management of plant diseases.
5. Plant volatile composition for trapping Eucalyptus gall wasp, *Leptocybe invasa.*

Revenue generated during 2021

The total revenue generated was Rs. 47,39,467 through following activities.

Details	Revenue generated (₹)
Commercialisation of technologies	38,25,000
Sale of macrobials	6,50,457
Sale of microbials	1,78,480
Insect identification services	60,750
Training	24,780
Contract research	0
Sale of publications	0
Total	**47,39,467**

12. CONFERENCE PAPERS

Ahmad J, Tarique M, Askary H, Patil J, Mohiudin S, Mukhtar M. 2021. Field efficacy of entomopathogenic nematodes against two lepidopteran pests infesting kale, *Brassica oleracea* L. var. Khanyariin Kashmir valley. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Amala U, Shivalingaswamy TM. 2021. Trap nesting – a viable approach for conservation of solitary bees in pigeon pea. In: *Book of Abstracts*, *National Web Symposium on Recent Advances in Beneficial Insects*, *Natural Resins and Gums*, ICAR–Indian Institute of Natural Resins and Gums, Ranchi, Jharkhand, 25–26 February 2021.

Apoorva V, Rangeshwaran R, Kandan A, Shylesha AN, Manjunatha C. 2021. *Bacillus thuringiensis* (NBAIR-BT25) for effective management of fall army worm, *Spodoptera frugiperda* in maize. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Arora S, Stanley J, Patil N, Adak T, Srivastava C, Singh JP, Ramya RS, Samodhi NO, Jena M, Asher PP, Patel F, Patel M. 2021. Phosphine as methyl bromide alternative for QPS treatment of food grains in India. In: *Book of Abstracts, 11th International Conference on Controlled Atmosphere and Fumigation in Stored Products*, Manitoba, Canada, 22–27 August 2021.

David KJ, Salini S, Sachin K. 2021. Fruit flies as weed biocontrol agents – an Indian Perspective. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Dubey AK, Joshi S, Shivanna BK. 2021. Species composition and identification keys of coccid insect pests infesting arecanut in south India. In: *Book of Abstracts*, *International Conference on Recent Advances in Agriculture, Engineering and Biotechnology for Food Security*, BHU, Varanasi, 25–26 September 2021.

Gracy RG, Patil S, Swathi RS, Mohan M, Venkatesan T. 2021. DNA barcoding and molecular phylogeny of Indian Sphecidae (sensu lato). In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Gracy RG, Venkatesan T, Jyoti P, Agrawal A. 2021. Gene mining and identification of glutathione-s-transferase involved in insecticide resistance in *Plutella xylostella* (L.) population. In: Haldhar SM, Saha RK, Nagesh M, Bakthavatsalam N, Sinha B. (eds) *Souvenir cum Abstract Book*, *National Conference on Priorities in Crop Protection for Sustainable Agriculture*, Central Agricultural University, Imphal, Manipur, 16–18 March 2021.

Jyoti P, Basavaarya, Gracy RG, Agrawal A, Venugopala KM, Mohan M, Venkatesan T. 2021. Gene expression studies in Imidacloprid resistant predator *Chrysoperla zastrowi sillemi* and their phylogenetic classification. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Kandan A, Rangeshwaran R. 2021. Microbial biopesticides based biological control of crop pests. In: *Book of Abstracts*, *International Conference on Industrial Perspective*, *Challenges and Strategies in the Development of Novel Bio-pesticides*: *its Implication in Sustainable Pest and Disease Management*, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore, 11–12 March 2021.

Khokhar MK, Kumar A, Suby SB, Jat SL, Soujnya PL, Varshney R, Sreelatha D. 2021. Synthesis and validation of IPM strategy in maize for fall army worm management in farmer participatory mode. In: Haldhar SM, Saha RK, Nagesh M, Bakthavatsalam N, Sinha B. (eds) *Souvenir cum Abstract Book*, *National Conference on Priorities in Crop Protection for Sustainable Agriculture*, Central Agricultural University, Imphal, Manipur, 16–18 March 2021.

Lalitha Y, Varshney R, Navik O, Patil J, Shylesha AN, Ballal CR. 2021. Influence of storage of *Corcyra cephalonica* (Stainton) eggs on production of *Trichogramma chilonis* Ishii. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Linga V, Vijayakumar R, Patil J, Subaharan K, Navik O, Bakthavatsalam N. 2021. Biocontrol potential of entomopathogenic nematodes and their exploitation in sustainable management of *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) in maize. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Mahendiran G, Ganie SA, Khursheed S. 2021. Bio-ecology and natural enemies of European red mite, *Panonychus ulmi* (Koch.) in apple and almond. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Navik O, Venkatesh V, Lalitha Y, Varshney R, Patil J. 2021. Diversity and occurrence of native egg parasitoids of invasive fall armyworm *Spodoptera frugiperda* (J.E. Smith) in India, p. 24. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Navik O, Venkatesh V, Lalitha Y, Varshney R, Patil J. 2021. Parasitism potential of geographical strains of *Trichogramma chilonis* Ishii against fall armyworm *Spodoptera frugiperda* (J.E. Smith), p. 89. In: Haldhar SM, Saha RK, Nagesh M, Bakthavatsalam N, Sinha B. (eds) *Souvenir cum Abstract Book*, *National Conference on Priorities in Crop Protection for Sustainable Agriculture*, Central Agricultural University, Imphal, Manipur, 16–18 March 2021.

Patil J, Bakthavatsalam N, Subaharan K, Navik O. 2021. The efficacy of selected indigenous entomopathogenic nematodes against fall armyworm, *Spodoptera frugiperda*, in maize. In: *Book of Abstracts*, *Second International Congress of Biological Control*, Davos, Switzerland, 26–30 April 2021.

Patil J, Linga V, Vijayakumar R, Nagesh M. 2021. Biological control potential of entomopathogenic nematodes for management of insect pests. In: Haldhar SM, Saha RK, Nagesh M, Bakthavatsalam N, Sinha B. (eds) *Souvenir cum Abstract Book*, *National Conference on Priorities in Crop Protection for Sustainable Agriculture*, Central Agricultural University, Imphal, Manipur, 16–18 March 2021.

Rachana R.R. 2021. Invasive thrips species, *Thrips parvispinus* (Karny): an emerging pest on chilli. In: *Book of Abstracts*, *5th National Symposium on Plant Protection in Horticulture: Challenges and a Roadmap Ahead*, ICAR–Indian Institute of Horticultural Research, Bengaluru, 27–29 December 2021.

Rachana RR. 2021. Biodiversity of thrips on vegetables in Karnataka. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Rachana RR. 2021. Biodiversity of thrips on vegetables in Tamil Nadu. In: *Book of Abstracts*, *Golden Jubilee International Conference on Emerging Trends in Plant Protection for Sustainable Vegetable Cultivation*, Agricultural College and Research Institute, Thanjavur, 25–26 August 2021.

Raghul S, Kumar K, Sampathkumar M. 2021. Diversity and seasonal distribution of spiders (Arachnida: Araneae) in horticultural ecosystem at Karaikal, U.T. of Pudhucherry, p. 56. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Ramya RS, Navik O, Arora S. 2021. Phosphine as an alternative to methyl bromide for management of coffee berry borer, *Hypothenemus hampei* (Ferrari, 1867), p. 246. In: Haldhar SM, Saha RK, Nagesh M, Bakthavatsalam N, Sinha B. (eds) *Souvenir cum Abstract Book*, *National Conference on Priorities in Crop Protection for Sustainable Agriculture*, Central Agricultural University, Imphal, Manipur, 16–18 March 2021.

Rani E, Bhagat D. 2021. Comparative studies of agriculture pest pheromone synthesis fermentation vs organic method. In: *Bengaluru Tech Summit – INDIA BIO 2021*, Department of Electronics, Information Technology, Biotechnology, and Science and Technology, Government of Karnataka, 17–19 November 2021.

Salini S, David KJ, Rabbani MK. 2021. A review of predatory stink bugs of India and their use as biological control agents. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Sampathkumar M, Reang B, Mahendiran G, Shaw SS. 2021. New record of long-jawed orb-weaver, *Tetragnatha nitens* Audouin (Araneae: Tetragnathidae) from India In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Sampathkumar M, Mohan M, Shylesha AN, Joshi S, Gupta A, Venkatesan T, Ashika TR, Bakthavatsalam N. 2021. Severe occurrence of a new invasive cassava mealybug, *Phenacoccus manihoti* Matile-Ferrero (Pseudococcidae: Hemiptera) on cassava and its classical biological control opportunities in India, p. 61. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Selvaraj K, Sumalatha BV, Kandan A, Shylesha AN. 2021. Emerging invasive whiteflies (Hemiptera: Aleyrodidae) in India and their management strategies, pp. 45–46. In: *Book of Extended Abstracts*, *International Conference on Global Perspectives in Crop Protection for Food Security* (*GPCP–2021*), Tamil Nadu Agricultural University, 8–10 December 2021.

Selvaraj K, Sumalatha BV, Sundararaj R, Shylesha AN. 2021. Recent experiences and preparedness in management of invasive insects: biosecurity and quarantine regulatory perspective, pp. 25–32. In: Haldhar SM, Saha RK, Nagesh M, Bakthavatsalam N, Sinha B. (eds) *Souvenir cum Abstract Book*, *National Conference on Priorities in Crop Protection for Sustainable Agriculture*, Central Agricultural University, Imphal, Manipur, 16–18 March 2021.

Sivakumar G. 2021. Characterization and evaluation of aqueous formulation of indigenous nucleopolyhedrovirus infecting fall armyworm, *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in India. In: *Book of Abstracts*, *Second International Congress of Biological Control*, Davos, Switzerland, 26–30 April 2021.

Sreerama Kumar P. 2021. A late bloomer: biocontrol in floriculture via predatory mites and pathogens. In: *Book of Abstracts*, *Webinar on Biological Control of Insect Pests and Mites on Commercial Flower Crops*, ICAR–Directorate of Floricultural Research, Pune, 27 September 2021.

Sreerama Kumar P. 2021. A mycelial–conidial formulation of a silkworm-safe isolate of *Hirsutella thompsonii* to control *Polyphagotarsonemus latus* in mulberry, p. 111. In: *Book of Abstracts*, *2021*

International Congress on Invertebrate Pathology and Microbial Control & 53rd Annual Meeting of the Society for Invertebrate Pathology, Universidad de Guanajuato, Guanajuato, Mexico, and Université de Tours, Tours, France, through Le Studium Loire Valley Institute for Advanced Studies, Région Centre - Val de Loire, France, 28 June–2 July 2021.

Sreerama Kumar P. 2021. Pathogens and phytoseiids to control phytophagous mites. In: *Book of Abstracts*, *National Webinar on Validation of IPM Strategies for Sustainable Agriculture in Present Indian Context*, College of Agriculture, Lembucherra, Tripura, 10–11 August 2021.

Sreerama Kumar P. 2021. Positioning *Typhlodromus* (*Anthoseius*) *transvaalensis* as a strong candidate for augmentative biological control of phytophagous mites and thrips. In: *Book of Abstracts*, *Entomology 2021: In-Person & Virtual Annual Meeting of the Entomological Society of America*, Denver, USA, 31 October–3 November 2021.

Sreerama Kumar P. 2021. Type III generalist predator *Typhlodromus* (*Anthoseius*) *transvaalensis* is the new kid on the block, p. 67. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Srinivasamurthy K, Salini S, Gracy RG, Vinoth M. 2021. Diversity of economically important plant bugs (Hemiptera: Heteroptera) in areas surrounding Bangalore region. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Varshney R, Ghosh E. 2021. Competitive interactions between *Telenomus remus* Nixon (Hymenoptera: Platygastridae) and two trichogrammatids, exploiting fall armyworm (FAW) eggs. In: Haldhar SM, Saha RK, Nagesh M, Bakthavatsalam N, Sinha B. (eds) *Souvenir cum Abstract Book*, *National Conference on Priorities in Crop Protection for Sustainable Agriculture*, Central Agricultural University, Imphal, Manipur, 16–18 March 2021.

Veena NV, Sreedevi K, Correya JC, Srinivasamurthy K. 2021. Molecular characterization of predominant *Anomala* spp. (Coleoptera: Scarabaeidae: Rutelinae) of South India. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021.

Vijayakumar R, Patil J, Linga V. 2021. Molecular identification and phylogenetic of entomopathogenic nematodes from Karnataka, India. In: Sivakumar G, Venkatesan T, Kandan A, Gracy RG, Gupta A, Mahendiran G, Sampathkumar, M, Amala U, Bakthavatsalam N. (eds) *Book of Abstracts*, *Sixth National Conference on Biological Control – Innovative Approaches for Green India*, Society for Biocontrol Advancement, Bengaluru, 3–5 March 2021

13. MEETINGS AND DECISIONS

XXV Research Advisory Committee Meeting

The XXV meeting of the Research Advisory Committee (RAC) of the National Bureau of Agricultural Insect Resources was held on 5 July 2021 through video conferencing mode.

The following members of the RAC attended the meeting.

Dr Hari C. Sharma	Chairman
Dr A.R. Prasad	Member
Dr S. Mohankumar	Member
Dr Pradyumn Kumar	Member
Dr N. Bakthavatsalam	Member
Dr S.C. Dubey	Member
Mr Nanjundappa	Member
Mr Shivakumar	Member
Dr M. Mohan	Member-Secretary

General comments

Dr N. Bakthavatsalam, Director (Acting) of ICAR-NBAIR welcomed the Chairman and members of the RAC and highlighted the achievements made by the institute including the research outputs, publications, commercialisation and revenue generated.

1. Capacity building of young scientists.
2. Toxicological data for potential microbial strains should be developed through collaboration with other Institutes and public private partnership.
3. It was suggested to convene a meeting with the farmers' representatives (RAC) to discuss the issues faced by them.

The following comments / suggestions were given by the RAC:

I. Division of Germplasm Collection and Characterisation

Dr Sunil Joshi presented the research achievements of the division.

Recommendations

1. ICAR-NBAIR should forge linkage with other research Institutes and AICRP centres for collection of target groups of insect pests and natural enemies.
2. The functional significance of newly described insect species to be unravelled.

II. Division of Genomic Resources

Dr M. Nagesh presented the research achievements of the division.

Recommendations

1. The rice and maize strains of FAW be functionally characterized on different plant hosts through host specificity tests.
2. Studies on host utilisation mechanisms by microbial toxins species specific markers may be advocated for identifying agriculturally important insects instead of relying only on COI.

III. Division of Germplasm Conservation and Utilisation

Dr A.N. Shylesha presented the research achievements of the division.

Recommendations

1. Bio control agents should be evaluated and validated at different AICRP centres, and the validated bioagents should be passed on to NCIPM/ AICRPs for demonstration on a large - scale.
2. Plant oils/extracts for the management of stored grain pests to be developed as workable formulation.
3. Explore the possibilities for obtaining funding from FCI to develop alternative strategies for pest management in storage.
4. Research collaboration should be developed with AICRP on Honeybees and Pollinators, and Dr Y.S. Parmar University of Horticulture and Forestry, Solan for possible utilisation of Megachilid bees for pollination in apple growing areas of temperate regions.
5. Data on yield enhancement of crops due to pollination by stingless bees needs to be generated.

IV. Institute Technology Management Unit (ITMU)

Dr A. Kandan, Officer i/c ITMU presented the report.

Recommendations

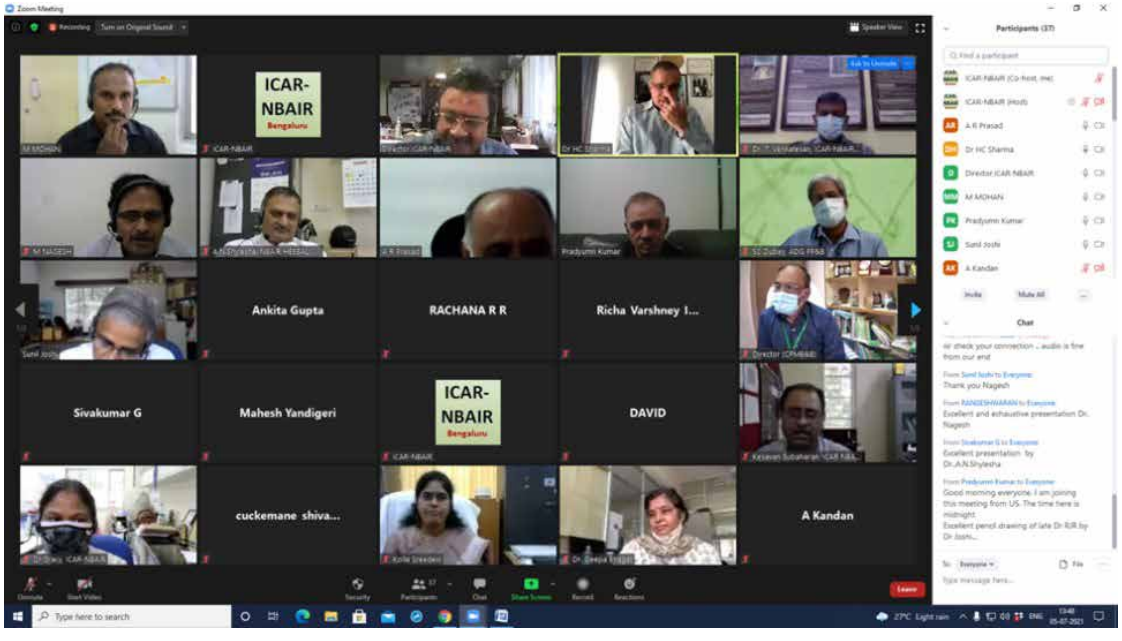
1. Figures and facts should be presented only for the technologies developed during the reporting period.

XLIV Institute Research Council Meeting

The XLIV Institute Research Council Meeting of the ICAR-NBAIR, Bengaluru, was held on 7–9 July 2021 under the chairmanship of Dr N. Bakthavatsalam, Director, ICAR–NBAIR.

General comments

1. Creation of National Identification service with a designated nodal officer.
2. Status paper on museum collections may be prepared.
3. Tailor-made paid training program on taxonomy of various groups should be taken up.
4. Preparation of dynamic distribution map for major insect groups with the help of Dr M Pratheepa.
5. Find ways to make the National Insect Museum as internationally popular among the researchers.
6. Use the IT funds appropriately for digitisation of museum specimens.
7. Propose YP-II for museum curation work.
8. National DNA barcode facility for insects to be created and issues related to DNA barcoding under different projects of the Bureau to be resolved.
9. Creation of stronger network for tackling invasives.
10. Strengthen work on new pest problems.
11. Standardize mass production technologies for challenging insects.
12. Add more technologies on microbials and pheromones.
13. Prepare list of exotic natural enemies to be imported in discussion with other scientists and Dr Muniappan, Director, IPM Innovation Lab, USA.
14. Roadmap for future research on insect pollinators with clear cut data.
15. Ways and means of preservation and cataloguing of all the microbial culture collections in one place to be discussed.



XXV RAC Meeting in progress

14. PARTICIPATION OF SCIENTISTS IN MEETINGS

Abroad (Virtual)

Dr P. Sreerama Kumar	"Executive Council Meeting of the Society for Invertebrate Pathology" organised online by the Society for Invertebrate Pathology, Verona, USA, 23 June 2021. "2021 International Congress on Invertebrate Pathology and Microbial Control & 53rd Annual Meeting of the Society for Invertebrate Pathology", virtual meeting organised by Universidad de Guanajuato, Guanajuato, Mexico, and Université de Tours, Tours, France, through Le Studium Loire Valley Institute for Advanced Studies, Région Centre - Val de Loire, France, 28 June–02 July 2021. "Business Meeting of the Society for Invertebrate Pathology" organised online by the Society for Invertebrate Pathology, Verona, USA, 02 July 2021. "First Virtual Meeting of the Main Authors on International Trade in Insects for a Special Issue of OIE Scientific and Technical Review" organised by Drs Megan Quinlan and John Mumford, Imperial College, London, UK, 24 September 2021. "Second Virtual Meeting of the Main Authors on International Trade in Insects for a Special Issue of OIE Scientific and Technical Review" organised by Drs Megan Quinlan and John Mumford, Imperial College, London, UK, 08 October 2021. "Entomology 2021: In-Person & Virtual Annual Meeting of the Entomological Society of America", Denver, USA, 31 October–03 November 2021.
Dr G. Sivakumar Dr Jagadeesh Patil	"Second International Congress of Biological Control" organised by International Organization for Biological Control (IOBC), Davos, Switzerland, 26–30 April 2021.
Dr Deepa Bhagat	"Insect olfaction and taste webinar" organised by Society of Entomology of Canada, 12 August 2021.
Dr Ankita Gupta	"Hymathon 2021" organized by the International Society of Hymenopterists - the Australasia Session, 7 May 2021.
Dr U. Amala	"Second International Webinar on Stingless Bees" organised by Regional Apiculture Center, Central Bicol State University of Agriculture, San Jose, Pili, 28 April 2021.
Dr R.S. Ramya	Natural History Live talk on "The Inside Out of Flies" by Dr Erica McAllister, Senior curator of Diptera at the Natural History Museum, London, organised by FSC Biolinks, 21 April 2021.

India

Dr T. Venkatesan	First Review meeting of Institute Biosafety committee, 6 August 2021. International Conference: Emerging Trends in Plant Protection for sustainable vegetable cultivation at Agricultural College & Research Institute, Eachankottai, Thanjavur, Tamil Nadu, 25–26 August 2021. Webinar on "Alternative to Chemical Pesticides for daily usage" organised by Institute for Pesticide Formulation Technology, Gurugram, Haryana, 13 October 2021. Webinar on "Implementation and Use of Agricultural Research Management System (ARMS)" organized by organized by ICAR–Indian Agricultural Statistics Research Institute, New Delhi, 20 October 2021.

Dr K. Srinivasa Murthy	Webinar on "Training on Enhancing Research skills and Refinement of Technology by a Scientist", organised by the ICAR–Indian Institute of Horticultural Research, Bengaluru, 18–20 January 2021. Webinar on "Role of ICAR-NAARM in promoting Agricultural Start-ups in BIRAC-BIG Grant, organised by the ICAR–National Agricultural Agricultural Research,18 January 2021. Webinar on "Entrepreneurship Opportunities in Post-Harvest Technologies" organised by NaaVIc Agribusiness Incubation Centre, ICAR–National Institute of Veterinary Epidemiology and Disease Informatics, College of Horticulture, University of Horticultural Sciences, Bengaluru, 29 January 2021. International Webinar on "Alternative Therapies to mitigate Microbial Resistance", organized by ICAR–Indian Veterinary Research Institute, Izatnagar, 23–24 February 2021. National Web Symposium on "Recent Advances in Beneficial Insects, Natural Resins and Gums" organised by ICAR-Indian Institute of Natural Resins and Gums, Ranchi, 25–26 February 2021. "Opportunities for Agri-Start-ups and entrepreneurs in microbial bio-inoculants, soy food processing and soybean production Technologies" organised by ICAR–Indian Institute of Soybean Research, Indore and Agribusiness Incubation Centre, New Delhi, 16–17 March 2021. ASEAN Fall Army Worm Resistance Management Plan Workshop, 27 April 2021. National Symposium on Biological Invasions (Africa Action together against Biological Invasives), 5 May 2021. Webinar on "Computational Approach for inferring molecular mechanisms in Psychiatric disorders", 15 May 2021. Webinar on "Implementation and Use of Agricultural Research Management System" organised by ICAR–Indian Agricultural Statistics Research Institute, New Delhi, 8 June 2021. Webinar on "Science Today-An Indian Perspective" organised by Indian Institute of Technology, Mumbai, 25 June 2021. Webinar on "Space Entomology - Its significance in Astronaut's world" organised by Plant Protection Association of India, Hyderabad, 29 November 2021. Webinar on "Ethics and Academic Integrity in Research" organised by ICAR-National Research Centre for Grapes, Pune, 29 November 2021.
Dr T.M. Shivalingaswamy	Virtual Annual General Body meeting of Indian Pollinator Initiative, 27 November 2021.
Dr P. Sreerama Kumar	"Brainstorming Meeting on Integrated Management of Sap-Sucking Pests (Thrips and Mites) of Mulberry–Current Status and Future Prospects" organised by the Karnataka State Sericulture Research and Development Institute at Thalaghattapura, Bengaluru, 23 February 2021.

Dr P. Sreerama Kumar	"National Webinar on Plant Diseases in Eastern and Northeastern India: Current Dynamics and Proposed Action Plan for Their Management" organised by Department of Plant Pathology, College of Agriculture (CAT, Lembucherra, Tripura) in collaboration with All-India Coordinated Research Project on Pigeonpea (Tripura Centre, CAT) and in association with ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 24–25 June 2021. "National Webinar on Validation of IPM Strategies for Sustainable Agriculture in Present Indian Context" organised by Department of Agricultural Entomology, College of Agriculture, Lembucherra, Tripura, in collaboration with Department of Botany, Rabindranath Thakur Mahavidyalaya, Sepahijala, Tripura, 10–11 August 2021. "Meeting on Integrated Management of Mites and Thrips of Mulberry with Special Reference to Utilising the Control Measures Available at ICAR–NBAIR" organised by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 13 August 2021.
Dr K. Subaharan	"Consultative meeting on Human Animal Conflict" at Hotel Taj, Bengaluru, September 2021. "Workshop on National Science and Technology Survey organized by ICAR–National Academy of Agricultural Research Management, 27 November 2021. "Consultative meeting on Regenerative Agriculture" organised by Echo Network, 31 November 2021.
Dr G. Sivakumar	Virtual meeting on "Technological Innovation and Brain Storming session for identifying Key Research areas for Small Tea Growers" organised by National Tea Research Foundation, 21 May 2021. Virtual "National Symposium on Sustainable Plant Health Management Amidst Covid Pandemic: Challenges and Strategies", 1–3 December 2021.
Dr M. Mohan	"Annual work progress of Consortium Research Platform on Genomics project", organised by ICAR–National Bureau of Fish Genetic Resources, Lucknow, 24 December 2021.
Dr Deepa Bhagat	Virtual webinar entitled "Biological Control of Soil Arthropod Pests" organised by the Foundation for Agricultural Resources Management and Environmental Remediation (FARMER), 2 January 2021. Board of studies meeting organised by Department of Physical Sciences, Rabindranath Tagore University, Bhopal, 14 July 2021. One day webinar "Vigyan Sai Samaj Tak" organised by I-STEM, 31 July 2021. One day online webinar "Invasive pests and diseases problem in Indian Agriculture" jointly organised by Department of Entomology and Plant Pathology and N.M. College of Agriculture, Navsari Agricultural University, Navsari, 7 August 2021. "DST & ACS Workshop", 11 August 2021. Virtual webinar on "Nanostructured Materials (NSMs) in Food Packaging, Preservation and diagnostics" organised by TERI-Deakin Nanobiotechnology Centre (TDNBC), Gurugram, India and Deakin University, Australia, in association with Department of Biotechnology, Government of India, 26 August 2021.

Dr Kolla Sreedevi	XXII Annual Review workshop of All India Network Project on Soil Arthropod Pests, 20 July 2021.
Dr Mahesh Yandigeri	Special Lecture Series "Aspergili: Advances and Challenges" organised by ICAR–Indian Agricultural Research Institute, New Delhi, 23 August, 2021.
Dr A. Kandan	Virtual International webinar on "Desert locust *Schistocerca gregaria* (Forskål) International scenario and a potential threat to India' organised by National Institute of Plant Health Management, Hyderabad, 02 July 2021. Virtual International webinar on "Recent advances in sustainable integrated disease management in plantation crops" organised by ICAR–Indian Institute of Oil Palm Research, Pedavegi from 6–8 July 2021. Regional webinar "Tools and challenges for the management of Desert locust" under Centre for Agriculture and Bioscience International(CABI)-Food and Agricultural Organization (FAO) project on Coordinative surveillance and early warning for sustainable management of Transboundary plant pests in Asia, 24 September 2021. Virtual International webinar on "Bio Control - A Global Sustainable Approach for Eco-Friendly Agriculture" organised by National Institute of Plant Health Management, Hyderabad, 24 September 2021.
Dr G. Mahendiran	Virtual "National Workshop on Follow-up Action on 'Delhi Declaration on Agrobiodiversity Management" organised by ICAR–National Bureau of Plant Genetic Resources, New Delhi, 10 August 2021. Virtual Diagnostic Entomology Photography Workshop "Techniques for producing high quality images for digital identification tools" presented by United States Department of Agriculture (USDA) Identification Technology Program, Hume Douglas and Agriculture and Agri-food Canada, 19 October 2021. Virtual "Two-day International Weevil Workers Meeting", 22–23 October 2021. Virtual International Webinar on "Fighting the Hunger using Smart Technology" organised by ICAR–Indian Institute of Oil Palm Research, Pedavegi, Andhra Pradesh, 26 October 2021.
Dr Ankita Gupta	Virtual meeting "Grow Asia: Biocontrol WS 6: Biopesticide efficacy Part 2: Effective design of biopesticide trials", 8 April 2021. Virtual meeting "Grow Asia: Biocontrol WS 8: Biocontrol as part of an IPM Approach" 6 May 2021. Virtual "Validation workshop on FAW management in India & Bangladesh on regional consultation workshop of Fall Armyworm Management in India, 13 September 2021. Virtual meeting with CABI co-partners for possible collaboration of CABI projects on 2 December 2021.
Dr M. Sampath Kumar	Workshop on "Biocontrol of Invasive Crop Pests and Utilization of Insects as Food in North-East Region of India", College of Horticulture & Forestry, Pasighat, Arunachal Pradesh, 8–9 February 2021. Workshop on "Biological control of insect-pests of crops in North-east region of India", Central Agricultural University, Imphal, Meghalaya, 9–10 March 2021.

Dr K. Selvaraj	"Farmers meet cum demonstration on rugose spiralling whitefly", Gubbi at Tumkur, Karnataka, 5 January 2021. "Farmers meet cum demonstration on rugose spiralling whitefly" at Sendamangalam, Namakkal, Tamil Nadu, 12 January 2021. Interactive meeting on "Rugose spiralling whitefly on coconut, yellow leaf disease and stem borer infestation on arecanut and their management" at Directorate of Horticulture, Lalbagh, Bengaluru, 19 January 2021. "Farmers meet cum demonstration on rugose spiralling whitefly" at Biramangala, Ramanagara, Karnataka, 30 January 2021. "Demonstration of biocontrol agents on invasive whiteflies in coconut" at Kanakapura, Ramanagara, Karnataka, 8 July 2021. Virtual Brainstorming session on "Invasive whitefly complex on plantation crops: Technical knowledge and technological interventions for management" organised by ICAR–Indian Institute of Oil Palm Research, Pedavegi, West Godavari, Andhra Pradesh, 17 July 2021. Awareness-cum-demonstration on "Biological control of rugose spiralling whitefly in coconut" at Krishi Vigyan Kendra, Hirehalli, Tiptur, Karnataka, 2 August 2021. Awareness-cum-demonstration on "Management of invasive whiteflies using biological control agents in coconut" at DSP farm & KRS, Mandya, Karnataka, 30 September 2021. Meeting on "Assessment of the impact of invasive whitefly species on coconut" along with Coconut Development Board, RC, Bengaluru and Department of Horticulture, Government of Karnataka, Tumkur, 7 October 2021. "Training cum demonstration on biological control of invasive whiteflies infesting coconut" at Paramathy, Karur, Tamil Nadu, 8 October 2021. "Farmers meet cum demonstration on invasive whiteflies in coconut" at Srirangapatana, Mandya, Karnataka, 11 October 2021.
Dr U. Amala	Virtual webinar on "Agro ecological approaches for fall armyworm management" organised by Food and Agriculture Organization of the United Nations, 16 July 2021. Virtual webinar on "Flying Food - Nutritious crickets for delicious food security, entrepreneurship and income generation", 15 September 2021. Virtual webinar on "Regional webinar on Agro ecological practices for Fall Armyworm Management" jointly organised by Food and Agriculture Organization (FAO) and Centre for Agriculture and Bioscience International (CABI) India, 21 October 2021.
Dr Navik Omprakash Samodhi	"Experience from Lab bioassays in India" in 'First Webinar on Regional Exchange on FAW' organised by Centre for Agriculture and Bioscience International, India, 22 February 2021.
Dr Kesavan Subaharan Dr G. Sivakumar Dr M. Mohan Dr Ankita Gupta Dr M. Sampath Kumar Dr Richa Varshney	Workshop on "Biocontrol of invasive crop pests and utilisation of insects as food in North-East region of India" at College of Horticulture & Forestry (COHF), Pasighat, Arunachal Pradesh, 8–9 February 2021.

Dr N. Bakthavatsalam Dr M. Nagesh Dr M. Pratheepa Dr Kolla Sreedevi Dr U. Amala Dr Navik Omprakash Samodhi Dr C. Manjunatha	Workshop on "Biocontrol of Invasive Crop Pests and Utilization of Insects as Food in North-East Region of India" organised by Central Agricultural University, Imphal and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru at College of Agricultural Engineering & Post Harvest Technology, Ranipool, Sikkim, 11–12 February, 2021.
Dr M. Nagesh Dr T.M. Shivalingaswamy Dr Kesavan Subaharan Dr M. Pratheepa Dr Deepa Bhagat Dr Ankita Gupta Dr Jagadeesh Patil Dr K. Selvaraj Dr Richa Varshney Dr R.S. Ramya	National Conference on "Priorities in Crop Protection for Sustainable Agriculture" at College of Agriculture, Iriosemba, Imphal, 16–18 March 2021.
All the scientists	Virtual International Webinar on "Insect Systematics: Importance, Challenges and Way forward" organised by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 29 January 2021.
	Virtual webinar to celebrate 'World Bee Day' under the theme 'Bee engaged – Build Back Better for Bees organised by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 20 May 2021.
	Virtual XXX Annual Group Meeting of All India Coordinated Research Project on Biological control of Crop Pests, 14 July 2021.
	Virtual webinar on "Genome editing for biotic stress management" by Dr. T. Makeshkumar, Principal Scientist, ICAR–Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram organised by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru 26 August 2021.
	Virtual webinar on "Taxonomic diversity vis a vis functional diversity in insects-Back to basics but looking forward' by Dr (Smt.) Dhriti Banerjee, Director, Zoological Survey of India, Kolkata organised by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru 6 October 2021.
All the scientists	Virtual webinar on "Microbes for IPM and its importance in Atmanirbhar Bharat for sustainable crop production" by Dr Rajab Abu Vyas, Anand Agricultural University, Gujarat organised by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 2 November 2021.
	Virtual Brainstorming session on 'Classical and Molecular Taxonomy - Standalone or complimentary' organised by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 18 November 2021.

15. TRAININGS CONDUCTED AND CAPACITY BUILDING

S. No.	Trainee(s)	Particulars of the training programme	Date(s)	Coordinator(s)**/ resource person(s)*	Number of partici-pants	Income generation if any (in ₹)
1.	Mr Pandurang V. Jagtap MSc (Agricultural Entomology), RCSM College of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra	EPN production techniques	18–22 January 2021	Dr Jagadeesh Patil*	1	NA
2.	Officials of Department of Horticulture, Government of Karnataka	Mass production of *Isaria fumosorosea* for the management of coconut RSW	05–06 February 2021	Dr K. Selvaraj* Dr A. Kandan*	7	NA
3.	Officials of Department of Horticulture, Government of Karnataka	Mass production of *Isaria fumosorosea* for the management of coconut RSW	17 February 2021	Dr K. Selvaraj* Dr A. Kandan*	8	NA
4.	Ms Gillella Vedavati PhD scholar, Madras Christian College, Tambaram, Chennai	Mass rearing of *Helicoverpa armigera* and *Spodoptera litura*	22 February 2021	Dr Richa Varshney*	1	590/-
5.	Ms Sneha Kumari, Research scholar, Department of Zoology, Babasaheb Bhimrao Ambedkar University, Lucknow	Mass rearing of wax moth and EPN	01–06 March 2021	Dr Jagadeesh Patil *	1	2,950/-
6.	Final year BSc Agriculture students (13 from University of Agricultural Sciences, Bengaluru, GKVK; and 6 from College of Agriculture, Hassan)	Student training under RAWEP/ READY programme	15 March–03 April 2021	Dr M. Sampath Kumar** Dr K. Subaharan** Dr Richa Varshney* Dr Navik Omprakash Samodhi* Dr Jagadeesh Patil* Dr R. Rangeshwaran* Dr A. Kandan* Dr T.M. Shivalingawamy* Dr U. Amala* Dr G. Sivakumar* Dr M. Mohan* Dr Y. Lalitha*	19	NA

7.	Scientists, Assistant Professors, Plant Protection Officers	Fruit fly surveillance and management, organized by National Institute on Plant Health Management, Hyderabad	21 April 2021 and 01 September 2021	Dr K.J. David*	30	NA
8.	Progressive farmers from Dharmapuri district, Dept. of Horticulture and Plantation Crops, Govt. of Tamil Nadu	Awareness training on cassava mealybug and fall armyworm	03 September 2021	Dr M. Sampath Kumar* Dr M. Mohan*	25	NA
9.	Dr V.K. Biradar, Associate Professor (Entomology) Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola	Identification of linseed midges and its parasitoids	21 September 21	Dr Sunil Joshi* Dr Ankita Gupta* Dr K.J. David*	1	NA
10.	K.N. Purna Chandra Rao, C/o Godrej Agrovet Ltd. Chintampalli, Andhra Pradesh	Mass production of *Isaria fumosorosea* for the management of coconut RSW	23 October 2021	Dr K. Selvaraj* Dr A. Kandan*	1	NA
11.	Ms Reji & Ms Subitha, C/o Cryptox Bio Solutions, Kanyakumari, Tamil Nadu	Scientific mass production techniques for major macrobials	26–28 October 2021	Dr M. Sampath Kumar** Dr Richa Varshney* Dr Navik Omprakash Samodhi* Dr Y. Lalitha*	2	21,240/-
12.	Assistant Professors (Entomology), Tamil Nadu Agricultural University; Officials (H.O. & A.D.H.) from Dept. of Horticulture and Plantation Crops, Govt. of Tamil Nadu	Trainers' training on mass production and release technique of *Anagyrus lopezi* for the classical biological control of cassava mealybug in India (Batch I)	12 November 2021	Dr M. Sampath Kumar** Dr Ankita Gupta** Dr M. Mohan* Dr A.N. Shylesha* Dr Sunil Joshi*	11	NA
13.	Assistant Professors (Entomology), Tamil Nadu Agricultural University; Officials (H.O. & A.D.H.) from Dept. of Horticulture and Plantation Crops, Govt. of Tamil Nadu	Trainers' training on mass production and release technique of *Anagyrus lopezi* for the classical biological control of cassava mealybug in India (Batch II)	23 November 2021	Dr M. Sampath Kumar** Dr Ankita Gupta** Dr M. Mohan* Dr A.N. Shylesha* Dr Sunil Joshi*	11	NA

14.	Final year BSc Agriculture students (9 from University of Agricultural Sciences, Bengaluru, GKVK; and 6 from College of Agriculture, Hassan)	Student training under RAWEP/ READY programme (Batch I)	29 November 2021–04 December 2021	Dr M. Sampath Kumar** Dr C. Manjunatha** Dr Richa Varshney* Dr Navik Omprakash Samodhi* Dr Jagadeesh Patil* Dr R. Rangeshwaran* Dr A. Kandan* Dr G. Sivakumar* Dr Y. Lalitha*	15	NA
15.	Assistant Professors (Entomology), Tamil Nadu Agricultural University; Officials (H.O. & A.D.H.) from Dept. of Horticulture and Plantation Crops, Govt. of Tamil Nadu	Trainers' training on mass production and release technique of *Anagyrus lopezi* for the classical biological control of cassava mealybug in India (Batch III)	02 December 2021	Dr M. Sampath Kumar** Dr Ankita Gupta** Dr M. Mohan** Dr A.N. Shylesha* Dr Sunil Joshi*	11	NA
16.	Final year BSc Agriculture students from University of Agricultural Sciences, Bengaluru, GKVK.	Student training under RAWEP/ READY programme (Batch II)	06–10 December 2021	Dr M. Sampath Kumar** Dr M. Mohan** Dr R.S. Ramya** Dr Richa Varshney* Dr Navik Omprakash Samodhi* Dr Jagadeesh Patil* Dr R. Rangeshwaran* Dr A. Kandan* Dr G. Sivakumar* Dr C. Manjunatha* Dr Y. Lalitha* Mr P. Raveendran*	9	NA
17.	Officials (H.O. & A.D.H.) from Dept. of Horticulture and Plantation Crops, Govt. of Tamil Nadu	Trainers' training on mass production and release technique of *Anagyrus lopezi* for the classical biological control of cassava mealybug in India (Batch IV)	14 December 2021	Dr M. Sampath Kumar** Dr Ankita Gupta** Dr M. Mohan** Dr A.N. Shylesha* Dr Sunil Joshi*	15	NA

HRD CELL ACTIVITIES

a. Capacity building programmes undertaken

S. No.	Particulars of the training programme	Date (s)	Clientele/s	Number of participants	Income generation if any (in ₹)
INSTITUTE CAPACITY BUILDING PROGRAMMES					
1.	Trainers' training on mass production and release technique of *Anagyrus lopezi* for the classical biological control of cassava mealybug in India (Batch I)	12 November 2021	Assistant Professors (Entomology), Tamil Nadu Agricultural University; Officials (H.O. & A.D.H.) from Dept. of Horticulture and Plantation Crops, Govt. of Tamil Nadu	11	NA
2.	Trainers' training on mass production and release technique of *Anagyrus lopezi* for the classical biological control of cassava mealybug in India (Batch II)	23 November 2021	Assistant Professors (Entomology), Tamil Nadu Agricultural University; Officials (H.O. & A.D.H.) from Dept. of Horticulture and Plantation Crops, Govt. of Tamil Nadu	11	NA
3.	Trainers' training on mass production and release technique of *Anagyrus lopezi* for the classical biological control of cassava mealybug in India (Batch III)	02 December 2021	Assistant Professors (Entomology), Tamil Nadu Agricultural University; Officials (H.O. & A.D.H.) from Dept. of Horticulture and Plantation Crops, Govt. of Tamil Nadu	11	NA
4.	Trainers' training on mass production and release technique of *Anagyrus lopezi* for the classical biological control of cassava mealybug in India (Batch IV)	14 December 2021	Officials (H.O. & A.D.H.) from Dept. of Horticulture and Plantation Crops, Govt. of Tamil Nadu	15	NA
INSTITUTE IN-HOUSE TRAINING PROGRAMME					
1.	In-house training on "Identification of linseed midges and its parasitoids"	21 September 2021	Associate Professor (Entomology) Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola	01	NA
2.	In-house training on "Mass production of *Isaria fumosorosea* for the management of coconut RSW"	23 October 2021	Godrej Agrovet Ltd. Chintampalli, Andhra Pradesh	01	NA
3.	Training on "Scientific mass production techniques for major macrobials"	26–28 October 2021	Cryptox Bio Solutions, Kanyakumari, Tamil Nadu	02	21,240

STUDENTS' TRAINING PROGRAMME					
1.	Training on "EPN production techniques"	18–22 January 2021	RCSM College of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra	01	NA
2.	Training on "Mass rearing of *Helicoverpa armigera* and *Spodoptera litura*"	22 February 2021	Madras Christian College, Tambaram, Chennai	01	590
3.	Training on "Mass rearing of wax moth and EPN"	01–06 March 2021	Department of Zoology, Babasaheb Bhimrao Ambedkar University, Lucknow	01	2950
4.	Student training under RAWEP/ READY programme	15 March–03 April 2021	Final year BSc Agriculture students (13 from University of Agricultural Sciences, Bengaluru, GKVK; and 6 from College of Agriculture, Hassan)	19	NA
5.	Student training under RAWEP/ READY programme (Batch I)	29 November 2021–04 December 2021	Final year BSc Agriculture students (9 from University of Agricultural Sciences, Bengaluru, GKVK; and 6 from College of Agriculture, Hassan)	15	NA
6.	Student training under RAWEP/ READY programme (Batch II)	06–10 December 2021	Final year BSc Agriculture students from University of Agricultural Sciences, Bengaluru, GKVK.	09	NA
FARMERS' VISIT-CUM-TRAINING PROGRAMME					
1.	Awareness training on cassava mealybug and fall armyworm	03 September 2021	Progressive farmers from Dharmapuri district, Dept. of Horticulture and Plantation Crops, Govt. of Tamil Nadu	25	NA

INSTITUTE VISITS

S. No.	Category	Date(s)	Institute/company they belong to	Number of visitors
1.	Virtual study tour attended by third year BSc (Ag.) students	16 September 2021	Kerala Agricultural University	100+3 staff
2.	MSc (Agricultural Entomology) and MSc (Plant Pathology) students	27 September 2021	College of Horticulture, University of Horticultural Sciences campus, GKVK, Bengaluru	19+2 staff
3.	Agricultural Department officials from Theni, Tamil Nadu	14 October 2021	Department of Agriculture, Government of Tamil Nādu	10
4.	UG students	29 November 2021	School of Agriculture, Lovely Professional University	4

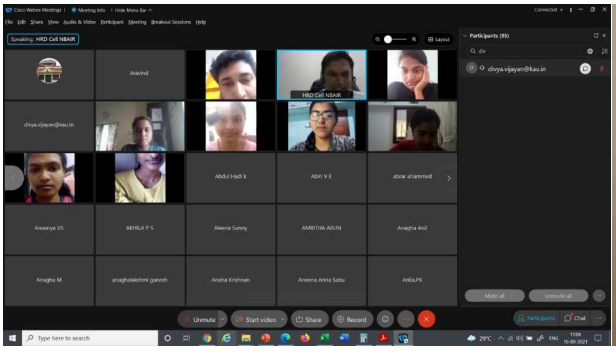
b. Capacity building programmes undergone by NBAIR staff

S. No.	Name	Designation	Discipline/ Division	Name of training programme attended	Date(s)	Place
1.	Dr Deepa Bhagat	Principal Scientist	Organic Chemistry/ GCU	Marketing intelligence of agricultural commodities– challenges and opportunities (Virtual)	12–14 January 2021	NA
2.	Dr Ankita Gupta	Senior Scientist	Entomology/GCC	DST e-training on emotional intelligence at work place for scientists and technologies	15–19 February 2021	NA
3.	Dr P. Sreerama Kumar	Principal Scientist	Plant Pathology/ GCU	NABL assessor training (Virtual)	10–12 March 2021	NA
4.	Dr R. Gandhi Gracy	Senior Scientist	Entomology/GR	NABL assessor training (Virtual)	10–12 March 2021	NA
5.	Mr K.M. Venugopala	Technical Assistant	Plant Pathology/ GR	Generic online training course in cyber security conducted by C-DAC, Hyderabad	25 March 2021	NA
6.	Dr Deepa Bhagat	Principal Scientist	Organic Chemistry/ GCU	Agilent 5977GC/MS techniques and operation with Mass Hunter data analysis	15–16 April 2021	NA
7.	Dr K. Sreedevi	Principal Scientist	Entomology/GCC	Generic online training course in cyber security conducted by C-DAC, Hyderabad	29 April 2021	NA
8.	Dr T. Venkatesan	Principal Scientist	Entomology/GR	Biodiversity and environmental laws for agricultural researchers	07–09 June 2021	NA
9.	Dr K. Subaharan	Principal Scientist	Entomology/GCU	Biodiversity and environmental laws for agricultural researchers	07–09 June 2021	NA
10.	Dr M. Mohan	Principal Scientist	Entomology/GR	Biodiversity and environmental laws for agricultural researchers	07–09 June 2021	NA
11.	Dr K. Sreedevi	Principal Scientist	Entomology/GCC	Biodiversity and environmental laws for agricultural researchers	07–09 June 2021	NA

12.	Dr T. Venkatesan	Principal Scientist	Entomology/GR	Online management development programme on leadership development (a pre-RMP programme)	14–25 June 2021	NA
13.	Dr T. Venkatesan	Principal Scientist	Entomology/GR	Online training workshop for vigilance officers of ICAR institutes conducted by ICAR–NAARM, Hyderabad	16–18 August 2021	NA
14.	Dr T. Venkatesan	Principal Scientist	Entomology/GR	Transcriptomic data analysis (Virtual)	28–30 September 2021	NA
15.	Dr. Mahesh S. Yandigeri	Senior Scientist	Microbiology / GR	Transcriptomic data analysis (Virtual)	28–30 September 2021	NA
16.	Dr R. Gandhi Gracy	Senior Scientist	Entomology/GR	Transcriptomic data analysis (Virtual)	28–30 September 2021	NA
17.	Dr R.S. Ramya	Scientist	Entomology/GR	Transcriptomic data analysis (Virtual)	28–30 September 2021	NA
18.	Dr Ankita Gupta	Senior Scientist	Entomology/GCC	Virtual workshop and demonstration on "Explore the hidden microscope world" organized by Division of Entomology, IARI, New Delhi	04–06 October 2021	NA
19.	Dr R. Gandhi Gracy	Senior Scientist	Entomology/GR	Level–2 of NABL training (Physical)	21–23 October 2021	Bengaluru
20.	Dr P. Sreerama Kumar	Principal Scientist	Plant Pathology/ GCU	Level–2 of NABL training (Physical)	21–23 October 2021	Bengaluru
21.	Dr Deepa Bhagat	Principal Scientist	Organic Chemistry/ GCU	Managing technology value chains (Virtual)	25–29 October 2021	NA

Trainers' training on mass production and release techniques of *Anagyrus lopezi* for the classical biological control of cassava mealybug in India organised during November–December 2021

Farmers' awareness training on cassava mealybug and fall armyworm organised during 3 September 2021 and 3 December 2021



Virtual tour of NBAIR to KAU third year BSc (Ag.) students on 16 September 2021

Visit of Agricultural department officials from Theni district, Tamil Nadu on 14 October 2021

Visit of Agricultural department officials from Theni district, Tamil Nadu on 14 October 2021

Student training under RAWEP/READY programme organised during March–April 2021 and November–December 2021

Beneficiaries from M/s Cryptox BioSolutions, Kanyakumari, Tamil Nadu who underwent In-house training on scientific mass production techniques for major macrobials during 26–28 October 2021

16. DISTINGUISHED VISITORS

- Dr C.A. Viraktamath, Professor Emeritus, Department of Entomology, University of Agricultural Sciences, Bengaluru, 2 July 2021.
- Dr Abraham Verghese, Former Director, ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 1 October 2021.
- Dr B.L. Jalali, Former Director, ICAR–National Centre for Integrated Pest management, New Delhi and Director of Research, Chaudhary Charan Singh Haryana Agricultural University, Hissar and Chairman, CAC NASF, 22 March 2021.

Dr C.A.Virakthamath visiting the insect museum at ICAR-NBAIR

Dr B.L.Jalali visiting the whitefly culture facility at ICAR-NBAIR, Yelahanka campus

17. MERA GAON MERA GAURAV

ICAR–NBAIR organised Farmers-Scientists interface meet on "Biological Management of Fall Armyworm (FAW) in maize" at Yelahanka campus on 28 September 2021. Around 83 maize farmers participated in the programme. The main objective of the interface meet is to sensitise the farmers about ecofriendly management of fall armyworm. The benefits of releasing egg parasitoids, especially Trichogrammatids was explained followed by an exhibition showcasing all the NB AIR technologies to the farmers. Microbial control of fall armyworm using entomopathogenic fungi and bacteria viz., *Metarhizium anisopliae*, *Beauveria bassiana*, *Pseudomonas fluorescens*, *Bacillus thuringiensis* and use of *Spodoptera frugiperda* NPV was explained to the farmers. Field use of entomopathogenic nematodes for the management of fall armyworm was deliberated. The use of pheromone trap and it's application for the management of fall armyworm was discussed. The farmers expressed their satisfaction in learning the techniques to manage fall armyworm infesting their maize crop.

Farmers scientist interface meeting at ICAR-NBAIR

ICAR–NBAIR has celebrated Poshan Vatika Maha Abhiyan & Tree plantation at Lakshmidevipura village, Dodaballapura taluka, Bengaluru Rural District, Karnataka on 17 September 2021 to commemorate Curtain Raiser of International Year of Millets 2023. Dr M. Nagesh, Director Incharge, ICAR–NBAIR Bengaluru delivered a lecture on 'Role of nutri-cereal and their role in human health'. Ms Kadariamma, a woman farmer from the Lakshmidevipura village shared her life time experience and emphasized on the importance of millets in the healthy diet and life style. Millet based products were distributed to all the girl children and young women participants. This was followed by tree plantation in the school premises and nearby farmers' fields and distribution of around 125 tree saplings to all the farmers including 65 women farmers.

Farmers meet to celebrate Poshan Vatika Abhiyan

ICAR–NBAIR organised Farmer's meet to celebrate 'Swachh Bharat Abhiyan' at Thalahalli village, Nandhi Hobli, Chikkaballapura district on 26 October 2021. ICAR-NBAIR Scientists, village panchayat leaders and 41 farmers participated in this programme. Scientists from ICAR-NBAIR explained about the Swachh Bharath theme, hygiene, Covid-19 measures and about the importance of vaccination. Drs.

Mahesh Yandigeri, S. Salini and U. Amala explained and demonstrated about the 'Waste to Wealth' by using black soldier fly (BSF) for the efficient conversion of kitchen wastes, vegetable wastes into manure/compost and the use of immature of the BSF as poultry feed and fish feed. Sanitizers made from ICAR-NBAIR and folders about 'Black Soldier Fly: An alternative for waste management and fish feed', was distributed to the farmers.

Farmers meet to celebrate Swarchh Bharat Abhiyan

Dr. Richa Varshney, Scientist, along with Dr Y. Lalitha, Chief Technical Officer visited Kulumedoddi village on 24 November, 2021. The mulberry growing farmers (16 numbers) were sensitised about the use of uzi fly traps, importance and release of trichocards and Chrysopids. Uzi fly pheromone traps (15 numbers) and *Trichogramma chilonis* cards (30 numbers) were supplied to 15 farmers. The release method of trichocards to manage leaf roller in mulberry was also demonstrated to the farmers.

Drs Richa Varshney, R.S. Ramya, Scientist and Dr Y. Lalitha, Chief Technical Officer visited Kadasegenahalli village and Thoudanahalli on 30 November 2021. Major crops of these areas are mulberry, tomato, ragi and vegetables. Farmers (26 nos.) were sensitized to use of Uzi fly and *Tuta absoluta* traps and importance and release of trichocards.

Under Mera Gaon Mera Gaurav, 753 trichocards of *T. chilonis*; 33 cards of *T. bactrae*; 31 cards of *T. japonicum*; 3 cards of *T. pretiosum*, 10 cards of *T. acheae,* 30 cc *Corcyra* eggs, 500 *Corcyra* larvae, 588 *Cryptolaemus montrouzieri*, 1, 10, 585 numbers of Chrysopids, 2850 numbers of *Goniozus nephantidis*, 720 *Chelonus* spp., 1000 adults of *Maconellicoccus*, 1300 adults of *Anagyrus pseudococci*, 100 adults of *Encasia guadeloupae* and 200 adults of *Acerophagus papayae* were supplied to 234 farmers. Lectures were delivered to sensitized subject matter specialists and farmers about various biocontrol agents.

18. EXHIBITION

NBAIR participated in the following exhibitions to showcase various technologies developed at the institute:

1. 'National Horticulture Fair 2021' organised at ICAR–Indian Institute of Horticultural Research, Bengaluru during 8–12 February 2021.
2. "Central Agricultural University Regional Agri Fair 2020-21" held at Central Agricultural University – Central Farm, Lamphelpat, Imphal, Manipur during 8–10 March 2021.
3. "Krishi Mela 2021" organised at University of Agricultural Sciences, Bengaluru during 11–14 November 2021.

Visitors at NBAIR exhibition stalls

19. PERSONNEL

S. No.	Name	Designation
Director		
1.	Dr N. Bakthavatsalam	Director (Superannuated on 31.07.2021)
2.	Dr M. Nagesh	Director (Acting) (From 01.08.2021)
Scientists		
Division of Germplasm Collection and Characterisation		
3.	Dr Sunil Joshi	Principal Scientist (Agricultural Entomology) & Head (In-Charge), Division of Germplasm Collection and Characterization
4.	Dr Kolla Sreedevi	Principal Scientist (Agricultural Entomology)
5.	Dr G. Mahendiran	Senior Scientist (Agricultural Entomology)
6.	Dr Ankita Gupta	Senior Scientist (Agricultural Entomology)
7.	Dr S. Salini	Senior Scientist (Agricultural Entomology)
8.	Dr K. J. David	Senior Scientist (Agricultural Entomology)
9.	Dr Jagadeesh Patil	Senior Scientist (Agricultural Entomology)
10.	Dr M. Sampath Kumar	Senior Scientist (Agricultural Entomology)
11.	Dr R.R. Rachana	Scientist (Agricultural Entomology)
12.	Dr Navik Omprakash Samodhi	Scientist (Agricultural Entomology)
Division of Germplasm Conservation and Utilisation		
13.	Dr A.N. Shylesha	Principal Scientist (Agricultural Entomology) & Head (In-Charge), Division of Germplasm Conservation and Utilisation
14.	Dr. T.M. Shivalingaswamy	Principal Scientist (Agricultural Entomology)
15.	Dr Prakya Sreerama Kumar	Principal Scientist (Plant Pathology)
16.	Dr Kesavan Subaharan	Principal Scientist (Agricultural Entomology)
17.	Dr G. Sivakumar	Principal Scientist (Microbiology)
18.	Dr Deepa Bhagat	Principal Scientist (Organic Chemistry)
19.	Dr A. Kandan	Principal Scientist (Plant Pathology)
20.	Dr K. Selvaraj	Senior Scientist (Agricultural Entomology)
21.	Dr U. Amala	Senior Scientist (Agricultural Entomology)
22.	Dr Richa Varshney	Scientist (Agricultural Entomology)
23.	Dr Veeresh Kumar	Scientist (Agricultural Entomology) (Deceased on 1 March 2021)
Division of Genomic Resources		
24.	Dr M. Nagesh	Principal Scientist (Agricultural Entomology) & Head (In-Charge), Division of Genomic Resources (Till 31.07.2021)
25.	Dr T. Venkatesan	Principal Scientist (Agricultural Entomology) & Head (In-Charge), Division of Genomic Resources (From 01.08.2021)
26.	Dr K. Srinivasa Murthy	Principal Scientist (Agricultural Entomology)
27.	Dr R. Rangeshwaran	Principal Scientist (Microbiology)

28.	Dr M. Mohan	Principal Scientist (Agricultural Entomology)
29.	Dr M. Pratheepa	Principal Scientist (Computer Applications)
30.	Dr Mahesh Yandigeri	Senior Scientist (Microbiology)
31.	Dr R. Gandhi Gracy	Senior Scientist (Agricultural Entomology)
32.	Dr R.S. Ramya	Scientist (Agricultural Entomology)
33.	Dr C. Manjunatha	Scientist (Plant Pathology) (Joined NBAIR on 22.01.2021)
34.	Mr K.T. Shivakumara	Scientist (Agricultural Entomology) (Joined NBAIR on 30.09.2021)
Technical Officers / Assistants		
35.	Dr Y. Lalitha	Chief Technical Officer (Superannuated on 31.12.2021)
36.	Dr B.K. Chaubey	Chief Technical Officer
37.	Mr Satendra Kumar	Chief Technical Officer
38.	Ms L. Lakshmi	Assistant Chief Technical Officer
39.	Mr P.K. Sonkusare	Senior Technical Officer (T6) (Superannuated on 31.10.2021)
40.	Mr H. Jayaram	Senior Technical Officer (T6)
41.	Ms S.K. Rajeshwari	Senior Technical Officer (T6) (Superannuated on 30.04.2021)
42.	Mr P. Raveendran	Technical Officer (T5)
43.	Dr A. Raghavendra	Senior Technical Assistant (Laboratory Technician)
44.	Mr M. Chandrappa	Senior Technical Assistant (Driver)
45.	Mr R. Narayanappa	Senior Technical Assistant (General Operator)
46.	Mr Umesh Kumar Sanjeev	Technical Assistant (Laboratory Technician)
47.	Mr R. Maruti Mehanth	Technical Assistant & Cashier (Laboratory Technician)
48.	Mr K.M. Venugopala	Technical Assistant (Laboratory Technician)
49.	Mr P. Madanathan	Technical Assistant (Driver)
Administrative Staff		
50.	Mr Malay Bisht	Administrative Officer (Transferred to ICAR-NIBSM, Raipur on 10.11.2021)
51.	Mr J. Mathew	Administrative Officer (Joined NBAIR on 23.12.2021)
52.	Ms S. Kusuma	Finance & Accounts Officer
53.	Ms S. Kaveriamma	Private Secretary to Director
54.	Ms Dipanwita Deb	Assistant Administrative Officer
55.	Ms M.S. Uma	Personal Assistant
56.	Ms Naziya Anjum	Assistant
57.	Ms P. Anitha	Upper Division Clerk
Supporting Staff		
58.	Mr Ramakrishnaiah	Skilled Supporting Staff
59.	Mr P. Nagaiah	Skilled Supporting Staff
60.	Ms Sanjeevini Desai	Skilled Supporting Staff