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Annual Report 2023

ICAR-National Bureau of Agriculture Insect Resources

Bengaluru India



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वार्षिक प्रतिवेदन 2022 ANNUAL REPORT 2022



ICAR- NATIONAL BUREAU OF AGRICULTURAL INSECT RESOURCES

Bengaluru - 560 024, Karnataka, India



Annual Report 2022



**ICAR-NATIONAL BUREAU OF AGRICULTURAL
INSECT RESOURCES**



Bengaluru - 560 024, India

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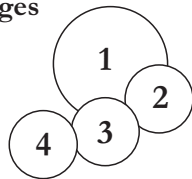
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- ICAR-NBAIR Building (courtesy: Mahendiran, G.)

PREFACE

ICAR–NBAIR Annual Report 2022 furnishes information that reflects the contribution made towards documentation of the diversity of agriculturally important insects and methods involving molecular tools and non-chemical strategies for pest management.

The three divisions of ICAR–NBAIR, viz. Germplasm Collection and Characterization (GCC), Genomic Resources (GR) and Germplasm Conservation and Utilization (GCU) focused on the mandate of the Bureau and churned out the following information to benefit the farmers, developmental agencies, policymakers and researchers involved in pest management.

Division of Germplasm Collection and Characterization conducted exploratory surveys for the documentation of arthropod biodiversity in India from January to December 2022 which resulted in the addition of 6063 specimens collected from 15 different states. In addition, seven isolates of entomopathogenic nematodes were isolated and added to EPN repository. Fifteen new taxa were described and the documentation provided new insights into the arthropod biodiversity of India. During the period under report, a total of 162 identification services were provided to researchers from agricultural universities, private companies and ICAR institutes.

Division of Genomic Resources complemented the taxonomic identity by generating DNA barcodes to identify agricultural and veterinary pests, parasitoids, predators, invasive pests, and pollinators. Molecular techniques facilitated the identification of the invasive chilli thrips, *Thrips parvispinus*. A novel technique, Multi-Locus Sequence Typing (MLST) was used to identify 40 EPN isolates, and draft whole genomes of five Indian EPN isolates were generated. Transcriptome analysis and RNAi machinery gene mining were carried out for identifying potential targets for RNA interference-based pest management strategies.

Division of Germplasm Conservation and Utilization focuses on developing biological control and its compatible technologies. Housing the largest 'Live Insect and Insect-Derived Resources Repository' in Asia with 136 live insect germplasms and microbial isolates, ICAR–NBAIR has facilitated in the supply of 542.70 lakhs live insects in 562 shipments and 146 shipments of microbials, to benefit the farmers and researchers. Non-chemical approaches involving semiochemicals were developed and the technologies were transferred to firms. Three entomofungal pathogens, viz. *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium fusisporum* and two bacterial strains viz. *Pseudomonas fluorescens* and *Bacillus albus* were identified to be effective in scaling down the damage caused by the invasive thrips, *T. parvispinus*.

To address the threat caused by cassava mealybug, ICAR–NBAIR has imported the parasitoid, *Anagyrus lopezi* and the first field release programme of the parasitoids and its distribution to the cassava farmers was conducted in the presence of 300 tapioca farmers from six districts of Tamil Nadu. As an awareness creation, a total of 28 training programmes were organised for 302 trainees, besides exposure visits for farmers, and students from various colleges and universities. Six NBAIR technologies were licensed to six firms and one Industry–Institute Interface Meeting was organized. In an attempt to use the digital platform to reach a wider clientele, three pest management mobile apps were developed with a focus on biological control.

The staff members of ICAR–NBAIR have contributed to the significant achievements of this organization. Over 90 papers were published in high-rated journals. In an attempt to celebrate the success of biocontrol, ICAR–NBAIR in association with the Society for Biocontrol Advancement organized Seventh National Conference on Biological Control - “75 years of Biological control of Pests and Diseases in Agriculture: Challenges and the Way Forward” brought in over 250 delegates and 25 industries to participate in the three-day conference. 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.

I would like to express my gratitude to Dr Trilochan Mohapatra, Former Secretary (DARE) and Director General (ICAR) and Dr Himanshu Pathak, Secretary (DARE) and Director General (ICAR) for their guidance and support. I am grateful to Dr Tilak Raj Sharma, DDG (Crop Sciences), ICAR for his innovative ideas in research and guidance. I acknowledge the inspiration and support provided by Dr Sunil Chandra Dubey, ADG (Plant Protection and Biosafety), ICAR. The services of the editorial team in compiling and the scientists for providing inputs for the Annual Report are appreciated.

I am hopeful that the scientists in NARES/NARS will find this publication informative. I look forward to any suggestions and comments for its improvement.

Bengaluru
27.02.2023

S.N.Sushil
Director

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 2022 yielded 74 species of Scarabaeidae (23 genera); 47 species of Tephritidae (28 genera); 45 species of Pentatomidae (38 genera); 22 species of Thripidae (10 genera); 2 species of Tessaratomidae (2 genera); 2722 specimens of aphids and coccids; 1236 specimens of weevils; 411 specimens of trichogrammatids; 284 specimens of tachinids and 1220 specimens of spiders. Samples were collected from Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Himachal Pradesh, Manipur, Meghalaya, Mizoram, Rajasthan, Tamil Nadu, Telangana, Tripura, Karnataka, Kerala and West Bengal. In addition, scarab specimens were also received from Uttar Pradesh for faunal studies.

Seven isolates of *Heterorhabditis indica* and one species of *Steinernema* were isolated from Chhattisgarh and added to NBAIR's repository of entomopathogenic nematodes EPN. A total of 125 isolates/species of *Steinernema*, *Heterorhabditis* and *Oscbeius* nematodes were maintained on wax moth larvae.

Fifteen new taxa across the country were described. In Diptera: a new genus, *Dacimita* and four new species of fruit flies, *Dacimita curvifasciatus*, *Platensina rabbani*, *P. flavistigma* and *Rhabdochaeta nigroapicalis*; in Hymenoptera, six species of braconids, *Leiophron crassivena*, *L. indefinita*, *Pambolus (Phaenodus) infuscatus*, *Paroligoneurus indicus*, *Paroplitis kbajjiarensis* and *Streblocera (Eutanycerus) breviflagellata*, a new pteromalid species, *Doddifoenus burksi*; in Thysanoptera, two species of thrips, *Hydatothrips initium* and *Pseudodendrothrips umbrolateralis* and in Hemiptera, one soft scale species, *Cyphococcus williamsi*.

Additionally, four species of scarab beetles belonging to the tribe Sericini, one species of Pentatomidae, three salticid spider species and one nematode species of family Steinernematidae were provisionally reported as new species.

Revisionary works include a review of a braconid genus viz. *Eurymeros* and three species were transferred to the genus *Euscelinus* (comb. n.) and synonymized with the type species (*Euscelinus sarawacus*; syn. n.); phylogenetic analysis of tephritid subfamily Tephritinae with Dacini as outgroup revealed the monophyly of tribes Schistopterini, Tephrellini and Dithrycini and polyphyly of tribe Tephritini; taxonomic studies on Indian species of genus *Pseudodendrothrips* resolved the misidentification of *P. bhattii* as *P. darci* and hence removed the former from thrips fauna of India; redescriptions of fourteen scarab beetle species (genus *Adoretus*) of the tribe Adoretini and seven species (genus *Popillia*) of the tribe Anomalini; ten longhorn beetle species (genus *Glenea*) of subfamily Lamiinae; type species of the genus *Eurymeros*, *E. tumespiraculum*; one armoured scale species, *Aulacaspis crawii* and one spider species, *Scytodes fusca*; taxonomic studies on the salticid spider genus *Rbene* with detailed examination of the type materials of seven species; establishment of eleven new synonymies and five new combinations.

New distributional records for India include one pteromalid genus *Doddifoenus*; two braconid species, *Aphaereta vondelparkensis* and *Centistes (Centistes) cuspidatus*; two armoured scale species, *Aulacaspis crawii* and *Kuwanaspis howardi* and one mealybug species, *Palmicultor lumpurensis*.

New distributional records for the states in India include one aphid species, *Conchaspis angraeci*, two armoured scales, *Rutherfordia major* and *Pinnaspis buxi*, a soft scale species, *Drepanococcus chiton* from Kerala; *D. chiton* and *P. buxi* from Andhra Pradesh; one aphid species, *Greenideoida ceyloniae*, a felted scale species, *Pedroniopsis beesoni* from Jharkhand; one soft scale species, *Ceroplastes cirripediformis* from Madhya Pradesh; one soft scale species, *Megapulvinaria maxima* from Rajasthan; two scarab beetle species viz. *Bunbunius hartmanni* and *Pseudopanotrogus lassallei* from Himachal Pradesh. Four salticid spider species viz. *Bianor angulosus* from Punjab, *Rbene flavicomans* from Kerala, *R. baldanei* from Madhya Pradesh and *R. rubrigeria* from West Bengal and Uttarakhand were reported as new distributional records.

New host/pest records documented were: *Doddifoenus burksi* as a parasitoid of Cerambycid beetle; *Tetrastichus epilachnae* for *Anisolemnia dilatata*; primary parasitoids viz. *Aenasius arizonensis* and *Pseudleptomastix mexicana* and six species of hyperparasitoids viz. *Aprostocetus* sp., *Chartocerus* sp., *Cheiloneurus* sp., *Homalotylus turkmenicus*, *Marietta leopardina* and *Prochiloneurus* sp. from primary parasitoids of *Phenacoccus solenopsis* and *Paracoccus marginatus* on *Gymnema sylvestre*; *Pseudarthria viscida* for *D. chiton*; *Flacourtia inermis* for *R. major*; *Pisum sitivum* for *Dysmococcus brevicepes*; *Saccharum officinarum* for *Kiritshenkella lingnani*; *Areca catechu* for *Cerataphis brasiliensis*; *Brassica nigra* for *Smyntburodes betae*; *Excoecaria* sp. for *Conchaspis angraeci* and *Gossypium herbaceum* and *Psidium guajava* for *Thrips parvispinus*. A melolonthine species, *Apogoina* sp. as a pest of *Theobroma cacao* and a buprestid species, *Sphenoptera indica* of *Cajanus cajan* were reported.

Diagnostic keys were published for several insect taxa: Twenty-one genera of subfamily Dacinae; world species of *Platensina*; Indian species of tribe Schistopterini; an updated key to the world species of *Paroplitis* and *Doddifoenus*; Oriental species of *Pambolus*; adult females of mealybugs infesting

cassava (field and microscopic characters); Indian species of *Antonina*, *Formicococcus* and *Maacoccus*; thrips species infesting cotton and Indian species of *Hydatothrips* and *Pseudodendrothrips*.

Annotated checklist for Indian Dryophthorinae and thirty factsheets for economically important weevil species were prepared. Two databases entitled “Pentatomidae fauna of India” and “True fruit flies of India” were prepared and published online.

Occurrence and parasitism of three trichogrammatid species viz. *Trichogramma chilostrae*, *T. achaeae* and *T. chilonis* were recorded from different pests infesting medicinal and aromatic plants. Two species of tachinids were identified with their associated hosts: *Palexorista* sp. reared from *Spodoptera frugiperda* and *Carcelia* sp. from black hairy caterpillar of sandalwood.

A total of 162 identification services were provided to researchers from agricultural universities, private companies and ICAR institutes.

Genomic Resources

Multi-Locus Sequence Typing (MLST) was carried out for the identification of 40 EPN isolates using four unique sequences. Draft whole genomes of five Indian EPN isolates were generated. Profiles of genes and their expression involved in tritrophism among insect host, EPN and EPNB combinations in white grub (a coleopteran insect) in comparison to those in lepidopterans viz. *Spodoptera frugiperda* and *Galleria mellonella* larvae indicated that most genes related to insect metabolism and immunity were common to both. Genes and their expression related to nematode-bacterium combinations were found to be variable. MALDI-TOFF analysis and profiling of proteins during pathogenesis in *G. mellonella* and *S. frugiperda* indicated the time-course relevance of certain proteins. Expressed protein details were archived at Protein Identification Data Base, EMBL-EBI (PRIDE).

Time-course gene expression in *G. mellonella* and *S. frugiperda* using Nanostring Custom Multiplexed assay provided information on important pathways. Specific EPN isolates with LD values and fitness attributes were identified for the management of coleopteran, hemipteran, lepidopteran and stored grain insect pests. Technology related to patented WP formulations of EPN was transferred to six firms and a revenue of Rs.12 lakhs was generated. One prospective EPN isolate was identified for controlling thrips based on lab assays.

Molecular characterization was carried out and DNA barcodes were generated using different molecular markers, viz. CO1, ITS-2, CO1A, CO1B, CO1 (Btab-850 bp) and species-specific markers for several agricultural and veterinary pests, parasitoids, predators, invasive pests and pollinators collected from different parts of the country. Different insect pests on apple, pear and many other temperate crops were identified and GenBank accession numbers were generated. An invasive pest, *Thrips parvispinus* was identified from farmers' fields in Andhra Pradesh, Chattisgarh (Raipur), Gujarat (Anand), Maharashtra (Aurangabad) and Tamil Nadu (Trichy) using molecular techniques. A molecular diagnostic marker was developed for the invasive fall armyworm, *S. frugiperda*.

Mealybug specimens which were collected from 62 locations and 29 host plants were subjected to morphological and molecular identification. Most of the specimens were *Phenacoccus solenopsis*, and few were *Paracoccus marginatus*, *Phenacoccus manihoti*, *Phenacoccus parvus*, *Phenacoccus saccharifolii*, *Planococcus citri* and *Rastrococcus iceryoides*. Identification of plant

bugs was achieved through both morphological and molecular means and accession numbers were generated, viz. *Acanthocoris scabrator* (OQ319472), *Carbula biguttata* (OQ324890), *Cletus pugnator* (OQ323459), *Dysdercus cingulatus* (OQ320754), *Leptocorisa acuta* (OQ320836) and *Riptortus pedestris* (Oq324691).

A moderate level of genetic diversity was observed among 39 Indian populations of *Maruca vitrata* using COI and microsatellite markers.

Bacillus thuringiensis strains, NBAIR-Bt25 and NBAIR BtAN4 were characterized morphologically, and molecularly by 16S rDNA, Multi Locus Sequence Typing and whole genome sequencing. Insecticidal genes profiling using Bt Toxin Digger showed 28 genes in both strains. A novel powder-based formulation of *B. thuringiensis* which has a shelf life of 2 years was designed using molasses.

Microflora from black soldier fly was identified using molecular tools and characterized using biochemical tests. Metagenomic and transcriptome analyses were accomplished using black soldier fly larvae.

Assembly and annotation of transcriptome data of *Maconellicoccus hirsutus* was done. Transcriptome mining of RNAi machinery genes was carried out. Annotation and identification yielded around 22 genes belonging to Argonaute, Dicer, Drosha and Loquacious gene families. Liquid diet assays for dsRNA feeding were standardized for *M. hirsutus* and *P. manihoti*.

The multi-insecticidal tolerant strain of *Trichogramma chilonis* was subjected to selection pressure using Emamectin benzoate, for which the last dose of exposure was 10 times the field dose which indicated the development of resistance. The multi-insecticidal tolerant strain of *Chrysoperla*

zastrowi sillemi was subjected to repeated selection pressure using Diafenthiuron, out of which the last dose was 1.2 times the field dose. Two predatory mites, *Typhlodromus* (*Anthoseius*) *transvaalensis* and *Neoseiulus indicus* were found to be highly susceptible to Fenazaquin.

Three mobile apps, (i) BIPM on coconut, (ii) BIPM on rice and (iii) BIPM on sugarcane were developed for pest and disease management with a special focus on biological control. They are accessible in three languages, English, Hindi and Kannada.

Germplasm Conservation and Utilisation

Egg laying, the total number of larvae, pupae developed and the number of adults that emerged were significantly higher for *Bracon brevicornis* developed on fifth instar larvae of fall armyworm when parasitism occurred 24 h after fungal inoculation (*Metarhizium anisopliae* Ma-35). Biology, feeding potential and prey preference was studied for anthocorid bug, *Blaptostethus pallescens* when *Lecanicillium lecanii* (ICAR-NBAIR VI-8) infected thrips (*Frankliniella schultzei*) and uninfected thrips were offered as prey. The total nymphal duration of *B. pallescens* was significantly higher when fed on *L. lecanii* (ICAR-NBAIR VI-8) treated thrips (*F. schultzei*) as compared to those fed on untreated thrips. All instars and adults of *B. pallescens* preferred uninfected thrips over *L. lecanii* VI-8 infected thrips. However, *L. lecanii* (ICAR-NBAIR VI-8) does not affect the biological parameters of the predatory mirid, *Dortus primarius*.

A survey of invasive whiteflies and their natural enemies revealed newer geographical distribution and extension of host ranges. A potential parasitoid, *Encarsia cubensis* against palm-infesting whitefly, *Aleurotrachelus atratus* was reported for the

first time in India. The prediction of potential distribution and habitat suitability mapping for the occurrence of invasive rugose spiraling whitefly (RSW) in India using the MaxENT modeling was developed.

Potential isolates of fungal and bacterial entomopathogens for the management of invasive South East Asian Thrips, *Thrips parvispinus* under laboratory and field conditions were studied. A novel *Pseudomonas entomophila* NBAIR-PEOWN effective for the management of brinjal shoot and fruit borer under field conditions was identified. The field efficacy of NBAIR-TATP *Trichoderma asperellum* strain for the management of mulberry root rot was evaluated.

Sub-lethal effect of *Spodoptera frugiperda* NPV (SpfrNPV) on the growth and development of fall armyworm was observed. It caused a reduction in egg hatchability in the subsequent generation. The highest yield of SpfrNPV i.e. 4.69×10^5 occlusion bodies (OBs) from a single third instar larva was obtained when the larva was inoculated with SpfrNPV @ 1×10^8 OBs/ml. The third instar larva was found optimum for harvesting the maximum of SpfrNPV at 7 days after inoculation. Enveloped virions were observed from the NPV-infected midgut tissues of *S. frugiperda* under light microscopy.

The Type III generalist predatory mite *Typhlodromus* (*Anthoseius*) *transvaalensis* suppressed the mulberry thrips, *Pseudodendrotbrips darci*, by 76% at Mattur in Raichur district. The predator could be established on wild sugarcane, *Saccharum spontaneum*, infested with the invasive sugarcane web mite, *Shizotetranychus krungthepensis*. In chrysanthemum, *T. (A.) transvaalensis* held the spider mite population in check throughout the crop period.

Laboratory and field assay revealed that *Heterorhabditis indica* and *Steinernema abbasi* were compatible with *Metarhizium anisopliae* Ma-4 and *Beauveria bassiana* Bb-45.

The olfactory receptor neurons in *Corcyra cephalonica* adults caused the physiological response to essential oils. The ajowan oil, its constituent thymol and geranium oil caused a high level of oviposition deterrence index. EO Sweet basil oil, its constituent's methyl chavicol, linalool and other EOs viz. betel oil, rosemary oil and their major constituents eugenol, eugenol acetate, geraniol and 1,8 cineole caused high-level inhibition of acetyl cholinesterase.

All India Coordinated Research Project on Biological Control of Crop Pests

Biological control of rice pests

Biointensive pest management module (BIPM) of seed treatment with *Pseudomonas fluorescens* @ 10 g/kg, two sprays of *P. fluorescens* @ 5 g/L from 30-40 days after transplantation, three releases of *Trichogramma chilonis* @ 1,00,000/ha for leaf folder and *T. japonicum* @ 1,00,000/ha/releases for stem borer from 25 days after transplantation, application of carbofuran granules 3G @ 10 kg/ha, at 30 DAP, two sprays of chlorpyrifos @ 2.5 ml/L, acephate @ 1.5 g/L and two sprays with propiconazole @ 1ml/L recorded the lowest leaf folder damage by 77.04%; stem borer damage by 84.13% and sheath blight incidence by 42.16%.

Biological control of sugarcane pests

Eight releases of temperature tolerant strain of *T. chilonis* @ 50,000 parasitoids/ha at weekly intervals significantly reduced the infestation of early shoot borer

Biological control of maize pests

Two releases of *T. pretiosum* @ 50,000/ha or *T. chilonis* @ 1,00,000/ha from 7 days after seedling

emergence followed by three foliar applications of *Bacillus thuringiensis* (NBAIRBT25) @ 2 ml/L or *Metarhizium anisopliae* (NBAIR Ma 35) @ 5 g/L 20 days after seedling emergence at 10 days intervals was effective in controlling fall armyworm.

Biological control of pulse pests

Foliar application of *Lecanicillium lecanii* 1×10^8 cfu/ml @ 5gm/L recorded the lowest infestation of cowpea aphid, *Aphis craccivora* in cowpea.

Biological control of tropical fruit pests

Spraying *Metarhizium anisopliae* ICAR-NBAIR Ma-4 @ 1% WP effectively reduced the population of mango hoppers.

Application of *Lecanicillium lecanii* (NBAIR VI8) @ 5g/L was effective in the reduction of thrips infestation in the citrus fruits (11.78%) followed by application of acephate 75SP (12.64%).

Application of *Beauveria bassiana* (AAU culture) 10^8 spores @ 5 ml/L at 15 days interval in the leaf axils recorded a maximum reduction of damage by fruit and leaf scaring beetles, *Nodostoma subcostatum* in banana.

Biological control of plantation crop pests

BIPM module with natural conservation of *Encarsia guadeloupae* + release of eggs of *Apertochyrsa astur* @ 1000/ha + Yellow sticky traps @ 20/ha effectively reduced the population of rugose spiraling whitefly (80%) in coconut.

Biological control of vegetable pests

A low level of damage by shoot and fruit borer was recorded in the plots sprayed with insecticides (17.82%) followed by BIPM plots (Azadirachtin 1500 ppm @ 2ml/lit (one round of spray) + *L. lecanii* (one round of spray) + *T. pretiosum* (8 releases) + pheromone traps @ 20/ha + cowpea as bund crop).

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 seed, maintenance of soil fertility and so forth. Their notoriety 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 the effective biological control was predicted 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 bureau 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 2,25,948 specimens, and the 379 types.

This is the only National Bureau under the National Agricultural Research System (NARS) that acts as the nodal agency for collection, characterization, 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, Thysanoptera and Orthoptera. Besides holding the world's smallest insect, *Kikiki huna*, in its collection, the museum also holds many undescribed species, and some species not found in other collections in the world. Online web diagnostic portals/web pages are hosted in ICAR-NBAIR domain. Presently there are 24 databases in the ICAR-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

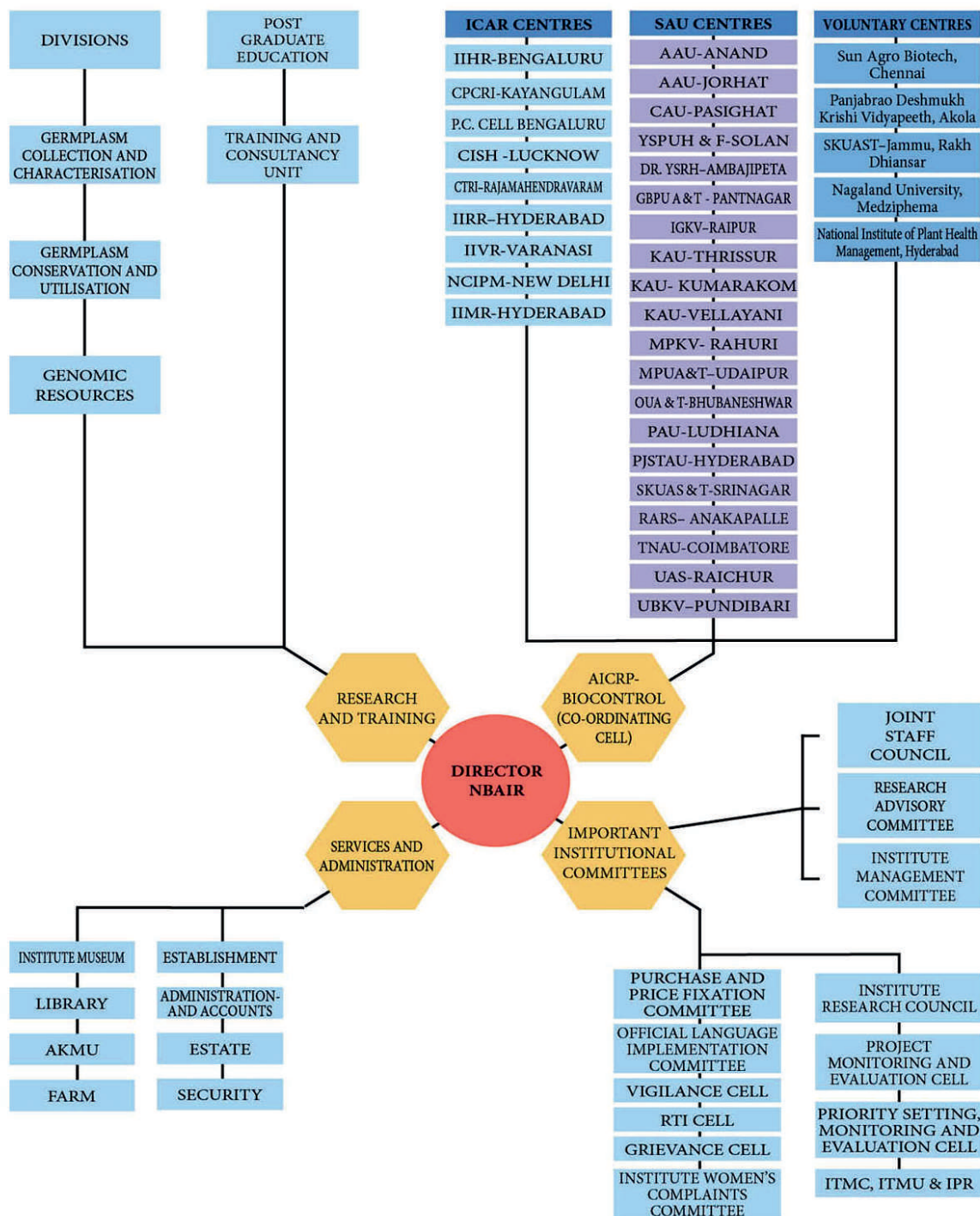
Promotion of biological control as a component of integrated pest and disease management in agriculture and horticultural crops for sustainable crop production.

Demonstration of usefulness of biocontrol in IPM in farmer's 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 of crop pests. The organogram is given on page 7.

ORGANOGRAM



Research achievements

Basic research

A new genus, *Dacimita* and four new species of fruit flies, *Dacimita curvifasciatus*, *Platensina rabbani*, *P. flavistigma* and *Rhabdochaeta nigroapicalis* were described.

Seven new species of parasitoids, *Doddifoenus burksi*, *Leiophron crassivena*, *L. indefinite*, *Pambolus (Phaenodus) infuscatus*, *Paroligoneurus indicus*, *Paroplitis khajjiarensis* and *Streblocera (Eutanycerus) breviflagellata* were described.

New host/pest records *Doddifoenus burksi* as a parasitoid of Cerambycid beetle; *Tetrastichus epilachnae* for *Anisolemmia dilatata* were documented.

Two databases entitled “Pentatomidae fauna of India” and “True fruit flies of India” were prepared and published online.

Two new species of thrips, *Hydatothrips initium* and *Pseudodendrothrips umbrolateralis* and one soft scale species, *Cyphococcus williamsi* were described.

Molecular characterisation was carried out and DNA barcodes were generated using different molecular markers viz. CO1, ITS-2, CO1A, CO1B, CO1 (Btab-850 bp) and species-specific markers for several agricultural and veterinary pests, parasitoids, predators, invasive pests and pollinators collected from different parts of the country.

Annotation of transcriptome data of *Maconellicoccus hirsutus* yielded around 22 transcripts belonging to Argonaute, Dicer, Drosha and Loquacious gene families.

Bacillus thuringiensis strains viz. NBAIR-Bt25 and NBAIR BtAN4 were characterised morphologically, and also molecularly by 16S rDNA, Multi Locus Sequence Typing and whole genome sequencing.

Applied research (Biological control)

A potential parasitoid, *Encarsia cubensis* against palm infesting whitefly, *Aleurotrachelus atratus* was reported for the first time in India.

Lecanicillium lecanii (ICAR-NBAIR VI-8) has no effect on biological parameters of predatory mirid, *Dortus primarius*.

A novel strain of *Pseudomonas entomophila* NBAIR-PEOWN effective for the management of brinjal shoot and fruit borer under field conditions was identified.

The Type III generalist predatory mite, *Typhlodromus (Anthoseius) transvaalensis* suppressed the mulberry thrips, *Pseudodendrothrips darci*, by 76% at Mattur in Raichur district.

Heterorhabditis indica and *Steinernema abbasi* were compatible with *Metarhizium anisopliae* Ma-4 and *Beauveria bassiana* Bb-45.

Highest yield of SpfrNPV ie. 4.69×10^5 occlusion bodies (OBs) from single third instar larva was obtained when the larva was inoculated with a concentration of SpfrNPV @ 1×10^8 OBs/ml.

The essential oil ajowan oil, its constituent thymol and geranium oil recorded high level of oviposition deterrence index in rice moth, *Coryra cephalonica*.

Three mobile apps, (i) BIPM on coconut, (ii) BIPM on rice and (iii) BIPM on sugarcane were developed for pest and disease management with special focus on biological control.

FINANCIAL STATEMENT 2022
ICAR-National Bureau of Agricultural Insect Resources

Head	Amount (₹ in lakhs)
Pay & allowances	1301.36
TA	16.75
Other charges, including equipment and office buildings	603.69
Information technology	13.03
Works and petty works	24.87
HRD	1.2
Pension	111.23
Loan	0.00
Total	2072.13

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

Name of the centres	Salaries	TA	RC	TSP	Total (₹ in lakhs)
AAU, ANAND	23.85	1.33	13.33	3.75	42.26
AAU, JORHAT	17.54	1.00	9.00	3.75	31.29
RARS-ANAKAPALLE	11.16	1.33	10.00	0.00	22.49
PJTSAU, TELANGANA	17.12	0.45	7.51	0.00	25.08
DR. YSPUH&F, SOLAN	23.23	1.59	3.33	0.75	28.90
GBPUAT, P'NAGAR	12.69	1.13	3.33	8.64	25.79
KAU, THRISSUR	12.83	0.69	6.25	0.00	19.77
MPKV, PUNE	22.61	0.50	7.50	0.00	30.61
PAU, LUDHIANA	25.69	0.92	4.58	0.00	31.19
SKUAST, SRINAGAR	22.00	0.92	1.33	0.00	24.25
TNAU, COIMBATORE	18.51	0.92	6.67	0.00	26.10
MPUAT, UDAIPUR		0.63	6.50	0.00	7.13
OUAT, B'WAR		0.50	0.00	1.50	2.00
CAU, PASIGHAT		0.62	4.79	1.50	6.91
UAS, RAICHUR		0.57	5.83	3.75	10.15
ICAR-CPCRI, KAYANKULAM		0.92	3.33	0.00	4.25
ICAR-IIHR, BENGALURU		0.50	2.00	0.00	2.50
ICAR-P.C. CELL, BENGALURU		0.00	0.00	0.00	0.00
ICAR-CISH, LUCKNOW		0.75	3.75	0.00	4.50
ICAR-IIRR, HYDERABAD		0.83	1.33	0.00	2.16
ICAR-IIMR, HYDERABAD		0.75	3.00	0.00	3.75
ICAR-IIVR, VARANASI		0.33	1.68	0.00	2.01
ICAR-NCIPM, NEW DELHI		0.50	1.00	0.00	1.50
IGKV, RAIPUR		1.01	3.33	13.25	17.59
KAU, KUMARAKOM		0.19	0.00	0.00	0.19
KAU, VELLAYANI		0.50	5.00	0.00	5.50
DR. YSRHU, AMBAJIPETA		1.25	3.33	0.00	4.58
UBKV, PUNDIBARI		0.67	2.00	0.75	3.42
Total	207.23	21.30	119.70	37.64	385.87

3. RESEARCH ACHIEVEMENTS

ICAR-National Bureau of Agricultural Insect Resources

Germplasm Collection and Characterisation Surveys and explorations

Surveys were undertaken to document the fauna of insects, spiders, mites and entomopathogenic nematodes across Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Himachal Pradesh, Manipur, Meghalaya, Mizoram, Rajasthan, Tamil Nadu, Telangana, Tripura, Karnataka, Kerala and West Bengal. Scarab specimens were received from Uttar Pradesh for faunal studies. Expeditions undertaken yielded, 74 species of Scarabaeidae in 23 genera; 47 species of Tephritidae in 28 genera; 45 species of Pentatomidae in 38 genera; 22 species of Thripidae in 10 genera; 2 species of Tesseractomidae in 2 genera; 2722 specimens of aphids and coccids; 1236 specimens of weevils; 411 specimens of trichogrammatids; 284 specimens of tachinids and 1220 specimens of spiders.

Description of a new genus

A new genus of fruit fly, *Dacimita* David & Hancock was described from India with *Dacimita curvifasciatus* David & Hancock (Fig. 12) as its type species. Flies were collected from leaves of tiger grass, *Thysanolaena* sp. adjacent to a bamboo thicket in Meghalaya. It is placed in the tribe Gastrozonini based on phylogenetic analysis using morphological and molecular methods though it resembled dacines.

Description of new species

Fourteen species of insects were described across various insect orders namely Diptera, Hemiptera, Hymenoptera and Thysanoptera. Six species of Braconidae in six genera, four species of Tephritidae in three genera, two species of Thripidae in two genera, one each of Coccidae and Pteromalidae were described from India (Table 1). Four species (*Maladera* sp.1, *Maladera* sp.2, *Serica* sp.1, *Serica* sp.2) of Scarabaeidae belonging to the tribe Sericini, one species (*Dunnius* sp.) of Pentatomidae, three spider species [*Afraflacilla* sp. (Fig. 15), *Carrhotus* sp. (Fig. 17), *Stenaelurillus* sp. (Fig. 16)] of Salticidae and one nematode species (*Steinernema* sp.) of family Steinernematidae were provisionally reported as new species. This nematode species will be the first ever described species from India.

Revisions/redescriptions of taxa

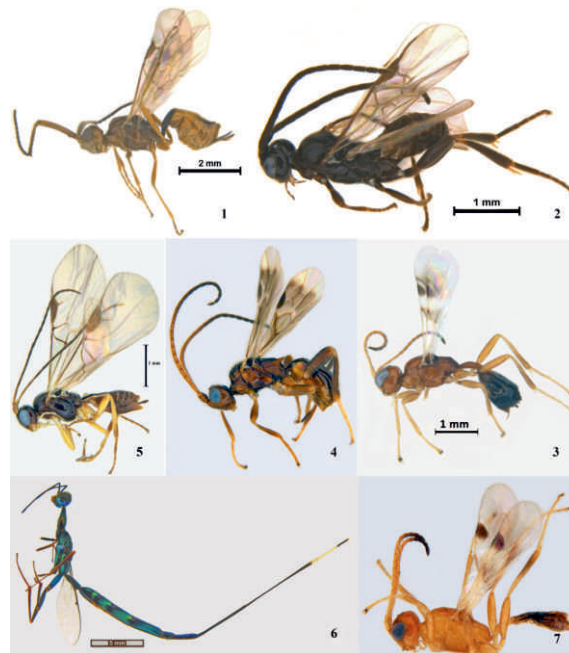
The genus *Eurymeros* Bhat (Braconidae, Alysiinae) was reviewed from India and three species viz. *E. gibbosa* Sharma, *E. mangifera* Sharma, and *E. namkumensis* Sharma & Naqvi, were transferred to the genus *Euscelinus* Westwood (comb. n.; Braconidae, Doryctinae) and synonymized with the type species (*Euscelinus sarawacus* Westwood; syn. n.). The monotypic status of the genus *Eurymeros* was retained. Phylogenetic analysis using 62 mt-COI sequences of fruit flies of subfamily Tephritinae (Diptera, Tephritidae) with Dacini as an outgroup revealed the monophyly of tribe Schistopterini, Tephrellini and Dithrycini, whereas Tephritini was polyphyletic. Indian species of the genus *Pseudodendrothrips* Schmutz (Thysanoptera, Thripidae) were studied and re-examined the original specimens of *P. bhattii* Kudo and *P. darci* (Girault) studied by the earlier reportees. The presence of lateral brown patches on pronotum and chaetotaxy on tergite IX of all the examined specimens matched the description and illustration of *P. darci* by Masumoto and Okajima (2017). Both the earlier reports had mentioned the presence of brown patches on pronotum, but with little information about chaetotaxy on tergite IX. Hence, the earlier report of *P. bhattii* from India is considered a misidentification of *P. darci* and thus *P. bhattii* is removed from the fauna of India. Fourteen species of genus *Adoretus* viz. *A. bicaudatus* Arrow (Fig. 18), *A. bimarginatus* Ohaus, *A. decanus* Ohaus (Fig. 24), *A. duvauceli* Blanchard (Fig. 20), *A. flavus* Arrow (Fig. 21), *A. fusciceps* Arrow (Fig. 27), *A. lasiopygus* Burmeister (Fig. 25), *A. nephriticus* Ohaus (Fig. 28), *A. nitidus* Arrow (Fig. 23), *A. ovalis* Blanchard (Fig. 29), *A. pusillus* Arrow (Fig. 19), *A. simplex* Sharp (Fig. 26), *A. stoliczkae* Ohaus (Fig. 22) and *A. versutus* Harold belonging to the tribe Adoretini and 7 species of genus *Popillia* viz. *P. complanata* (Newman), *P. cupricollis* (Hope), *P. cyanea* (Hope), *P. macclellandi* (Hope), *P. nasuta* (Newman), *P. pilicollis* (Kraatz) and *P. schizonyca* (Arrow), belonging to the tribe Anomalini of subfamily Rutelinae (Coleoptera, Scarabaeidae) were redescribed with important species delineating characters along with morphometric measurements and illustrative diagnostic keys.

Ten species of longhorn beetles belonging to the genus *Glenea* Newman of subfamily Lamiinae (Coleoptera, Cerambycidae) were redescribed with comprehensive documentation of morphological characters. The type species of the genus *Eurymeros*, *E. tumespiraculum* Bhat (Fig. 30) was redescribed. The armoured scale, *Aulacaspis crawii* (Cockerell) was redescribed. Indian species of the genus *Rbene* Thorell (Aranei: Salticidae) were studied with a detailed examination of the type materials of seven species. *Rbene mus* (Simon) was redescribed with illustrations for the first time in 132 years since its first description. The following eleven new synonyms and five new combinations were proposed: *Zeuxippus* Thorell syn. n. with *Rbene* Thorell; *R. biembolusa* Song & Chai syn.n. with *R. flavicomans* Simon; *R. baldanei* Gajbesyn.n.

with *Bianor angulosus* (Karsch); *R. decorata* Tikader syn. n. and *R. pantharae* Biswas & Biswas syn. n. with *R. pallida* (Thorell); *R. citri* (Sadana) syn. n., *R. danieli* Tikader syn. n., *R. indica* Tikader syn. n., *R. kbandalaensis* Tikader syn. n. and *R. sangbrakshiti* Gajbe syn. n., with *R. flavigera* (C.L. Koch); *Rbenefictus tropicus* Logunov syn. n. with *Rbenefictus wandae* (Wang & Li) comb. n. (ex. *Rbene*), *Rbene atellana* (Thorell) comb. n., *Rbene bistrio* (Thorell) comb. n., *Rbene pallida* (Thorell) comb. n., and *Rbene yunnanensis* (Peng & Xie) comb. n. (all ex. *Zeuxippus*). Detailed digital illustrations and distributional maps (Fig. 31) were also provided.

Table 1. List of new species described

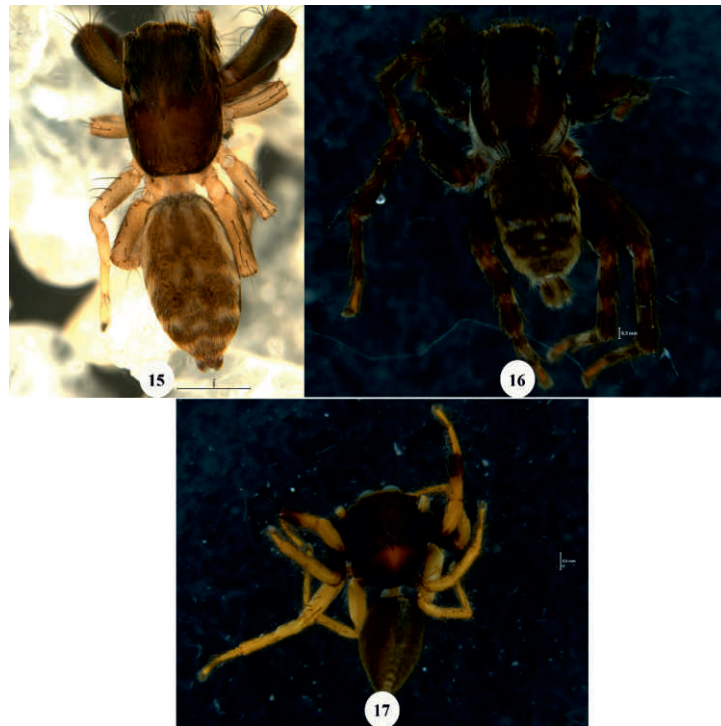
S. No	Scientific name	Family	Holotype deposited
Diptera			
1	<i>Dacimita curvifasciatus</i> David & Hancock (Fig. 12)	Tephritidae	ICAR-NBAIR, Bengaluru
2	<i>Platensina rabbani</i> David & Hancock (Fig. 8)	Tephritidae	ICAR-NBAIR, Bengaluru
3	<i>Platensina flavistigma</i> David & Hancock (Fig. 9)	Tephritidae	ICAR-NBAIR, Bengaluru
4	<i>Rhabdochaeta nigroapicalis</i> David, Hancock & Sachin (Fig. 10)	Tephritidae	ICAR-NBAIR, Bengaluru
Hemiptera			
5	<i>Cyphococcus williamsi</i> Joshi & Rajgopal (Fig. 11)	Coccidae	ICAR-NBAIR, Bengaluru
Hymenoptera			
6	<i>Doddifoenus burksi</i> Gupta, Sankararaman & Hemanth Kumar (Fig. 6)	Pteromalidae	ICAR-NBAIR, Bengaluru
7	<i>Leiophron crassivena</i> Gupta & van Achterberg (Fig. 3)	Braconidae	ICAR-NBAIR, Bengaluru
8	<i>Leiophron indefinita</i> Gupta & van Achterberg (Fig. 7)	Braconidae	ICAR-NBAIR, Bengaluru
9	<i>Pambolus (Phaenodus) infuscatus</i> Gupta & van Achterberg (Fig. 4)	Braconidae	ICAR-NBAIR, Bengaluru
10	<i>Paroligoneurus indicus</i> Gupta & van Achterberg (Fig. 5)	Braconidae	ICAR-NBAIR, Bengaluru
11	<i>Paroplitis kbajjiarensis</i> Gupta & Fernández-Triana (Fig. 2)	Braconidae	ICAR-NBAIR, Bengaluru
12	<i>Streblocera (Eutanycerus) breviflagellata</i> Gupta & van Achterberg (Fig. 1)	Braconidae	ICAR-NBAIR, Bengaluru
Thysanoptera			
13	<i>Hydatothrips initium</i> Rachana, Amarendra and Gracy (Fig. 13)	Thripidae	ICAR-NBAIR, Bengaluru
14	<i>Pseudodendrothrips umbrolateralis</i> Rachana, Amarendra and Gracy (Fig. 14)	Thripidae	ICAR-NBAIR, Bengaluru



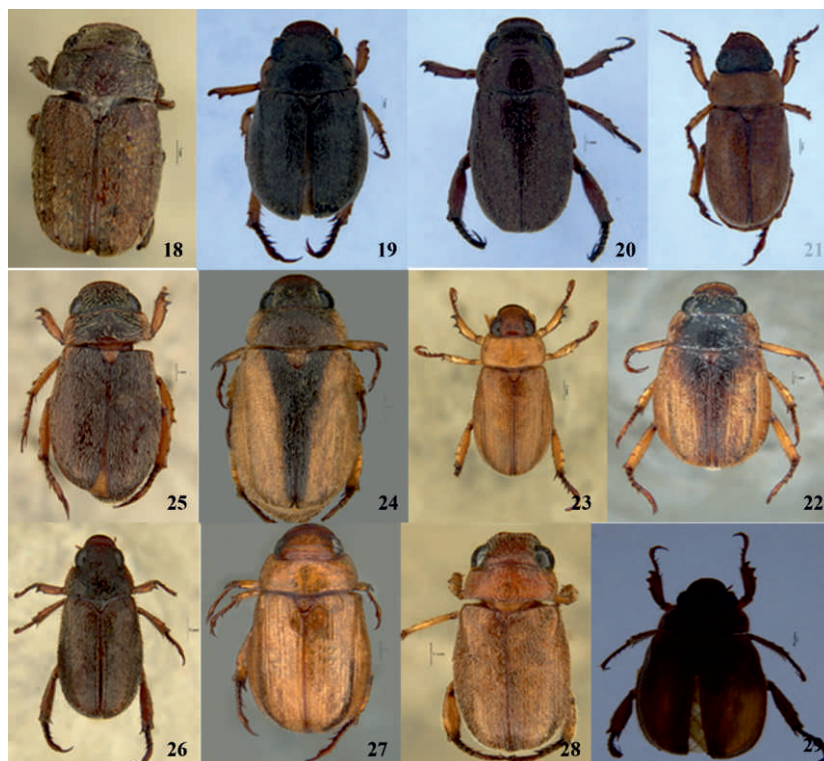
Figures 1–7. New taxa of Hymenoptera described from India. 1, *Streblocera(Eutanycerus) breviflagellata* Gupta & van Achterberg; 2, *Paroplitis kbajjiarensis* Gupta & Fernández-Triana; 3, *Paroligoneurus indicus* Gupta & van Achterberg; 4, *Pambolus(Phaenodus) infuscatus* Gupta & van Achterberg; 5, *Leiophron crassivena* Gupta & van Achterberg; 6, *Doddifoenus burksi* Gupta, Sankararaman & Hemanth Kumar; 7, *Leiophron indefinita* Gupta & van Achterberg



Figures 8–14. New taxa described from India. 8, *Platensina rabbani* David & Hancock; 9, *Platensina flavistigma* David & Hancock; 10, *Rhabdochaeta nigroapicalis* David, Hancock & Sachin; 11, *Cyphococcus williamsi* Joshi & Rajgopal; 12, *Dacimita curvifasciatus* David & Hancock; 13, *Hydatothrips initium* Rachana, Amarendra and Gracy; 14, *Pseudodendrothrips umbrolateralis* Rachana, Amarendra and Gracy



Figures 15–17. Provisionally described new spider taxa. 15, *Afrafacilla* sp.; 16, *Stenaelurillus* sp.; 17, *Carrbotus* sp.



Figures 18–29. Redescribed scarab species of the genus *Adoretus*. 18, *A. bicaudatus* Arrow; 19, *A. pusillus* Arrow; 20, *A. duvauceli* Blanchard; 21, *A. flavus* Arrow; 22, *A. stoliczkae* Ohaus; 23, *A. nitidus* Arrow; 24, *A. decanus* Ohaus; 25, *A. lasiopygus* Burmeister; 26, *A. simplex* Sharp; 27, *A. fusciceps* Arrow; 28, *A. nephriticus* Ohaus; 29, *A. ovalis* Blanchard



Figure 30. *Eurymeros tumespiraculum*

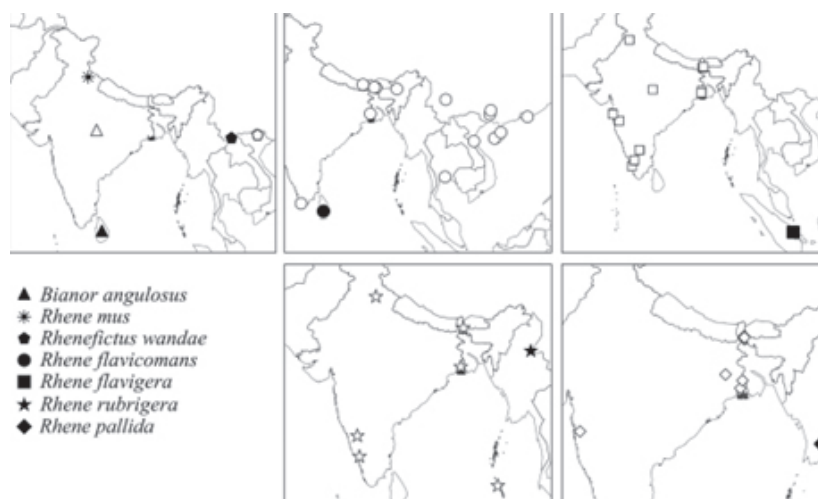
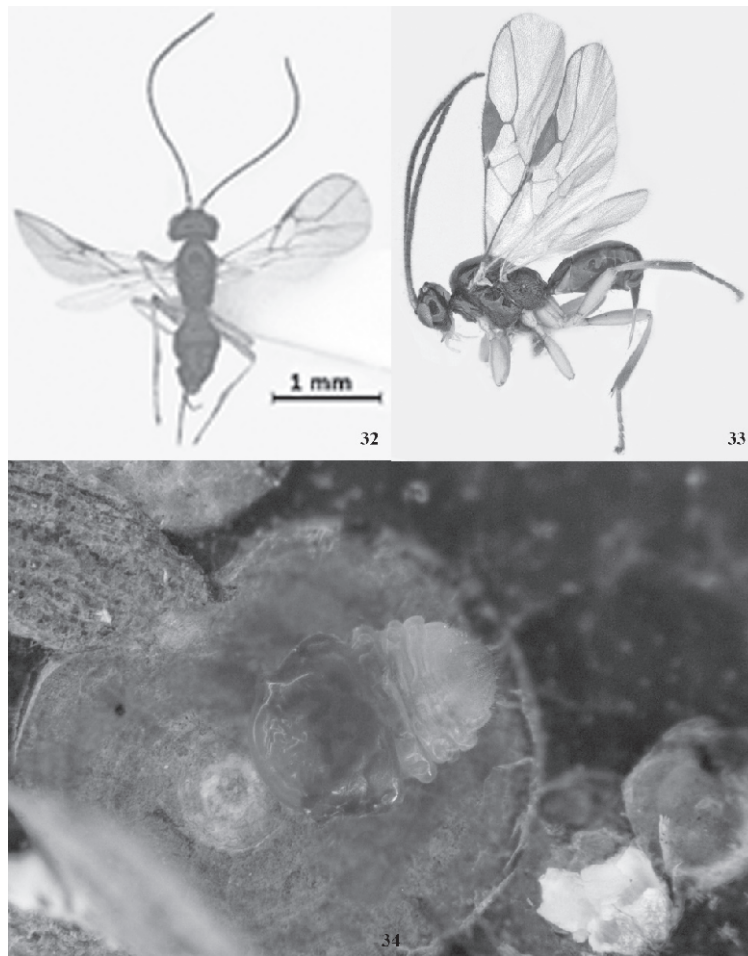


Figure 31. Type localities (solid black) and distributional records (solid white) of *Rhene* species

New distributional records

New distributional records for India include two armoured scale species, *Aulacaspis crawii* (Cockerell) (Fig. 34) infesting *Melia dubia* Cav. (Meliaceae), *Kuvanaspis howardi* (Cooley) infesting *Phyllostachys* sp. (Poaceae) and a mealybug species, *Palmicultor lumpurensis* (Takahashi) infesting *Dendrocalamus longispathus* (Kurz) Kurz. In Hymenoptera, a pteromalid genus, *Doddifoenus* Bouček and two braconid species, *Aphaereta vondelparkensis* (van Achterberg et al.) (Fig. 32) and *Centistes* (*Centistes*) *cuspidatus* (Haliday) (Fig. 33) were recorded. Regarding new distribution records for the state; one aphid species, *Conchaspis angraeci* Cockerell, two armoured scales, *Rutherfordia* major (Cockerell) and *Pinnaaspis buxi* (Bouché) and a soft scale species, *Drepanococcus chiton* (Green) were reported from

Kerala; *D. chiton* and *P. buxi* from Andhra Pradesh; one aphid species, *Greenideoida ceyloniae* van der Goot and a felted scale species, *Pedroniopsis beelsoni* Green from Jharkhand; one soft scale species, *Ceroplastes cirripediformis* Comstock from Madhya Pradesh and one soft scale species, *Megapulvinaria maxima* (Green) from Rajasthan. Scarab species viz. *Bunbunius hartmanni* and *Pseudopanotrogus lassallei* were recorded from Himachal Pradesh. Four salticid spider species viz. *Bianor angulosus* (Karsch) was reported from Punjab, *R. flavicomans* from Kerala, *R. baldanei* from Madhya Pradesh and *Rhene rubrigera* Prószyński from West Bengal and Uttarakhand.



Figures 32–34. New regional records. 32, *Aphaereta vondelparkensis* (van Achterberg et al.); 33, *Centistes* (*Centistes*) *cuspidatus* (Haliday); 34, *Aulacaspis crawii* (Cockerell)

New host records/pest records

Doddifoenus burksi was reported to parasitize Cerambycidae (Coleoptera), which is the first biological information reported globally under the genus *Doddifoenus*. *Tetrastichus epilachnae* (Giard) was reported to parasitize *Anisolemnia dilatata* (Fab.) (Coccinellidae: Coleoptera) at West Bengal. Primary parasitoids viz. *Aenasius arizonensis* (Girault) and *Pseudleptomastix mexicana* Noyes & Schauff and six species of hyperparasitoids viz. *Aprostocetus* sp., *Chartocerus* sp., *Cheilononeurus* sp., *Homalotylus turkmenicus* Myartseva, *Marietta leopardina* Motschulsky and *Prochiloneurus* sp. were recorded from primary parasitoids of *Phenacoccus solenopsis* Tinsley and *Paracoccus marginatus* Williams & Granara de Willink (Hemiptera: Pseudococcidae) on *Gymnema sylvestre* (R. Br) in the semi-arid region

of India. *Pseudarthria viscida* was reported as a new host plant for *D. chiton*. *Flacourtia inermis* was documented as a new host plant for *R. major*. *Dysmococcus breviceps* was recorded on *Pisum sativum* and *Kiritshenkella lingnani* on *Saccharum officinarum*. *Areca catechu* and *Brassica nigra* were the new host plants recorded for *Cerataphis brasiliensis* (Hempel) and *Smynthuroides betae* Westwood, respectively. *Conchaspis angraeci* was recorded on a host plant, *Excoecaria* sp. *Gossypium herbaceum* and *Psidium guajava* were reported as new host plants of invasive thrips species, *Thrips parvispinus* (Karny). A melolonthine species, *Apogoina* sp. was reported to cause considerable damage to *Theobroma cacao* at Kahikuchi, Assam and a buprestid species, *Sphenoptera indica* was found infesting *Cajanus cajan* at Anand, Gujarat.

Flacourtia inermis was documented as a new host plant for *R. major*. *Dysmoccoccus brevicepes* was recorded on *Pisum sativum* and *Kiritshenkella lingnani* on *Saccharum officinarum*. *Areca catechu* and *Brassica nigra* were the new host plants recorded for *Cerataphis brasiliensis* (Hempel) and *Smyntburodes betae* Westwood, respectively. *Conchaspis angraeci* was recorded on a host plant, *Excoecaria* sp. *Gossypium herbaceum* and *Psidium guajava* were reported as new host plants of invasive thrips species, *Thrips parvispinus* (Karny). A melolonthine species, *Apogoina* sp. was reported to cause considerable damage to *Theobroma cacao* at Kahikuchi, Assam and a buprestid species, *Sphenoptera indica* was found infesting *Cajanus cajan* at Anand, Gujarat.

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

Diagnostic keys to the following taxa have been published

- Twenty-one genera of subfamily Dacinae, world species the genus *Platensina* Enderlein and Indian species of tribe Schistopterini.
- An updated key to the world species of the genera *Paroplitis* Mason and *Doddifoenus* Bouček and Oriental species of the genus *Pambolus* Haliday.
- Adult females of mealybugs infesting cassava (field and microscopic characters), Indian species of *Antonina* Signoret, *Formicococcus* Takahashi and *Maacoccus* Tao, Wong & Chang.
- Thrips species infesting cotton, Indian species of the genera *Hydatothrips* Karny and *Pseudodendrothrips* Schmutz.

Annotated checklist has been prepared for Indian Dryophthorinae. Thirty factsheets were prepared for economically important weevil species.

Two databases entitled “Pentatomidae fauna of India” and “True fruit flies of India” were prepared and published online. Catalogued 3228 specimens of Cicindellidae, 1209 specimens of Cerambycidae and 557 specimens of Elateridae preserved in the Insect Museum of ICAR-NBAIR.

Diversity studies

The diversity of *Apis* and non-*Apis* bees from thirteen districts of Chhattisgarh was documented. A total of 723 bee specimens were collected which represented three families, six subfamilies, 11 tribes, 25 genera and 52 species. Among all three families, the highest abundant family was Halictidae with two subfamilies viz. Halictinae and Nomiinae representing 14 genera and 23 species followed by the family Apidae with two subfamilies: Xylocopinae and Apinae, seven tribes: Xylocopini, Apini, Ceratinini, Eucerini, Anthophorini, Melectini and Meliponini; seven genera and 19 species. A total of 390 bees belonging to three families, 27 genera and 40 species were analysed from the natural (undisturbed) ecosystems of Chhattisgarh.

The diversity index values of the total captured population were as follows: Shannon Wiener Diversity Index (3.16) showed a high level of diversity while Menhinick's diversity index (2.12) and Margalf richness index (6.87) showed high diversity in the natural ecosystem. The species evenness value (0.84) showed an uneven population with multiple species. A total of 333 bees were captured from different agro-ecosystems belonging to three families and 34 species. The Shannon Wiener Diversity Index value (2.89) showed a highly diverse population. The value of Species evenness (0.82), Menhinick's diversity index (1.86), and Margalf richness index (5.68) showed high species richness within the population.

The diversity of thrips species on cotton at Coimbatore, Tamil Nadu was studied. The survey revealed the presence of three species, viz. *Scirtothrips dorsalis* Hood, *Thrips palmi* Karny and *Thrips tabaci* Lindeman on leaves and four species, viz. *Thrips florum* Schmutz, *Thrips hawaiiensis* (Morgan), *Frankliniella schultzei* (Trybom) and *Thrips parvispinus* (Karny) in flowers.

The diversity of native *Trichogramma* species under released and non-released conditions in medicinal and aromatic crop ecosystem was examined. Five species of trichogrammatids viz. *Trichogramma achaeae* Nagaraja & Nagarkatti, *T. chilonis* Ishii, *T. danausicida* (Nagaraja), *Trichogrammatoidea bactrae* Nagaraja and *Trichogrammatoidea armigera* Nagaraja were recovered from the area released with *Trichogramma* spp. whereas six trichogrammatid species viz. *T. achaeae*, *T. chilonis*, *T. chilostrae* Nagaraja & Nagarkatti, *T. danausicida*, *Tr. bactrae* and *Tr. armigera* were recovered from the non-released area. *Trichogramma chilostrae* was collected from the eggs of *Catopsilia pyranthe* (Linnaeus) infesting *Senna occidentalis* (L.) Link from the non-released area. Occurrence of *T. achaeae* and *T. chilostrae* were recorded on the eggs of *C. pyranthe* infesting *S. occidentalis* with a parasitism per cent of 3.7 and 5.71, respectively. Similarly, the occurrence of *T. chilonis* and *T. achaeae* were recorded on the eggs of *Helicoverpa armigera* (Hubner) and *Thysanoplusia orichalcea* (Fabricius) infesting methanol mint with 34.78 and 27.78 per cent egg parasitism, respectively.

Two species of tachinids were identified with their associated hosts. The identified tachinids were *Palearorista* sp. which was reared from *Spodoptera frugiperda* (J. E. Smith) and *Carcelia* sp.

from a black hairy caterpillar of sandalwood. Tachinid parasitoids were also reared from *Celosterna scabrator* (Fabricius), a pest of grapes and cabbage caterpillar, *Crocidolomia pavonana* (Fabricius). The diagnostic characters of *Senometopia quarta* (Baranov) which was reared from *Perixeria* sp., an inflorescence pest of cashew were digitized. The diversity, density, guild composition and functional significance of spiders at different trophic levels of cassava mealybug (CMB) colonies in the cassava ecosystem were elucidated (Table 2). The dominance of eleven spider species was recorded during the studies undertaken at Tamil Nadu and Namakkal. Predominately, salticid spiders shared the niche of CMB colonies along with other insects. Spiders feeding on the CMB (as pest) and grubs of *Hyperaspis maindroni* Sicard, adults of *Spalgis epius* (Westwood) affirmed its role as a general predator. Intra-guild predation of *Thyene imperialis* (Rossi) feeding on the juveniles of *Carrhotus viduus* (K.L. Koch) was observed. The presence of orb-weaver spiders in the CMB colonies was very limited except for *Neoscona* sp. Euryphagous spiders in great numbers against low-density CMB population at the initial stage of the crop resulted in the complete exclusion of CMB without warrant of other bioagents. Hence, spider conservation strategy in the cassava ecosystem becomes very imperative in checking the CMB population along with other potential bio agents.

Table 2. Spider assemblages at the third trophic level in the cassava mealybug niche

S. No.	Spider species	Guild	*Mean spider density/shoot tip (Density scale 4: ≥ 1000 mealybugs/shoot tip)	Remarks
1	<i>Thyene imperialis</i> (Rossi) (Salticidae: Araneae)	Stalkers	2.40	General predator; Observed all stages (male, female, and juveniles) of the spider. Interguild predation, female spider feeding on juveniles of <i>C. viduus</i> was seen.
2	<i>Carrhotus viduus</i> (C. L. Koch) (Salticidae: Araneae)	Stalkers	1.60	General predator; Observed all stages of spider predominantly juveniles.
3	<i>Hyllus semicupreus</i> (Simon) (Salticidae: Araneae)	Stalkers	0.40	General predator; female and juvenile forms were more abundant
4	<i>Plexippus paykulli</i> (Audouin) (Salticidae: Araneae)	Stalkers	0.40	General predator; females were
5	<i>Plexippu petersi</i> (Karsch) (Salticidae: Araneae)	Stalkers	0.40	General predator; females were observed
6	<i>Thomisus pugilis</i> Stoliczka (Thomisidae: Araneae)	Ambushers	1.20	General predator; females only recorded feeding on the blue butterfly adult, <i>S. epius</i>
7	<i>Scytodes fusca</i> Walckenaer (Scytodidae: Araneae)	Ambushers	0.20	General predator; commonly called spitting spider known for its hunting. However, not seen feeding any arthropods in the CMB niche

8	<i>Cheiracanthium approximatum</i> O. Pickard-Cambridge (Cheiracanthiidae: Araneae)	Foliage runners	1.00	General predator; observed male and female spiders
9	<i>Cheiracanthium</i> sp. (Cheiracanthiidae: Araneae)	Foliage runners	0.20	General predator; observed only juveniles feeding on grubs of <i>H.</i> <i>maindroni</i>
10	<i>Indoxysticus</i> sp. (Thomisidae: Araneae)	Ambushers	0.20	General predator; observed only juveniles feeding on cassava mealybug
11	<i>Neoscona</i> sp. (Araneidae: Araneae)	Orb-web builders	0.20	General predator; observed mummified ants from the small retreat build by the spider

*Spider density based on the mean of five shoot tips

Table 3. Insects identified for Directorate of Plant Protection Quarantine and Storage stations

DPPQS station	Date of interception	Fruit/plant imported	Country from which imported	Identification intercepted insect
Mumbai	26/08/2022	Citrus	Egypt	<i>Lepidosaphes beckii</i>
		Citrus	South Africa	<i>Aonidiella aurantii</i>
Mumbai	16/09/2022	Citrus	South Africa	<i>Aonidiella aurantii</i>
Hyderabad	02/12/2022	Kiwi	UAE	<i>Pseudaulacaspis pentagona</i>
Mumbai	07/12/2022	Kiwi	Greece	<i>Pseudaulacaspis pentagona</i>

Division of Genomic Resources

Mitochondrial genomes of entomopathogenic nematodes (EPN)

The assembled contigs were annotated by BLAST homology search against NCBI NT database. The contigs which mapped with *Steinernema* were further annotated using GeSeq using *Steinernema abbasi* and *Steinernema carpocapsae* as references. The circular genome was drawn using the OGDRAW program (Fig. 35).

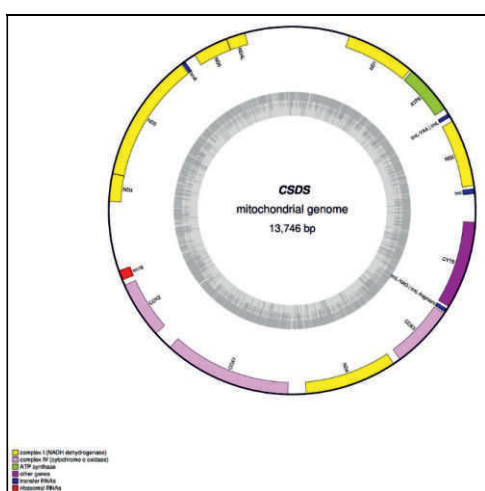


Figure 35. Circular *Steinernema abbasi* and *Steinernema carpocapsae* genes are represented with boxes inside or outside the circle to indicate clockwise or counter-clockwise transcription direction respectively. The inner circle indicates the GC content and inverted repeat boundaries.

Whole genome sequencing of bacterial symbionts of entomopathogenic nematodes

Ten bacterial samples isolated from ten EPN isolates correspondingly, were subjected to WGS using Illumina platform with 2 × 150 bp chemistry. An average of ~2.20 Gb high-quality data was generated for 10 samples.

De-novo sequencing: The high-quality paired-end data of 8 samples were assembled de novo using SPAdes genome assembler and refined using GFinisher resulting in draft genomes of ~4.14 Mb in average. An average of 3,620 genes were predicted across all 8 samples. BlastX analysis resulted in the functional annotation of 96.5% of the total genes predicted whereas 3.5% of the genes

had no significant BLAST hits for all 8 samples. Most of the genes were found to be homologous with *Xenorhabdus indica* in 6 samples (11A, 11B, 20A, 20B, SFG and SFNG) and most of the genes in 2 samples (Ag, Akg) were found to be homologous with the genes of *Xenorhabdus cabanillasii*. On average, 1,712 genes from all 8 samples were annotated based on KEGG pathway database via KAAS.

Reference sequencing: High-quality data of the other 2 samples, viz. Menase and Kashmir were mapped on the respective reference genomes using BWA (mem). Genome coverage was observed to the tune of 90.20% and 90.09%, respectively (Table 4). A total of 81,561 and 78,728 SNPs were identified in the samples, Menase and Kashmir, respectively. A total of 388 and 302 InDels were identified, respectively.

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

Profiles of genes and their expression involved in tritrophism among insect host, EPN and EPNB combinations in white grub (a coleopteran insect) in comparison to those in lepidopteran insects, viz. *Spodoptera frugiperda* and *Galleria mellonella* larvae indicated that most genes related to insect metabolism and immunity were common to both orders. Genes and their expression related to nematode-bacterium combinations were found to be variable (Fig. 36).

Fitness attributes of entomopathogenic nematodes

The bio control potential of 40 EPN strains belonging to *Heterorhabdus bacteriophora*, *H. indica*, *Heterorhabdus* sp., *Steinernema abbasi*, *S. carpocapsae*, *S. feltiae*, *S. riobrave* and *Steinernema* sp. in terms of virulence, environmental tolerance (to heat, desiccation, and cold), host-seeking ability etc. was estimated. Virulence assays were carried out against 12 species of pests belonging to Coleoptera and Lepidoptera. Most isolates infected *G. mellonella* between 16 and 37 degree celsius with higher fecundity at 25-30°C. Bio control potential was variable among nematode species and among the host species. MALDI-TOFF analysis and profiling of proteins during pathogenesis indicated the time-course relevance of certain proteins. Expressed protein details were archived at Protein Identification Data Base, EMBL-EBI (PRIDE).

Table 4. Blast hit distribution summary

SI No.	Sample Name	# Total Genes	# Genes with blast hit	# Genes with no blast hit
1	SFNG	3,656	3,528	128
2	SFG	3,608	3,478	130
3	Akg	3,613	3,497	116
4	Ag	3,617	3,494	123
5	11A	3,631	3,501	130
6	11B	3,620	3,492	128
7	20A	3,611	3,484	127
8	20B	3,603	3,475	128

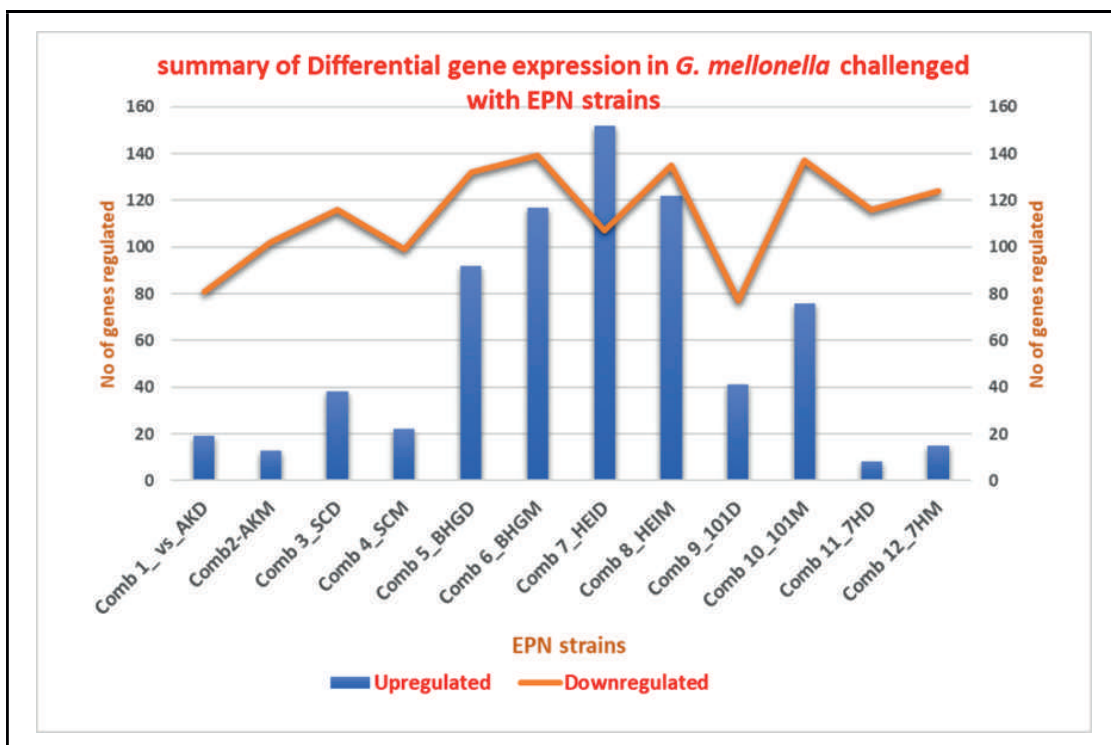


Figure 36. Summary of genes up and down-regulated in the insect host, *Galleria mellonella*

Simultaneous detection of gene expression of insects, nematode and bacterial specific genes to monitor the infection

NanoString technology gene expression quantification platform was used to study the expression of toxin genes causing infections from bacteria (*Photorhabdus* and *Xenorhabdus*), nematode (*H. indica*, *S. riobrave* and *S. carpocapsae*) specific genes for detection and immune-related genes from the infected insects (*S. frugiperda* and *G. mellonella*).

The study revealed the expression of different immune-related genes from the infected insects (*S. frugiperda* and *G. mellonella*) and helped in understanding the trend of expression of the gene in the samples from the healthy condition to the death stage (Table 5). Variations in gene expression were seen as per the expectation. GSE197737. <https://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE197737>.

Table 5. Some of the down-regulated host genes during infection common to the two insect hosts infected with EPN

XP_026748798.1juvenile hormone-binding protein-like [<i>Galleria mellonella</i>]
AXY94926.1Hexamerin S [<i>Galleria mellonella</i>]
XP_026756605.1apolipoporphin-3 [<i>Galleria mellonella</i>]
XP_026755044.1collagenase-like [<i>Galleria mellonella</i>]
XP_026748905.1cathepsin L [<i>Galleria mellonella</i>] XP_026748906.1
NP_001037265.1ribosomal protein S9 [<i>Bombyx mori</i>] XP_022118407.1 40S ribosomal protein S9 [<i>Pieris rapae</i>] AAV34865.1 ribosomal protein S9 [<i>Bombyx mori</i>]
XP_026752995.1cytochrome P450 4c3-like [<i>Galleria mellonella</i>]
XP_026758876.1general odorant-binding protein 56d [<i>Galleria mellonella</i>]
XP_026762957.1CCHC-type zinc finger protein CG3800-like [<i>Galleria mellonella</i>] XP_026762959.1
ADT80828.1serine protease 58 [<i>Mamestra configurata</i>]
XP_026759084.1acanthoscurrin-1-like [<i>Galleria mellonella</i>]
XP_026750985.1glutathione S-transferase 1-like isoform X1 [<i>Galleria mellonella</i>]
XP_026761353.1superoxide dismutase [Cu-Zn]-like, partial [<i>Galleria mellonella</i>]
XP_026751101.1dual specificity protein phosphatase 14 [<i>Galleria mellonella</i>]
XP_026758812.1sialic acid synthase [<i>Galleria mellonella</i>]
XP_026756005.1NADH dehydrogenase [ubiquinone] 1 alpha subcomplex subunit 8 [<i>G. mellonella</i>]
XP_026753241.1inducible metalloproteinase inhibitor protein-like [<i>Galleria mellonella</i>]

Metagenomic analysis was carried out for the insect host infected with EPN. Bacterial profiles of 8 samples of host larvae infected with EPN during infection were generated (Table 6).

Table 6. Bacterial profiles of host larvae infected with EPN during infection

	Sample 1 MG1HS (%)	Sample 2 MG1SF (%)	Sample 3 MG2HS (%)	Sample 4 MG2SF (%)	Sample 5 MG3HS (%)	Sample 6 MG3SF (%)	Sample 7 MG4HS (%)	Sample 8 MG4SF (%)
Phylum	Proteobacteria (57.60)	Firmicutes (82.57)	Proteobacteria (36.84)	Proteobacteria (51.46)	Proteobacteria (48.81)	Proteobacteria (73.12)	Actinobacteria (29.64)	Firmicutes (69.70)
Class	Gammaproteobacteria (55.76)	Bacilli (82.52)	Gammaproteobacteria (32.77)	Gammaproteobacteria (49.09)	Gammaproteobacteria (47.08)	Gammaproteobacteria (46.52)	Actinobacteria (29.13)	Bacilli (69.59)
Order	Enterobacteriales (43.20)	Lactobacillales (82.39)	Lactobacillales (25.54)	Enterobacteriales (48.83)	Enterobacteriales (36.84)	Enterobacteriales (36.67)	Actinomycetales (29.13)	Lactobacillales (54.19)
Family	Enterobacteriaceae (43.20)	Enterococcaceae (81.90)	Enterococcaceae (25.38)	Enterobacteriaceae (48.83)	Enterobacteriaceae (36.84)	Enterobacteriaceae (36.67)	Porphyromonadaceae (25.72)	Enterococcaceae (53.83)
Genus	Xenorhabdus (38.75)	Enterococcus (81.05)	Enterococcus (24.89)	Photorhabdus (48.63)	Dysgonomonas (27.27)	Xenorhabdus (35.64)	Unclassified genus from order Actinomycetales (14.41)	Enterococcus (53.26)
Species	japonica (30.60)	asini (49.12)	Unclassified species from genus Enterococcus (23.34)	Unclassified species from genus Photorhabdus (48.51)		japonica (28.32)		asini (32.46)

Molecular characterization and DNA barcoding of agriculturally important insects

Molecular characterization and DNA barcoding using different molecular markers like CO1, ITS-2, CO1A, CO1B, CO1 (Btab-850 bp) and species-specific markers were done for agricultural and veterinary pests, parasitoids, predators and invasive pests collected from different parts of the country, viz. Andhra Pradesh, Chhattisgarh, Gujarat, Jammu and Kashmir, Karnataka, Maharashtra, Tamil Nadu and Telangana. Due to large-scale infestation of thrips on chilli, thrips samples were received from farmers' fields in Andhra Pradesh, Chattisgarh (Raipur), Gujarat (Anand), Maharashtra (Aurangabad) and Tamil Nadu (Trichy), and were identified as *Thrips parvispinus* for which accession numbers were obtained (ON799413, ON799419, ON800215 and ON800702). Specimens of egg parasitoids that were received from different parts of Tamil Nadu, viz. Amrithapuram, Arungunam, Chitteri, Padur and Rajapalayam were identified as *Trichogramma chilonis* using mitochondrial COX1 gene (Accession numbers: OL913800, OL913900, OL913974, OL958541, OL958558) and ITS2 gene (Accession numbers: OM283598, OM327556, OM283610, OM283611, OM283618). Various specimens of insects that were found to occur on apples, pears and many other temperate crops in Jammu and Kashmir were subjected to molecular characterization and were identified as *Agriotes ogurae* (OP380046), *Hypomecis atomaria* (OP379715),

Liorhyssus hyalinus (OP002311), *Mythimna separata* (OP379774), *Stictopleurus* sp., (OP018544) and *Zicrona caerulea* (OP002144). Honey bee specimens collected from different parts of Karnataka, viz. Bengaluru, Chettalli, Ponnampet and Shivamogga were identified as *Apis cerana* and *Apis mellifera*. Specimens of insects of veterinary importance were received from Veterinary College, Hebbal for molecular identification and the insects were identified as *Musca asiatica* (OM281303) and *Stomoxys calcitrans* (OM281304).

Specimens of green stink bug found in a consignment from Germany were received from a pharmaceutical company in Mumbai for molecular identification. The specimens were identified as *Nezara viridula* using both morphological and molecular means and an accession number (OM108162) was obtained for the same.

Mealybug specimens collected from 62 locations and 29 host plants were subjected to morphological and molecular identification. The mealybug-specific primers used were, PCO F1 5' to 3'; Lep – R3 3' to 5'. Protocol for mealybug molecular characterization was standardized with the following PCR conditions: initial denaturation (95°C for 5 minutes), denaturation (95°C for 30 seconds), annealing (51°C for 40 seconds), 35 thermal cycles, extension (72°C for 45 seconds), final extension (72°C for 10 minutes) and 4°C for infinite hold of PCR amplified products. Most of the identified specimens were *Phenacoccus solenopsis* and few were *Paracoccus marginatus*, *Planococcus citri* and *Rastrococcus iceryoides*.

Identification of plant bugs was achieved through both morphological and molecular means and accession numbers were obtained as follows, *Acanthocoris scabrator* (OQ319472), *Carbula biguttata* (OQ324890), *Cletus pugnator* (OQ323459), *Dysdercus cingulatus* (OQ320754), *Leptocorisa acuta* (OQ320836) and *Riptortus pedestris* (OQ324691).

Analysis of genetic diversity in *Maruca vitrata* based on CO1 gene sequence polymorphism

The mitochondrial cytochrome oxidase subunit 1 (CO1) is a robust marker (688 bp) for species identity as well as for analysis of genetic diversity among populations. The variations of CO1 gene sequences obtained from *Maruca vitrata* samples collected from 39 locations (latitude: 10.5276° to 17.9104° N and longitude: 76.2144° to 81.2560° E) across south India were examined. The resultant sequences were compared with the retrieved sequences of Indian populations of *M. vitrata* from NCBI database. The sequence alignment and editing resulted in a consensus sequence of 642 bp length across all *M. vitrata* populations. To maximize the number of reference sequences from India, 630 bp consensus sequences were used for the diversity analysis. A total of 17 haplotypes were identified among the samples analysed with a haplotype diversity of 0.533 and nucleotide diversity of 0.00150. There were 17 polymorphic sites and a relatively less average number of nucleotide differences of 0.94743 (Table 7).

Microsatellite marker analysis of *Maruca vitrata*

Using Illumina HiSeq sequencing tool, 140,888,511 bp reads were assembled into 93,504 contigs, (GC content - 42.91%; N50 - 1998; N90 - 687 bp length) (Table 8). To develop novel molecular markers, all of the 93,504 contigs were used to mine microsatellite loci with minimum repeats for microsatellite types set to ten for mono-nucleotide, six for di-nucleotide, five for tri-nucleotide, four each for tetra-nucleotide, penta-nucleotide and hexa-nucleotide. A total of 46,505 microsatellites were identified from 93,504 contigs covering a length of 6,60,323 bp with an average length of 14.20 bp. The microsatellites covered 0.34 per cent of sequences from the total length of the sequence with a relative abundance of 239.3 loci/Mb and a relative density of 3397.80.

The results revealed that an average of 10.44 alleles per locus were detected from the 39 samples of *M. vitrata*, with a range of 4 (MVSSR6) to 21 (7_02K06) having 51.85 per cent polymorphism. The observed heterozygosity (H_o) ranged from 0 to 0.333, with a mean value of 0.126. The overall mean expected heterozygosity (H_e) was 0.393 in the 39 samples, with a range of 0.172 (MVSSR2) to 0.834 (C32008). The F_{ST} , F_{IS} and F_{IT} ranged from 0.099 to 0.818 (mean of 0.583), from -0.455 to 1.000 (mean of 0.557) and 0.655 to 1.000 (mean of 0.868), respectively. The gene flow (N_m) ranged from 0.078 to 2.277, with an average of 0.432. The Shannon's information index (I) revealed that an average of 1.938 was observed, with a range of 1.041 to 2.948.

Table 7. Molecular diversity indices based on CO1 gene sequence analysis of *M. vitrata* populations

Sampling locations	N	S	H	Hd	π	K
Tamil Nadu	18	08	09	0.895	0.00321	2.05882
Karnataka	15	14	07	0.657	0.00344	2.20952
Other states of south India	06	04	04	0.800	0.00208	1.33333
Pooled South India	39	18	15	0.796	0.00317	2.03239
All India	126	17	17	0.533	0.00150	0.94743

[N- Number of samples; S- Polymorphic sites; H- Haplotypes; Hd- Haplotype diversity; π - Nucleotide diversity; K-Average number of nucleotide differences]

Table 8. Summary statistics of microsatellites from the transcriptome of *Maruca vitrata*

Item	Description	Number
Total number of microsatellites	Counts	46,505
Total length of microsatellites	bp	660323
The average length of microsatellites	Total microsatellites length/Total microsatellites count (bp)	14.20
Microsatellites per sequence	Total microsatellites counts/Sequence counts	0
The percentage of sequence covered by microsatellites	Total microsatellites length/Total sequence length (%)	0.34
Relative abundance	Total microsatellites/Total valid length (loci/Mb)	239.30
Relative density		3397.81

Molecular studies on *Bacillus thuringiensis*

Bacillus thuringiensis strain NBAIR-Bt25

Bacillus thuringiensis strain NBAIR-Bt25 was characterised morphologically by simple microscopy (shape of spores) (Fig.37) and also molecularly by 16S rDNA, Multi Locus Sequence Typing and whole genome sequencing.

16S rDNA characterisation of Bt25 was done by partial amplification of the gene. Sanger sequencing of PCR product fetched 1,516 bp (partial) which was submitted in NCBI database and an accession number (MN327970) was obtained. Multi Locus Sequence Typing of *Bacillus thuringiensis* strain NBAIR BtAN4 was

done using Glp, Gmk, ilvD, Pta, Pur, Pyc A and Tpi genes. Whole genome sequencing was done using NextSeq500 Illumina platform. A total of 8,407,039 reads were obtained with 577 scaffolds and genome size of ~6.62 Mb was obtained. KEGG pathway analysis showed 6,980 genes in the KEGG annotated genes. Gene ontology study showed 2,325 genes for biological function, 1,971 genes for cellular components and 2,967 genes for molecular function. Insecticidal genes profiling of *Bacillus thuringiensis* strain NBAIR Bt25 using Bt toxin Digger showed 28 genes which are depicted in Table 9.

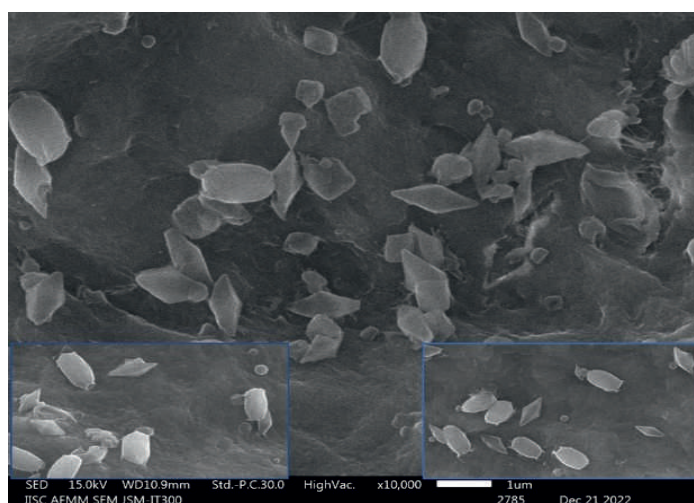


Figure 37. Visualisation of crystal proteins in scanning electron microscope

Table 9. Insecticidal genes profiling of NBAIR Bt25

Sl. No.	Gene	Per cent coverage (%)	Per cent Identity (%)
1.	cry1Ia11	100	100
2.	cry2Aa9	100	100
3.	cry1Ea12	100	99.74
4.	cry2Ab4	100	100
5.	cry70Aa1	74.81	27.83
6.	cry8Aa1	57.22	63.44
7.	vip3Aa59	100	100
8.	zwa6-other	100	29.07
9.	ChitinaseC	100	99.27
10.	zwa5A-other	96.62	31.21
11.	zwa5A-other	100	98.15
12.	zwa5B-other	100	97.83
13.	zwa6-other	100	98.39
14.	zwa5A-other	92.31	29.00
15.	zwa6-other	96.77	34.00
16.	bmp1-other	64.39	60.35
17.	Enhancin-other	100	98.79
18.	bmp1-other	66.63	31.43
19.	inhA1-other	100	78.02
20.	inhA1-other	100	74.87
21.	bmp1-other	63.61	79.40
22.	bmp1-other	100	96.53
23.	zwa5A-other	95.08	29.45
24.	inhA1-other	100	96.11
25.	inhA2-other	100	98.62
26.	cyt1Da2	57.87	28.57
27.	spp1Aa1	99.21	80.28
28.	vpb4Aa1	62.59	37.58
29.	cry1Gc1	12.08	100
30.	cry1Ab14	12.55	100
31.	cry2Ab4	100	100
32.	cry70Aa1	74.81	27.83
33.	cry8Aa1	57.22	63.44
34.	cry1Ea10	71.48	100
35.	cry2Aa9	100	100
36.	cry1Ia44	100	100
37.	cry1Ab9	70.82	99.88
38.	vip3Aa59	100	100
39.	zwa5A-other	100	98.15
40.	zwa5B-other	100	97.83
41.	zwa6-other	100	98.39
42.	cyt1Da2	57.87	28.57
43.	vpb4Aa1	62.59	37.58

Bacillus thuringiensis strain NBAIR-BtAN4

Bacillus thuringiensis strain NBAIR BtAN4 was characterised morphologically by simple microscopy (shape of spores) (Figs. 38-39), and molecularly by 16S rDNA, Multi Locus Sequence Typing and whole genome sequencing. Bio-efficacy studies of *Bacillus thuringiensis* strain NBAIR BtAN4 showed up to 76% mortality in *Holotrichia serrata*.

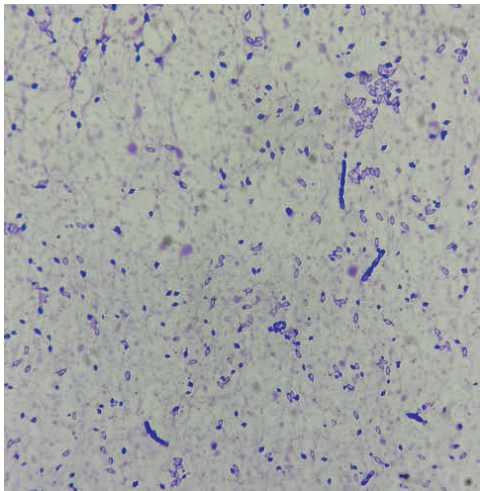


Figure 38. Visualisation of crystal proteins in a simple microscope

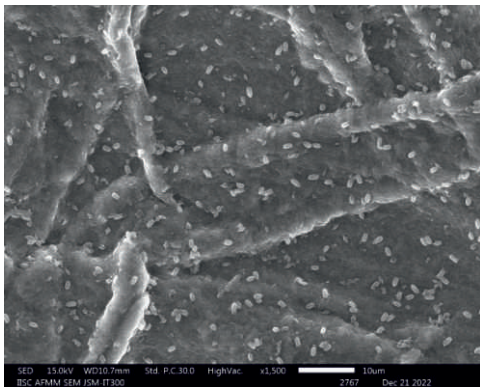


Figure 39. Visualisation of crystal proteins in scanning electron microscope

16S rDNA characterisation of BtAN4 was done by partial amplification of gene. Sanger sequencing of PCR product fetched 679 bp (partial) which was submitted in NCBI database and accession number (KY451835) was obtained. Multi Locus Sequence Typing of Bt strain NBAIR BtAN4 was done using *Glp*, *Gmk*, *ilvD*, *Pta*, *Pur*, *Pyc A* and *Tpi* genes. Whole genome sequencing was done using

NextSeq500 Illumina platform. A total of 5,873,521 reads were obtained with 808 scaffolds and a genome size of ~5.69 Mb was obtained. KEGG pathway analysis showed 1,887 genes in the KEGG annotated genes. Gene ontology study showed 2,119 genes for biological function, 1,813 genes for cellular components and 2,733 genes for molecular function. Insecticidal genes profiling of Bt strain NBAIR BtAN4 using BtToxin Digger showed 28 genes as depicted in Table 10.

Table 10. Insecticidal genes profiling of NBAIR BtAN4

Sl. No.	Gene	Percent coverage (%)	Percent Identity (%)
1.	<i>cry2Aa9</i>	100	100
2.	<i>cry1Ia44</i>	100	100
3.	<i>cry2Ab35</i>	100	100
4.	<i>cry1Ac29</i>	55.70	100
5.	<i>cry1Ac5</i>	36.62	100
6.	<i>cry1Ab28</i>	37.00	100
7.	<i>cry1Ac37</i>	24.14	100
8.	<i>vip3Aa7</i>	100	100
9.	<i>zwa5A</i>	100	100
10.	<i>zwa5B</i>	100	100
11.	<i>zwa6</i>	100	100
12.	<i>mpp46Ab1</i>	79.28	33.60
13.	<i>vpb4Ca1</i>	12.39	66.42
14.	<i>Bmp1 other1</i>	66.63	31.43
15.	<i>Bmp1 other2</i>	63.61	79.05
16.	<i>Bmp1</i>	100	96.86
17.	Chitinase C	100	99.27
18.	<i>cry2Aa</i>	100	100
19.	Enhancin	100	92.86
20.	<i>InbA</i>	100	100
21.	<i>InbA1</i>	100	75.25
22.	<i>InbA2</i>	100	98.37
23.	<i>Spp1Aa1</i>	99.21	80.68
24.	<i>zwa5A</i>	92.31	28.67
25.	<i>zwa6</i>	96.00	34.11
26.	<i>zwa6 other</i>	100	29.07
27.	<i>zwa5A other1</i>	94.15	29.08
28.	<i>zwa5A other2</i>	96.31	30.99

Novel formulation of *Bacillus thuringiensis*

A novel powder-based formulation was made with use of molasses which acts as humectant/ spreader, binder, multipurpose UV screen with dispersant and diatomaceous earth which acts as both carrier and flowing agent. Out of 24 treatments tested, the highest cfu count of log 9.48 was observed at 18 months in T10 (SSG 3%, Kaolin 75%, Diatomaceous Earth 10% and 15% a.i.). It also showed good shelf life. Bioassay against *Spodoptera frugiperda* showed LC₅₀ of 0.12 to 0.16 mg/ml.

Microflora associated with insects and their role in farm waste management

A total of 14 microflora from all five instars of black soldier fly larvae were identified using 16S rRNA gene sequences as *Bacillus altitudinis*, *Citrobacter amalonaticus*, *Citrobacter farmeri*, *Escherichia marmotae*, *Klebsiella pneumoniae* (4), *Morganella morgani* (3), *Paenibacillus lautus*, *Providencia rettgeri* and *Providencia stuartii*. Biochemical characterization of microflora from black soldier fly for hydrolytic enzymes like amylase, lipase and protease using qualitative and quantitative assays revealed that 8 isolates are positive for starch hydrolysis, 4 isolates for casein hydrolysis and 8 for cellulose hydrolysis (Fig. 40).

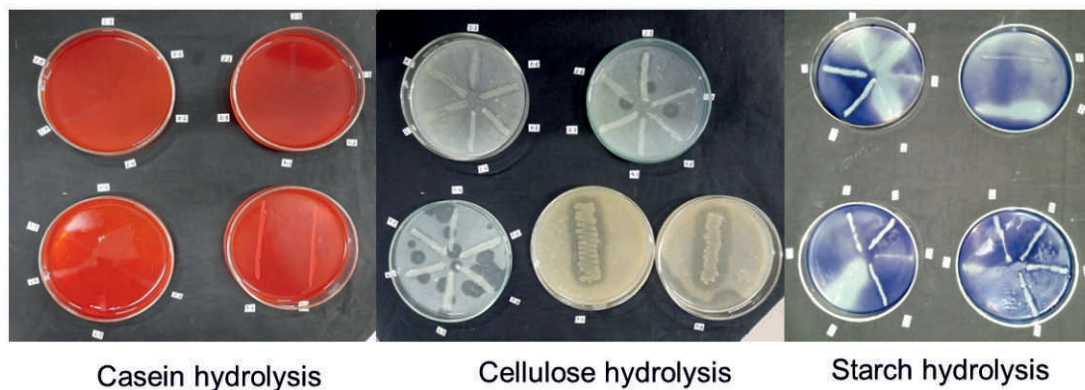


Figure 40. Biochemical characterisation of microflora from black soldier fly

Metagenomic analysis of black soldier fly larvae yielded a total of 257 operational taxonomic units (OTUs). In the metagenomic analysis, *Acetobacter* genus was found to be dominant, followed by *Morganella*, *Campylobacter* and *Enterococcus* (Fig. 41). Comparative transcriptome analysis was performed using the publicly available transcript sequences of *Drosophila melanogaster* (dmel-all-transcript-r6.44) from FlyBase and *Anopheles gambiae* from NCBI (GCF_000005575.2_AgamP). Gustatory receptors and olfactory receptors identified were homogenous with those earlier reported in *Hermetia illucens*. Ionotropic receptors and olfactory binding proteins identified were homogenous with those already reported in *H. illucens* and *D. melanogaster*.

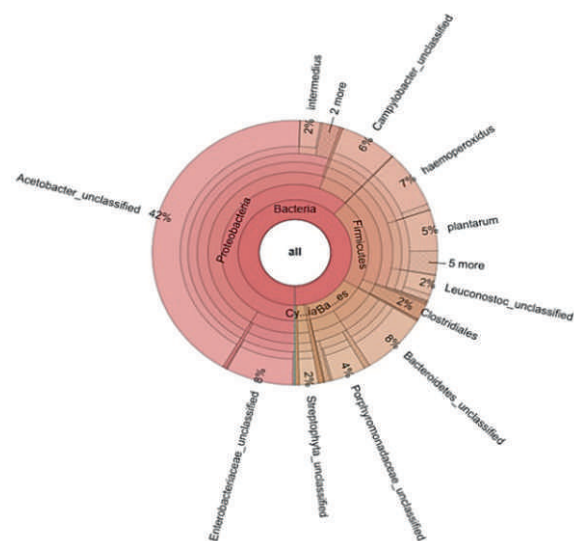


Figure 41. Metagenomic Krona Pie Chart distribution of black soldier fly larvae

Whole transcriptome sequencing of pink mealybug, *Maconellicoccus hirsutus*

Whole transcriptome sequencing of *Maconellicoccus hirsutus* was carried out using Illumina MiSeq, denovo based assembly. High-quality RNA was isolated using Trizol reagent. Raw data was processed to obtain high-quality reads. The open-source software package, Trimmomatic was used to identify and 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 Bruijn graph to represent the overlap among the reads.

The assembly was further refined using the tr2aacds pipeline in Evidential Gene package (<http://arthropods.eugenec.org/EvidentialGene/>) which reduced the redundancy by selecting the 'optimal set' of assembled transcripts based on their coding potential, leading to the final non-redundant transcriptome assembly containing a unique set of transcripts. To check the quality of the assembled transcriptome, Nx matrices were analyzed and the coding capacity of the assembly was assessed using BUSCO v 3.0.2.

The annotated gene data was used for gene mining of RNAi machinery genes which yielded around 22 transcripts belonged to Argonaute, Dicer, Drosha and Loquacious gene families. These genes were validated using copy number and also nr database-blastx search for CDD and blastn search. The validated genes were taken for further analysis. Primers around 800bp for PCR and 200bp for qRT PCR were designed using Primer-3 software.

Standardization of liquid diet feeding assays for *M. hirsutus* was carried out. Various doses of sucrose + yeast extract were evaluated using the parafilm sandwich method, and the results showed that 15% sucrose + 2.5% YE is optimal for mealybug survival and no mortality was observed up to 9 days.

Development of improved strains of selected natural enemies for insecticide resistance

The multi-insecticidal tolerant strain of *Trichogramma chilonis* being maintained in NBAIR was subjected to selection pressure using Emamectin benzoate which is a common insecticide recommended against borer pests.

Starting from half the field dose, the MITS was exposed continuously to a total of 25 insecticidal sprays. The last dose to which the population was exposed was 10 times the field dose of Emamectin benzoate which indicated the development of resistance.

The multi-insecticidal tolerant strain of *Chrysoperla zastrowi sillemi* was also subjected to selection pressure using Diafenthiuron which is recommended against sucking pests. The population was exposed to 6 sprays with increasing doses of Diafenthiuron, out of which the last dose was 1.2 times the field dose.

Safety of Fenazaquin, which is a common acaricide was tested against the predatory mite, *Typhlodromus (Anthoseius) transvaalensis*. The field dose, half the field dose and 1/10th of the field dose caused 100% mortality in *T. transvaalensis*. Another acaricide, Propargite was also evaluated to assess its safety against *T. transvaalensis*. Field dose and half the field dose caused 90% and 80% mortality respectively in *T. transvaalensis*. The safety of Fenazaquin was evaluated against another predatory mite, *Neoseiulus indicus*. Field dose and half the field dose caused 96.29% and 93.10% mortality respectively in *N. indicus*.

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

Three mobile apps, (i) BIPM on coconut, (ii) BIPM on rice and (iii) BIPM on sugarcane (Fig. 42) were developed for pest and disease management with a special focus on biological control. These mobile apps contain two main options, "Pests" and "Diseases". The user can click either of these options to view further information on pests and diseases. The key elements present in these mobile apps are "Identification", "Damage symptoms", "Biology" and "Management" with different methods including biological control along with relevant pictures and videos. These mobile apps are available at Google Play Store and ICAR-NBAIR website and the web links are <https://play.google.com/store/apps> and <https://nbair.res.in/mobile-app>. They are accessible in three languages, English, Hindi and Kannada. Farmers/users can download and install these mobile apps from the Google Play Store by

using the keywords, BIPM on coconut, BIPM on rice and BIPM on sugarcane and can utilize the information for effective biointensive pest and disease management on these crops.

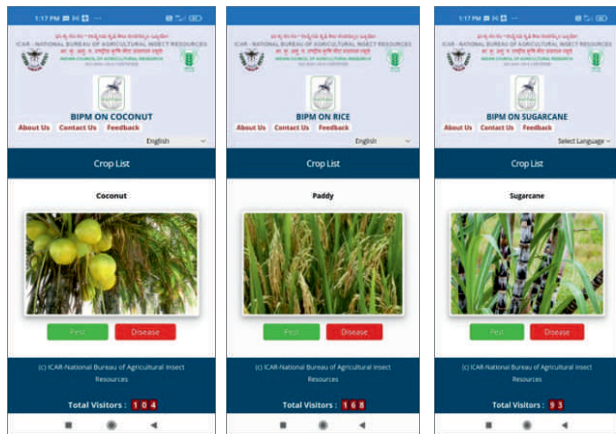


Figure 42. Screenshots of the mobile apps, BIPM ON Coconut, BIPM on Rice and BIPM on Sugarcane

Division of Germplasm Conservation and Utilisation

Biology of the parasitoid, *Anagyrus lopezi*

The total duration of development from oviposition to adult emergence was 18–23 days under laboratory conditions. The longevity of a male wasp supplied with honey as a food source was 33 days. Mated ovipositing females survived for a period of 13 days. The oviposition period of the wasp lasted for 11 days. Mated females produced both male and female progenies. However, unmated females were observed to produce male progeny alone. The female: male ratio was 1:2.

Mass production of *A. lopezi*

ICAR–NBAIR has standardised the mass production protocol of *A. lopezi* on cassava mealybug infested cassava setts (Fig. 43). The duration from oviposition to adult emergence of *A. lopezi* ranged between 18–20 days. Protray method of raising cassava setts for infestation of cassava mealybug and parasitoid multiplication is under investigation. The male and female wasps immediately after emerging from the cocoons under netted enclosure should be collected with the help of an aspirator and released (1:1 ratio) in test tubes or any rearing box/jar for mating (Fig. 44).

Mating was observed on the same day after emergence. Honey strips or honey streaked on glass surface act as a food source for the mating pairs. The unmated female laid unfertilized eggs that developed into male parasitoids.



Figure 43. Raising of cassava plants and mealybug infestation



Figure 44. Mass production of *A. lopezi* parasitoid

Interaction between *Metarhizium anisopliae* (Ma-35) and *Bracon brevicornis* under laboratory condition

Ten per cent mortality was observed when adults of *B. brevicornis* were exposed to *M. anisopliae* (ICAR-NBAIR Ma-35) @ 1×10^8 spores/ml. When 3rd, 4th and 5th of fall armyworm (FAW) were exposed to Ma-35 (1×10^8 spores/ml) at different duration (0, 24 and 48 hrs) and offered to *B. brevicornis*; the egg laying, total number of larvae and pupae developed and the adults emerged were higher in *B. brevicornis* exposed to fifth instar fall armyworm at 24 h after fungal inoculation.

Laboratory study on the effect of *Lecanicillium lecanii* (ICAR-NBAIR VI-8) on biology, feeding potential and prey preference of *Blaptostethus pallescens* fed on infected thrips *Frankliniella schultzei*

Biology, feeding potential and prey preference were studied for *B. pallescens* when *L. lecanii* (ICAR-NBAIR VI-8) infected thrips (*F. schultzei*) and uninfected thrips were offered as prey. The total nymphal duration was significantly higher on treated thrips (25.3 ± 0.16) compared to untreated thrips (19.5 ± 0.29). There was no difference in pre-oviposition, incubation period and percent hatching. However, a reduction in fecundity and longevity was observed when infected thrips were provided as prey. Total thrips consumption during nymphal period was significantly higher when uninfected thrips (163 ± 0.23) were provided compared to treatment where VI-8 infected thrips (163 ± 0.36) were provided. In the prey preference study, all instars and adults of *B. pallescens* preferred uninfected thrips over VI-8 infected thrips.

Laboratory study on the effect of *Lecanicillium lecanii* (ICAR-NBAIR VI-8) on biology and feeding potential of *Dortus primarius* fed on infected thrips *Frankliniella schultzei*

Biology and feeding potential were studied for *D. primarius* when *L. lecanii* (ICAR-NBAIR VI-8) infected thrips (*F. schultzei*) and uninfected thrips were offered as prey. There was no significant difference in total nymphal duration when fed on infected (20.11 ± 0.25). and uninfected thrips (19.27 ± 0.18). There was no difference in other

biological parameters like pre-oviposition, incubation period and percent hatching. However, a reduction in fecundity was observed when infected thrips were provided as prey. There was no difference in the consumption of total thrips during nymphal period in both treatments. The results showed that *L. lecanii* (ICAR-NBAIR VI-8) did not affect biological parameters of *D. primarius*.

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 the bottom and top leaves. They even 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 the bottom and top leaves, respectively.

Shatpada Treat

A simple and cost-effective mass production and application technology for *Typhlodromus (Anthoseius) transvaalensis* has been developed for the first time in the world. *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 (e.g., *Scirtothrips dorsalis*).

Geographical distribution of whiteflies

About 15 exploratory surveys were conducted in eight states viz. Andhra Pradesh, Assam, Karnataka, Kerala Rajasthan, Tamil Nadu, Telangana and West Bengal to collect the whiteflies and their natural enemies. The survey revealed the newer geographical distribution and extension of host ranges for invasive

whiteflies. Palm-infesting whitefly was recorded in Kerala and Andhra Pradesh; Woolly whitefly, *Aleurotrixus floccosus* was recorded in Andhra Pradesh; Bondar's nesting whitefly, *Paraleyrodes bondari* and *Pealius nagarcoilensis* were recorded in Assam and Solanum whitefly, *Aleurotrixus trachoides* was recorded in West Bengal.

Encarsia cubensis, a potential parasitoid of palm infesting whitefly, Aleurotrachelus atratus

During the surveys, the immature stages of the Neotropical palm infesting whitefly, *Aleurotrachelus atratus* were found parasitized by an aphelinid parasitoid, *Encarsia cubensis* (Hymenoptera: Aphelinidae). The parasitoids were collected and identified by their morphological characteristics and also characterized by DNA barcoding of adult parasitoids using partial (658 bp) mitochondrial cytochrome oxidase 1 (CO1) gene (GenBank accession number ON881119). The first report of the occurrence of *E. cubensis* as primary parasitoids on *A. atratus* in India and its natural parasitism of 46–68% on coconut across the different locations in Karnataka was reported. The parasitoid, *E. cubensis* was hypothesized to have entered India along with *A. atratus* and evolved as a potential biological natural enemy against *A. atratus*.

Development of prediction models and habitat mapping of rugose spiralling whitefly

The prediction model for potential distribution and habitat suitability mapping for the occurrence of invasive rugose spiralling whitefly (RSW) in India in the present (2020) and future climate change emission scenarios in 2050 and 2070 using the MaxENT modelling was developed. The prediction models could be used to formulate control measures for monitoring, surveillance and early pest warning of rugose spiralling whitefly and combating outbreaks well in advance in newer locations.

Electrophysiological response of adults of Corcyra cephalonica to essential oils (EOs)

The summated neuronal response for the essential oils tested were above 0.5 mV (Fig. 45). This established the response of olfactory response of the receptors in the antennae of *C. cephalonica* adult.

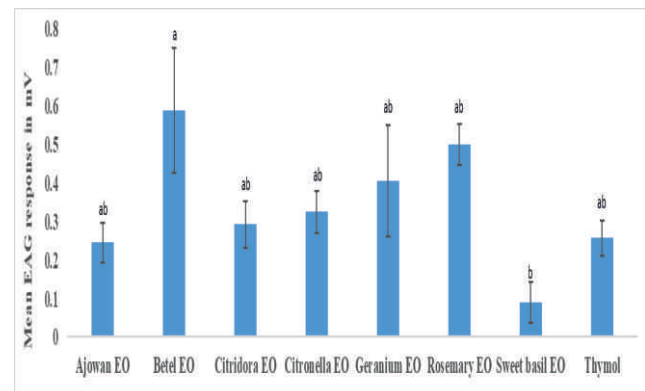


Figure 45. Electrophysiological response of adults of *Corcyra cephalonica* to essential oils. Bars showing the same alphabet do not differ significantly ($P > 0.05$).

Behavioral response of C. cephalonica adults - Oviposition deterrent activity

The essential oil ajowan oil, its constituent thymol and geranium oil recorded a high level of oviposition deterrence index (Fig. 46).

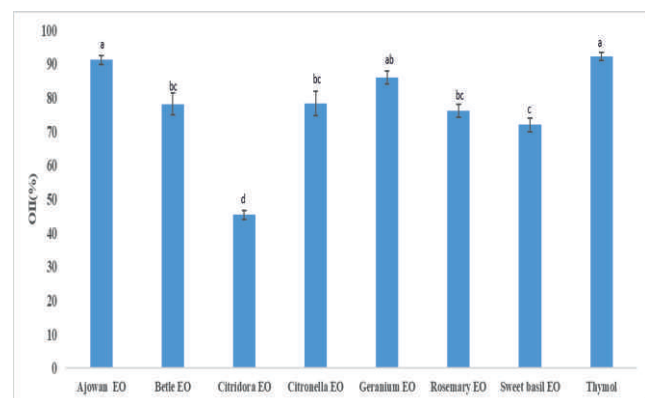


Figure 46. Oviposition deterrence of essential oils on *Corcyra cephalonica*; Mean values were subjected to One way ANOVA and Post hoc Tukey's test, means within a column followed by the same letter are not significantly different ($p < 0.05$).

EO Sweet basil oil, its constituents methyl chavicol, linalool and other EOs viz. betel oil, rosemary oil and their major constituents eugenol, eugenol acetate, geraniol and 1,8 cineole caused high-level

inhibition of acetylcholinesterase and it was on par with organophosphate insecticide malathion. All the EO and the constituents evaluated inhibited the AChE (Fig. 47).

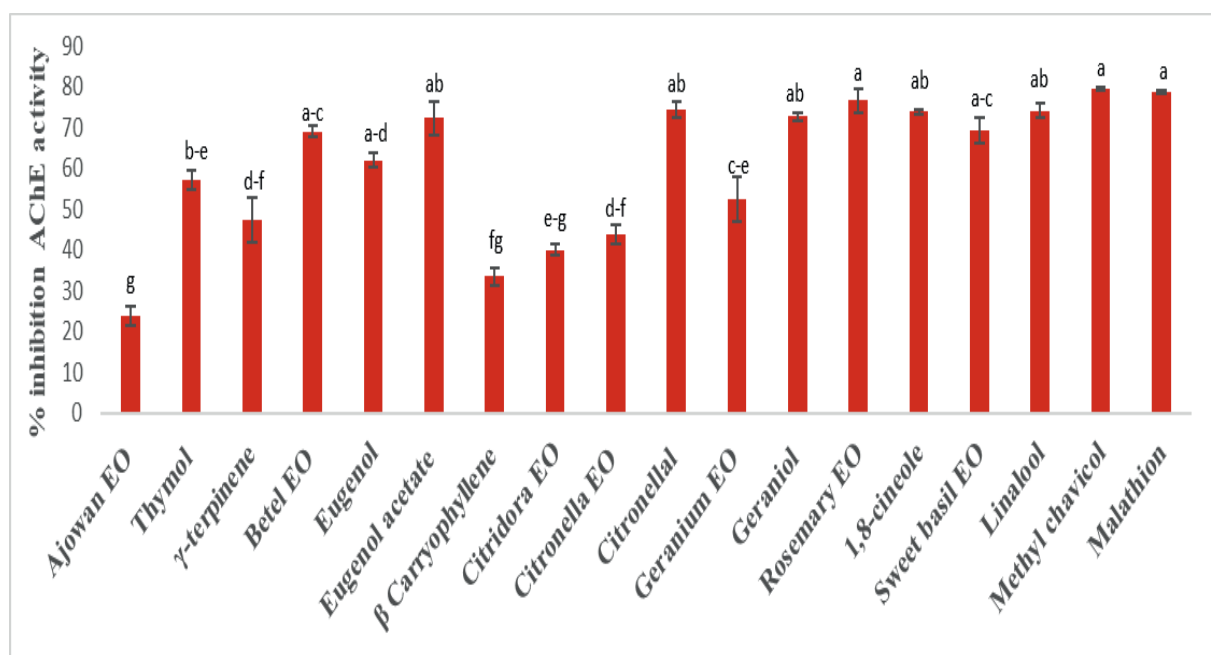


Figure 47. Percent inhibition of acetylcholinesterase activity in the larvae of *C. cephalonica*

Slow release pheromone formulations for insect pests

The volatile compounds of *Solanum tuberosum* L., were isolated by steam distillation and extraction. The attractants for potato tuber moth; *Phthorimaea operculella* were identified with gas chromatography coupled to mass spectrometry (GC-MS). The identified attractants were converted to slow-release formulations. Again, subjected to gas chromatography coupled to mass spectrometry (GC-MS) found that there is no change in attractant's chemical structure before and after immobilization in formulations. The volatile compounds of male and female attractants were isolated and identified by GCMS for Litchi fruit and shoot borers; *Conopomorpha sinensis* and converted to slow-release formulations. The field trials were conducted successfully on Delta trap loaded with slow-release formulations of female attractants and male attractants of Litchi fruit borer at Government Garden and Fruit nursery, village khiala Bulanda, District Hoshiapur, Punjab. The

volatile compounds of Pomegranate were isolated, identified by GCMS and converted to slow-release pheromone formulations for the management of Pomegranate fruit borer; *Virachola isocrates*. The volatile compounds as attractants for mango stem borer were isolated, identified by GCMS and converted to slow-release pheromone formulations for the management of Mango stem borer; *Batocera rufomaculata*. The volatile compounds were isolated from cashew, and identified by GCMS and attractants were converted to slow-release pheromone formulations for the management of Cashew stem borer; *Plocaederus obesus*. The attractants terpenoids were isolated, identified and converted to slow-release formulations for the management of Red hairy caterpillar; *Amsacta albistriga*, Pigeonpea pod fly; *Melanagromyza obtusa*.

Laboratory and field evaluation of fungal and bacterial entomopathogens for the management of invasive South East Asian Thrips, *Thrips parvispinus*

Three promising entomofungal pathogens viz. *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium fusisporum* and two bacterial strains viz. *Pseudomonas fluorescens* and *Bacillus albus* were effective in the management of invasive *T. parvispinus* under laboratory (Fig. 48) and field conditions. The extent of the reduction of thrips population under field conditions ranged between 60–70 percent in Chinthamani and Raichur areas in Karnataka (Fig. 49).



Figure 48. Untreated control (left), mortality and mycosis of *T. parvispinus* treated with bacterial and fungal biopesticides



Figure 49. Biopesticides sprayed Chilli field at Chinthamani, Karnataka

A novel *Pseudomonas entomophila* NBAIR-PEOWN strain with excellent insecticidal activity for management of shoot and fruit borer of brinjal

A novel bacterial strain, *Pseudomonas entomophila* NBAIR-PEOWN produced a high quantity of siderophores, chitinase, proteases, cellulases, lipases, indole acetic acid (IAA)enzymes, that played an important role in pest management and growth promotion in brinjal. Talc-based formulation of *Pseudomonas entomophila* NBAIR-PEOWN was developed and the dose was standardized for the effective management of the brinjal shoot and fruit borer, *Leucinodes orbonalis* (Fig.50). There was 75-80 percent reduction in the damage of shoot and fruit borer compared to untreated control.



Figure 50. *Pseudomonas entomophila* NBAIR-PEOWN sprayed brinjal field (left), untreated control showing borer damage (middle) and biopesticide sprayed brinjal (last image)

Management of mulberry root rot by *Trichoderma asperellum* strain NBAIR-TATP at Pavagada taluk, Tumkur district, Karnataka

Mulberry root rot disease caused by *Rhizoctonia bataticola* (= *Macrophomina phaseolina*) and other pathogens like *Fusarium solani*, *F. oxysporum*, *Botryodiplodia theobromae* etc is an economically important disease in Karnataka, and management of this disease is very challenging to the mulberry farmers. Root zone drenching of *Trichoderma asperellum* strain NBAIR-TATP @ 2% solution at the rate of 50 ml per plant effectively suppressed the root rot disease and control the further spread of root rot disease in mulberry. It also further boosted the growth of the mulberry plants with healthy leaves under field conditions at the farmer's field (Fig. 51).



Figure 51. Root rot infected mulberry plants show typical wilting symptoms (left), after application of *T. asperellum* showed recovery of mulberry plants from root rot disease (right).

Characterisation of viruses with special reference to Lepidoptera and Coleoptera

Sub-lethal effect of *Spodoptera frugiperda* NPV (SpfrNPV) has been observed on the growth and development of fall armyworm. As a result of

larval infection, the larval developmental time was significantly prolonged as compared to the untreated insects. The percentage of pupal mortality ranged from 72.73 to 40.74 at varying doses of SpfrNPV and recorded low pupal weight in all the treatments than control. The fertility and fecundity of infected adult moths were significantly reduced when compared to the untreated insects in a concentration dependant fashion. Sub-lethal effects of baculoviral infection on different biological parameters were studied. The mean developmental period of infected third and fourth larval instars was significantly higher ($F = 2.945$; $F = 18.414$ $df = 5, 20$ $P < 0.05$) in SpfrNPV infected larvae than the control at all tested viral concentrations. The percentage of pupal mortality ranged from 40.74 to 72.73 in the lowest and highest concentrations of SpfrNPV, respectively. The developmental period of male pupae was found to be significantly longer in infected groups than the uninfected ones. (Table 11).

The infected adults had significantly reduced longevity in both males ranged from 3.5 to 5.75 days ($F = 6.273$; $P = 0.002$) and females ranged from 3.5 to 7.00 days ($F = 13.652$; $P = 0.001$). Further, the mates of virus-treated adults showed a highly reduced egg production ($F = 31.255$; $P < 0.05$) ranged from 150.03 to 338.33 eggs/female and the larval emerging ranged from 71.11 to 227.89 ($F = 74.52$; $P < 0.05$), which was again significantly lower than the control. Viral infection symptoms were observed on larva, pupa and adult due to SpfrNPV infection (Fig. 52). The percentage of egg hatching ranged from 47.40 to 86.41%. The highest yield of SpfrNPV (4.69×10^5 occlusion bodies (OBs) from a single third instar larva was obtained when the larva was inoculated with the concentration of SpfrNPV @ 1×10^8 OBs/ml. The third instar larva was found optimum for harvesting the maximum of SpfrNPV at 7 days after inoculation. Enveloped virions were observed from the NPV infected midgut tissues of *S. frugiperda* under light microscopy.

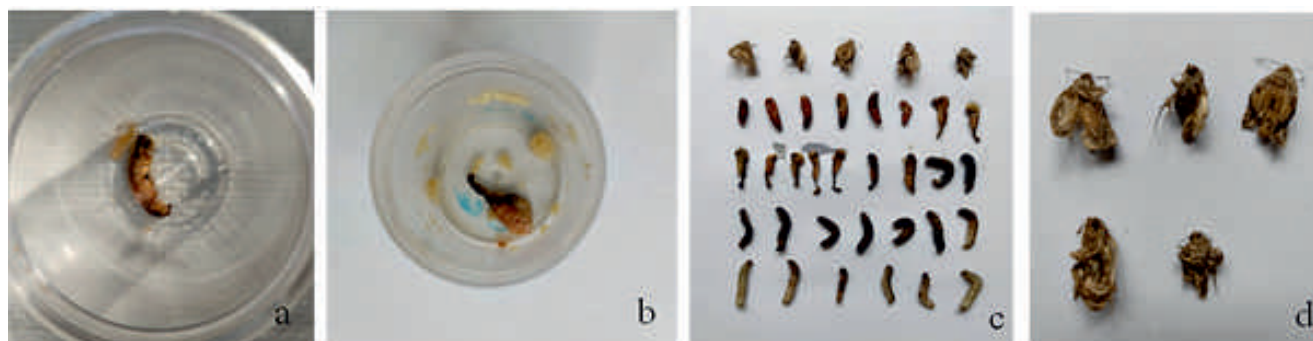


Figure 52. a. Liquification from fifth instar larva of *S. frugiperda*; b. Moulting defects in SpfrNPV infected *S. frugiperda* larva; c. Mortality observed in fourth and fifth instar *S. frugiperda* larvae, pre-pupae, pupa due to SpfrNPV infection; d. Deformation in wings, antennae and abdomen of adult moths of *S. frugiperda* due to SpfrNPV infection

Table 11. Debilitating effect of different concentrations of SpfrNPV on pupal period, pupal weight and adult longevity (mean \pm SE) of *Spodoptera frugiperda*

Treatment s	Concentrations	Pupal period (days)		Total percent of pupal mortality	Weight of Pupae (mg)		Adult longevity (days)	
		Female	Male		Female	Male	Female	Male
T1	1.20x10 ⁷	11.99 \pm 0.40a	11.33 \pm 0.65a	72.73	164.44 \pm 4.84b	188.89 \pm 2.22ab	3.50 \pm 0.64 ^c	3.50 \pm 0.86 ^b
T2	2.83x10 ⁶	11.48 \pm 0.47ab	10.88 \pm 0.69ab	62.06	153.89 \pm 7.22b	165.33 \pm 1.33ab	4.25 \pm 0.47 ^c	3.71 \pm 0.47 ^b
T3	2.00x10 ⁶	9.81 \pm 0.50b	9.48 \pm 0.55ab	62.50	170.22 \pm 1.93b	175.55 \pm 9.49ab	5.50 \pm 0.28 ^{bc}	4.00 \pm 0.70 ^b
T4	1.29x10 ⁵	10.94 \pm 0.34ab	10.94 \pm 0.34ab	55.17	157.77 \pm 8.01b	139.22 \pm 9.33b	5.75 \pm 0.62 ^{bc}	5.51 \pm 0.64 ^{ab}
T5	5.69x10 ⁴	11.41 \pm 0.62ab	10.21 \pm 0.34ab	40.74	149.99 \pm 8.81ab	167.77 \pm 22.79ab	7.00 \pm 0.70 ^{ab}	5.67 \pm 0.62 ^{ab}
T6	Control	11.50 \pm 0.46ab	9.01 \pm 0.38b	8.10	202.42 \pm 9.87a	201.11 \pm 11a	9.25 \pm 0.40 ^a	7.75 \pm 0.47 ^a

Within columns, means followed by the same letter do not differ significantly [ANOVA, Tukey's HSD; P<0.01]

Compatibility and efficacy of entomopathogenic nematodes with entomopathogenic fungi combinations against invasive pest *Spodoptera frugiperda* (Lepidoptera:

The survival of infective juveniles (IJs) of two species of EPNs, *Heterorhabditis indica* and *Steinernema abbasi* after exposure to *Metarhizium anisopliae* Ma-4 and *Beauveria bassiana* Bb-45 and a combination of these nematodes and these entomofungal pathogens at different rates for the control of *Spodoptera frugiperda*, were evaluated both in the laboratory and maize fields (Fig.53). In the laboratory assays, the two entomofungal pathogens at different concentrations had no or negligible effect on survival of both the nematode species, with mortality rates below 2-4%.

The combinations had a synergistic or additive effect on the third-instar larvae of fall armyworm and caused faster mortality than one EPN species or entomofungal pathogens alone. Mortality and speed of kill were significantly increased in the combination of *Heterorhabditis indica*-*M. anisopliae*, *H. indica*-*B. bassiana* and *S. carpocapsae*-*M. anisopliae* but nematode establishment is not affected by these insecticides. Both in the laboratory and in maize fields, the degree of interaction, however, varies with nematode species, being synergistic for *H. indica*-*M. anisopliae*, *H. indica*-*B. bassiana* and *S. carpocapsae*-*M. anisopliae* against larvae of *S. frugiperda*. These nematodes-entomofungal pathogens combinations performed equally well compared to that of emamectin benzoate treatment. Cost-benefit analysis showed that *H. indica* 2.5×10^8 IJ ha⁻¹ combined with *M. anisopliae* is a practical strategy for the management of fall armyworm larvae in maize production.

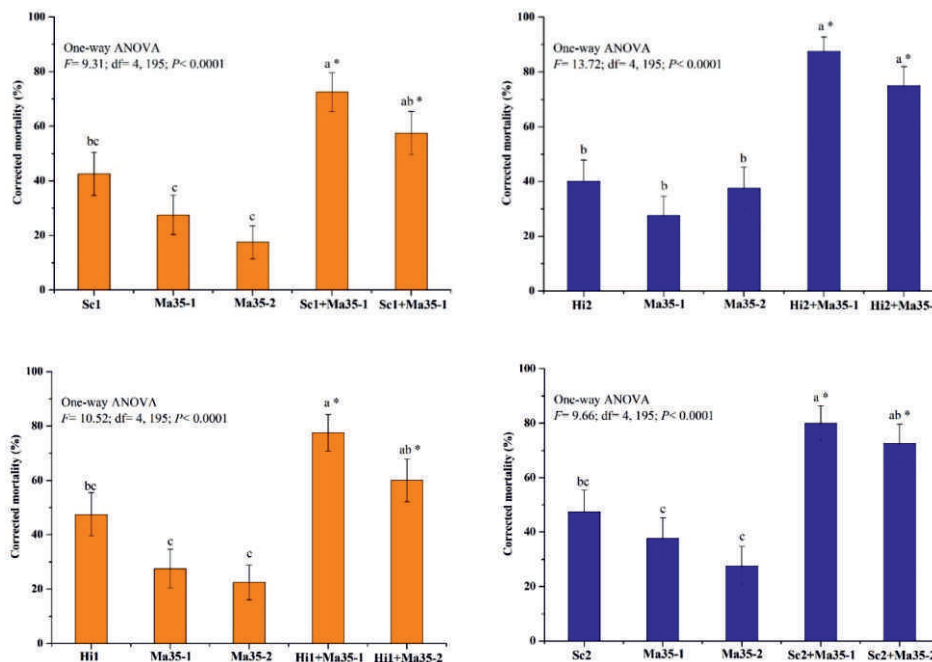


Figure 53. Corrected mortalities of third-instar larvae of FAW larvae treated with different combinations of EPNs and EPFs or single agent in a laboratory experiment at five DAT. Sc: *Steinernema carpocapsae*; Hi: *Heterorhabditis indica*; MA35, *Metarhizium anisopliae*; 1: 1×10^6 spores/ml and 2: 1×10^4 spores/ml of EPFs; 1= 10 IJs per larva, 2=5 IJs per larva.

* Indicated significant synergistic interactions between the EPNs and EPFs.

Documentation of non-bee pollinators on different crops

On fennel and coriander, ant species *Myrmecaria brunnea* was associated with the flowers in large numbers. Three to four species of dipterans and vespids were recorded. Studies to identify the species of insects associated with these crops and to ascertain their role as pollinators are under progress.

Sustainable reduction of feral colonies of stingless bees

A technique to sustainably multiply the colonies of stingless bees from the perennial feral colonies without complete destruction was attempted. The settlement of foragers inside the rectangular hive connected to feral colony and construction of storage pots was recorded 18.20 ± 2.49 days and 11.0 ± 1.91 days after hive acceptance and settlement of foragers in the hive. A decline in the construction number of storage pots was observed over a period of time. Seeding the laying queen in the hived colonies resulted in the construction of advancing fronts (indicative of brood cells construction) in a time period of 26.67 ± 2.58 days. The viability of the perennial feral colony was preserved for a time period of nine months without loss in the activity of foragers.

Requeening techniques in orphaned stingless bee colony

Three techniques viz. the addition of laying queen, the addition of advancing fronts with brood, the addition of mature queen cells and introduction of gynes. The initiation of oviposition was observed in a shorter time period by the addition of laying queen (6.20 ± 1.58 days) followed by 10.13 ± 1.47 days where gynes are introduced. In the colonies where advancing front were added, the oviposition was observed after 41.20 ± 7.64 days.

Foraging behaviour of stingless bees in the hives installed in protected cultivation

The hive establishment and foraging behavior of stingless bees were studied in cucumber grown under two protected cultivation structures viz. polyhouse and greenhouse. The mean number of hive-entering foragers was significantly higher in the hives installed in ventilated screen house (10.20 bees/5 minutes) compared to the polyhouse (1.32 bees/5 minutes). The hive departing bees were significantly higher in the ventilated screen house (4.50 bees/5 minutes) compared to the polyhouse (15.60 bees/5 minutes).

Effect of yeast addition in diets over the development of *Zophobas morio*

The larval development period of *Zophobas morio* was significantly reduced 84.81 days (sole rice bran) to 50.40 days in the media containing rice bran added with yeast (10%). A significant reduction in the number of moults of the larvae of *Z. morio* was observed in rice bran + vegetable supplement + yeast (11.47 moults) compared to rice bran + vegetable supplement without yeast (13.60 moults).

Black soldier fly as poultry feed

Black soldier fly prepupal powder was prepared for poultry layer trials and nutrition analysis after feeding as a protein source in the diet of layer chicken. White leghorn layers were used and response criteria were measured after replacing the routine diet with 5% and 10% protein sources for egg production, feed intake, feed conversion ratio, egg weight and egg quality for 3 months in collaboration with ICAR-National Institute of Animal Nutrition & Physiology, Adugodi, Bengaluru (Fig.54). Technology 'Waste to wealth: Technology on Black Soldier Fly mediated bioconversion of farm and kitchen wastes' was popularized among farmers,

students, researchers, entrepreneurs through talks and demonstrations during different programmes organized like PM Kisan Samman Sammelan, Swachhta Pakhwada – Kisan Diwas Celebration at ICAR–National Bureau of Agricultural Insect Resources, Bengaluru.



Figure 54. Layer feeding trial using black soldier fly meal

All India Coordinated Research Project on Biological Control of Crop Pests

Biological suppression of plant diseases

Seed treatment + root application+ foliar spray of bacterial antagonists viz., *Trichoderma harzianum* (Th) and *Pseudomonas fluorescens* (Pf) recorded the lowest disease intensity (16.50%) of early blight as compared to control (39.83%) in tomato.

Biological suppression of cotton pests

Biointensive pest management module (BIPM) with six releases of *Trichogrammatoidea bactrae* @ 100,000/ha/release, starting from 55 days after germination with the installation of funnel-type pheromone traps @ 10/plot recorded the lowest damage of pink bollworm (22%) compared to control (32%) along with 20% increase in yield.

Biological suppression of rice pests

Biointensive pest management module (BIPM) module of seed treatment with *Pseudomonas*

fluorescens @ 10 g/kg, two sprays of *P. fluorescens* @ 5 g/L from 30-40 days after transplantation, three releases of *T. chilonis* @ 1,00,000/ha for leaf folder and *T. japonicum*@ 1,00,000/ha/releases for stem borer from 25 days after transplantation, application of Carbofuran granules 3G @ 10 kg/ha at 30 DAP, two sprays of chlorpyrifos @2.5 ml/L, acephate @ 1.5 g/L and two sprays with propiconazole @ 1ml/L recorded the lowest leaf folder damage by 77.04%; stem borer damage by 84.13% and sheath blight incidence by 42.16% resulted in 12.81% yield increase in BIPM (5.74 t/ha) compared to farmers practice (5.09 t/ha) with net returns of ₹17,928 /- per ha and high incremental benefit-cost ratio in BIPM (2.36) compared to chemical control (1.57).

The mean number of dead hearts/m² in the plots sprayed with *Bacillus thuringiensis*, *Beauveria bassiana* and *Heterorhabditis indica* were 1.5, 1.83 and 3.17 dead hearts/m² were on par with flubendiamide (2.67 dead hearts/m²) 14 days after third spray and could be viable alternative to flubendiamide for the management of stem borer in rice. The mean number of leaf rolls per leaf in the plots sprayed with entomopathogenic nematode, *Steinernema carpocapsae* and entomopathogenic fungus, *Metarhizium anisopliae* were 1.33 and 1.63 rolled leaves/m² at 28 days after third spray that was on par with the insecticidal control (0.83 rolled leaves/m²).

Biological control of sugarcane pests

Eight releases of temperature tolerant strain of *T. chilonis* @ 50,000 parasitoids/ha at weekly intervals starting from 40 days after shoot emergence was significantly superior in reducing the early shoot borer infestation (6.41% dead hearts) with maximum cane yield (139.64 Mt/ha) and B:C ratio 2.31.

Biological control of maize pests

Two releases of *T. pretiosum* @50,000/ha or *T. chilonis* @ 1,00,000/ha from 7 days after seedling emergence

followed by three foliar applications of *Bacillus thuringiensis* (NBAIRBT25) @ 2 ml/L or *Metarhizium anisopliae* (NBAIR Ma 35) @ 5 g/L 20 days after seedling emergence at 10 day intervals was effective in controlling fall armyworm in comparison with the insecticidal check (Azadirachtin + chlorantraniliprole + emamectin benzoate). The cob yield recorded in biocontrol treatments egg parasitoid + *Bt* was 39.97q/ha followed by egg parasitoid + *M. anisopliae* (39.38 q/ha) that was on par with chemical control (40.18 q/ha).

Biological control of ragi pests

Foliar application of oil formulation of *Metarhizium anisopliae* (ICAR-NBAIR Ma35) @ 10 ml/lit at 20 and 40 days after emergence of crop and application of oil formulation of *Beauveria bassiana* (ICAR-NBAIR Bb-45) @ 10 ml/lit at 20 & 40 days after emergence of crop were significantly superior in the management of pink borer, *Sesamia inferens* and was statistically on par with soil application of Carbofuran 3G @ 20kg /ha twice at 20 and 40 days after crop emergence.

Biological control of pest of pulses

Application of *Lecanicillium lecanii* 1×10^8 cfu/ml @ 5gm/L recorded the lowest infestation of cowpea aphid, *Aphis craccivora* which was on par with spinosad 45 SC @ 0.3 ml/L with maximum yield.

Biological control of pest of oilseed crops

Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg + soil drenching with *Trichoderma asperillum* @ 5 g/L at 30, 60 days after sowing was effective in managing stem rot in sesame (4.29%) with high grain yield (376 kg/ha), and on par with chemical, carbendazim seed treatment @ 1 g/kg + soil drenching @ 5 g/L (stem rot 11.13% and yield 258 kg/ha).

Biological control of pests of tropical fruit crops

Biointensive pest management module (BIPM) with the spraying of entomopathogenic fungus *Metarhizium anisopliae* ICAR-NBAIR Ma-4 @ 1% WP as a sole component was highly effective in reducing the population of mango hoppers.

Application of *Lecanicillium lecanii* (NBAIR V18) @ 5g/L was effective in the reduction of thrips infestation in the citrus fruits (11.78%) followed by the application of acephate 75SP (12.64%). The percent fruit infestation of thrips in *Beauveria bassiana* @ 5g/L (16.09%) and *Metarhizium anisopliae* @ 5g/L (16.72%) were statistically on par with each other. Control recorded the highest fruit infestation (24.83%).

Leaf axil application of *Beauveria bassiana* (AAU culture) 10^8 spores @ 5 ml/L at 15 days interval recorded a maximum reduction of damage by fruit and leaf scaring beetles, *Nodostoma subcostatum* in banana.

Biological control of pests in plantation crops

BIPM module with natural conservation of *Encarsia guadeloupae* + release of eggs of *Apertochyrsa astur* @ 1000/ha + Yellow sticky traps @ 20/ha was demonstrated in Chinnappampalayam, Anaimalai block, Coimbatore district. In BIPM field, there was 80% reduction in the population of rugose spiraling whitefly (RSW), compared to untreated control (60%).

Large-scale demonstrations conducted in 50 acres of farmer fields in Malnad region of Karnataka showed that the consortia application of *T. harzianum*, *B. subtilis* and *P. fluorescens* @ 4 kg/ha each recorded lower incidence of soft rot in ginger.

Biological control of pests in vegetables

Brinjal: The damage by shoot and fruit borer was significantly low (17.82%) in plots sprayed with

insecticides followed by 21.80 per cent fruit damage in BIPM plots (Azadirachtin 1500 ppm @ 2ml/lit (one round of spray) + *L. lecanii* (one round of spray) + *T. pretiosum* (8 releases) + Pheromone traps @20/ha + Cowpea as bund crop). The cost-benefit ratio realized in BIPM was 1:3.90 as against 1:4.83 in insecticides treated plots.

Onion: Application of *Metarbizium anisopliae* (AAU strain Ma1) significantly reduced the thrips population (3.70 thrips/plant) compared to untreated control (15.02 thrips/ plant). Significantly highest bulb yield was recorded in the *M. anisopliae* sprayed plots (113.67 q/ha) compared to the untreated control (45.33 q/ha).

Cucurbits: Release of *Blaptostethus pallelescens* @ 20 m/row plots and spraying Spiromesifen were effective in causing a consistent reduction in the cucumber mite population indicating the potential of the predator to be a safer alternative to synthetic acaricides in managing spider mites in cucumber under polyhouse conditions. The highest mean yield of cucumber 2.73 kg per plant was obtained in plots released with *B. pallelescens*, which was on par with acaricide treated plot at (2.70 kg/plant).

Cole crops: Spraying *Lecanicillium lecanii* (V1-8) @ 5 ml/L effectively reduced the population of aphids (3.17/plant) and diamondback moth (4.74/plant), with the highest yield of 205.25q/ha.

4. GENBANK /BOLD ACCESSIONS

S. No.	ORGANISM	ACCESSION NUMBER
COLEOPTERA (COI)		
1.	<i>Agriotes ogurae</i>	OP380046
2.	<i>Callosobruchus maculatus</i>	OQ135340
3.	<i>Cheilomenes sexmaculata</i>	ON797322
4.	<i>Cheilomenes sexmaculata</i>	OM422837
5.	<i>Coccinella septempunctata</i>	ON705842
6.	<i>Coccinella transversalis</i>	MZ959832
7.	<i>Coelophora bissellata</i>	MZ959854
8.	<i>Monolepta</i> sp.	ON557624
9.	<i>Thanasimus lewisi</i>	ON955906
DIPTERA (COI and 16S)		
10.	<i>Acroceratitis bimacula</i>	OP391609
11.	<i>Acroceratitis ceratitina</i>	OP383043
12.	<i>Acroceratitis incompleta</i>	OP383042
13.	<i>Acroceratitis parastriata</i>	OP328815
14.	<i>Acroceratitis</i> sp.	OP383044
15.	<i>Acrotaeniostola connexa</i>	OP328814
16.	<i>Actinoptera reticulata</i>	OP317356
17.	<i>Bactrocera syzygii</i>	OP379572
18.	<i>Clogmia albipunctata</i>	OM838313
19.	<i>Clogmia albipunctata</i>	OM838293
20.	<i>Dacus crabroniformis</i>	OP328813
21.	<i>Hermetia illucens</i>	OM909154
22.	<i>Musca asiatica</i>	OM281303
23.	<i>Phaeospilodes bambusae</i>	OP324570
24.	<i>Pristaciura monochaeta</i>	OP391692
25.	<i>Stomoxys calcitrans</i>	OM281304
26.	<i>Taeniostola vittigera</i>	OP317357

HEMIPTERA (COI)		
27.	<i>Acesines bambusana</i>	ON965369
28.	<i>Acrozangis antica</i>	OP825025
29.	<i>Aelia rostrata</i>	OP810946
30.	<i>Aelia rostrata</i>	OP810955
31.	<i>Agathocles flavipes</i>	OP297208
32.	<i>Agonoscelis nubilis</i>	ON949949
33.	<i>Amyotea malabarica</i>	ON956934
34.	<i>Antestia punctatissima</i>	OP900632
35.	<i>Aphis gossypii</i>	OP649433
36.	<i>Aphis nerii</i>	OL889886
37.	<i>Bagrada bilaris</i>	ON950047
38.	<i>Bathyoelia indica</i>	OP862876
39.	<i>Bemisia tabaci</i>	OM912362
40.	<i>Bemisia tabaci</i>	OM925488
41.	<i>Bemisia tabaci</i>	OM943865
42.	<i>Bemisia tabaci</i>	OM943920
43.	<i>Bemisia tabaci</i>	OM424282
44.	<i>Bemisia tabaci</i>	OM944047
45.	<i>Cantao ocellatus</i>	OP872658
46.	<i>Cappaea taprobanensis</i>	ON949922
47.	<i>Carbula aliena</i>	ON956935
48.	<i>Carbula crassiventris</i>	ON950048
49.	<i>Carbula crassiventris</i>	OP863027
50.	<i>Catacanthus incarnatus</i>	ON965365
51.	<i>Coridius janus</i>	OP872669
52.	<i>Coridius</i> sp.	OP825026
53.	<i>Dalpada neoclavata</i>	OP872670
54.	<i>Dalpada oculata</i>	OQ028264
55.	<i>Erthesina</i> sp.	OP871003
56.	<i>Eurydema dominulus</i>	OP809635

57.	<i>Eurydema oleracea</i>	OP872659
58.	<i>Eysarcoris ventralis</i>	OP872656
59.	<i>Glaucias nigromarginatus</i>	ON955904
60.	<i>Graphosoma rubrolineatum</i>	OP108844
61.	<i>Halyomorpha picus</i>	ON949923
62.	<i>Halyomorpha picus</i>	ON955903
63.	<i>Halys shaista</i>	OP808229
64.	<i>Halys sulcata</i>	ON946754
65.	<i>Halys sulcata</i>	ON947765
66.	<i>Lodosocoris santhae</i>	OP807176
67.	<i>Lodosocoris santhae</i>	OQ028263
68.	<i>Macrocheraia grandis</i>	ON965341
69.	<i>Megymenum</i> sp.	OP880216
70.	<i>Menida versicolor</i>	ON950046
71.	<i>Nezara viridula</i>	OP036612
72.	<i>Nezara viridula</i>	OM108162
73.	<i>Niphe subferruginea</i>	OM131601
74.	<i>Niphe subferruginea</i>	OP209982
75.	<i>Palomena prasina</i>	OP288777
76.	<i>Phenacoccus solenopsis</i>	ON799435
77.	<i>Picromerus griseus</i>	OQ029299
78.	<i>Piezodorus hybneri</i>	ON965381
79.	<i>Piezodorus lituratus</i>	OP288466
80.	<i>Placosternum</i> sp.	OP036611
81.	<i>Placosternum</i> sp.	OP288796
82.	<i>Placosternum</i> sp.	OP871004
83.	<i>Planococcus minor</i>	ON811688
84.	<i>Plantia crossota</i>	ON949951
85.	<i>Plantia crossota</i>	ON955905
86.	<i>Priassus exemptus</i>	ON965329

87.	<i>Pycanum</i> sp.	OP825027
88.	<i>Rhynchocoris humeralis</i>	OP108841
89.	<i>Rhynchocoris humeralis</i>	OP210011
90.	<i>Sabaenus humeralis</i>	ON562581
91.	<i>Sarju brevirostrata</i>	OQ031657
92.	<i>Sciocoris indicus</i>	ON965363
93.	<i>Scotinophara lurida</i>	OP247617
94.	<i>Spermatodes variolosa</i>	OP808222
95.	<i>Spermatodes variolosa</i>	OP808310
96.	<i>Starioides</i> sp.	OP469992
97.	<i>Strachia crucigera</i>	OP297207
98.	Tessaratomidae sp.	OP288797
99.	<i>Tolumnia basalis</i>	ON955909
100.	<i>Tolumnia immaculata</i>	OP252625
101.	<i>Tolumnia latipes</i>	OP288778
102.	<i>Zicrona caerulea</i>	ON982541
HEMIPTERA (169)		
103.	<i>Aeliomorpha lineatocollis</i>	OP198907
104.	<i>Agathocles flavipes</i>	OP295478
105.	<i>Alcmena spinifex</i>	OL958633
106.	<i>Aleurodicus rugioperculatus</i>	OP020879
107.	<i>Aleurodicus rugioperculatus</i>	OP020723
108.	<i>Aleurodicus rugioperculatus</i>	OM368661
109.	<i>Bagrada hilaris</i>	OP168132
110.	Berytidae sp.	ON959210
111.	<i>Brachycerocoris petrii</i>	OP295486
112.	<i>Cappaea taprobanensis</i>	OP263746
113.	<i>Carbula aliena</i>	OP199044
114.	<i>Carbula crassiventris</i>	OP168131
115.	<i>Catacanthus incarnatus</i>	OP198908

116.	<i>Cletus rubidiventris</i>	MZ959856
117.	<i>Degonetus serratus</i>	OP198813
118.	<i>Dohycois indicus</i>	OP198985
119.	<i>Glaucias nigromarginatus</i>	OP476701
120.	<i>Halyomorpha picus</i>	OP198909
121.	<i>Halyis shaista</i>	OP198809
121.	<i>Hermolaus rolstoni</i>	OP295479
122.	<i>Liorhyssus hyalinus</i>	OP002311
123.	<i>Liorhyssus hyalinus</i>	OP002117
124.	<i>Liorhyssus hyalinus</i>	OP002098
125.	<i>Macrocheraia grandis</i>	OP199027
126.	<i>Macrosiphum euphorbiae</i>	UWI48408
127.	<i>Nezara viridula</i>	OP263747
129.	<i>Nezara viridula</i>	OP263943
130.	<i>Niphe subferruginea</i>	OP199031
131.	<i>Piezodorus hybneri</i>	OP198807
132.	<i>Piezodorus lituratus</i>	OP339491
133.	<i>Placosternum</i> sp.	OP263941
134.	<i>Placosternum</i> sp.	OP288112
135.	<i>Plantia crossota</i>	OP263942
136.	<i>Priassus exemptus</i>	OP199028
137.	<i>Rhopalosiphum padi</i>	UWI83465
138.	<i>Rhynchosiphum humeralis</i>	OP199036
139.	<i>Rhynchosiphum humeralis</i>	OP199037
140.	<i>Sciocoris indicus</i>	OP199026
141.	<i>Scotinophara lurida</i>	OP247618
142.	<i>Stictopleurus</i> sp.	OP018544
143.	<i>Strachia crucigera</i>	OP295477
144.	<i>Tolumnia basalis</i>	OP198810
145.	<i>Tolumnia immaculata</i>	OP263748
146.	<i>Zicrona caerulea</i>	OP002144

HYMENOPTERA (COI)

147.	<i>Apanteles sodalis</i>	MZ960056
148.	<i>Apis cerana</i>	OP763658
149.	<i>Apis cerana</i>	OP763644
150.	<i>Apis cerana</i>	OP763749
151.	<i>Apis cerana</i>	OP782568
151.	<i>Apis cerana</i>	OP763646
152.	<i>Apis cerana indica</i>	OP727527
153.	<i>Apis mellifera</i>	OP763642
154.	<i>Apis mellifera</i>	OP782572
155.	<i>Apis mellifera</i>	OP782573
156.	<i>Apis mellifera ligustica</i>	OP763654
157.	<i>Chelonus formosanus</i>	OM422609
158.	<i>Choeras</i> sp.	OP293230
159.	<i>Cotesia ruficrus</i>	OM422687
160.	<i>Cotesia ruficrus</i>	OM422642
161.	<i>Cotesia vestalis</i>	ON797332
162.	<i>Diaeretiella rapae</i>	ON797330
163.	<i>Encarsia cubensis</i>	ON881119
164.	<i>Glyptapanteles obliquae</i>	OL873558
165.	<i>Habrobracon hebetor</i>	ON428249
166.	<i>Homalotylus</i> sp.	ON637052
167.	<i>Mesochorus</i> sp.	OP598595
168.	<i>Pachyneuron aphidis</i>	ON331743
169.	<i>Pachyneuron</i> sp.	ON803455
170.	<i>Telenomus remus</i>	OM424280
171.	Tetrastichinae sp.	ON803454
172.	Tetrastichinae sp.	ON637051
173.	<i>Therophilus festivus</i>	MZ959803
174.	<i>Trichogramma chilonis</i>	OM283610
175.	<i>Trichogramma chilonis</i>	OM283598
176.	<i>Trichogramma chilonis</i>	OM283611
177.	<i>Trichogramma chilonis</i>	OM283618

178.	<i>Trichogramma chilonis</i>	OM327556
179.	<i>Trichogramma chilonis</i>	OL958558
180.	<i>Trichogramma chilonis</i>	OL958541
181.	<i>Trichogramma chilonis</i>	OL913974
182.	<i>Trichogramma chilonis</i>	OL913900
183.	<i>Trichogramma chilonis</i>	OL913800
LEPIDOPTERA (COI)		
184.	<i>Archips machlopiis</i>	OP649556
185.	<i>Archips machlopiis</i>	ON557568
186.	<i>Artaxa guttata</i>	OP598097
187.	<i>Cadra cautella</i>	ON377348
188.	<i>Cydia pomonella</i>	OQ186760
190.	<i>Euproctis subflava</i>	OP597800
191.	<i>Helcystogramma hibisci</i>	ON545806
192.	<i>Hypomecis atomaria</i>	OP379715
193.	<i>Indarbela obliquifasciata</i>	ON059570
194.	<i>Mythimna separata</i>	OP379774
195.	<i>Pycnarmon cribrata</i>	ON545929
196.	<i>Selepa discigera</i>	OP648283
197.	<i>Strepsicrates semicanella</i>	OP648297
NEUROPTERA (COI)		
198.	<i>Cunctochrysa</i> sp.	OP785769
199.	<i>Cunctochrysa</i> sp.	OP785771
200.	<i>Gayomyia</i> sp.	OP785770
THYSANOPTERA (COI)		
201.	<i>Bathrips melanicornis</i>	OP788079
202.	<i>Gynaikothrips uzeli</i>	OP572096
203.	<i>Gynaikothrips uzeli</i>	OP522381
204.	<i>Gynaikothrips uzeli</i>	OP788111
205.	<i>Haplothrips andresi</i>	ON597615
206.	<i>Megalurothrips usitatus</i>	OP364888
207.	<i>Retithrips syriacus</i>	OP787969

208.	<i>Rhipiphorothrips cruentatus</i>	OP703521
209.	<i>Scirtothrips dorsalis</i>	OP787974
210.	<i>Selenothrips rubrocinctus</i>	OP518600
211.	Thripidae gen. n. sp.	OP714094
212.	<i>Thrips andrewsi</i>	OP518597
213.	<i>Thrips hawaiiensis</i>	OP518596
214.	<i>Thrips orientalis</i>	OP518600
215.	<i>Thrips parvispinus</i>	ON799413
216.	<i>Thrips parvispinus</i>	ON303614
217.	<i>Thrips parvispinus</i>	OM085664
218.	<i>Thrips parvispinus</i>	OM085663
219.	<i>Thrips parvispinus</i>	OM095426
220.	<i>Thrips parvispinus</i>	OM095429
221.	<i>Thrips parvispinus</i>	ON800702
222.	<i>Thrips parvispinus</i>	ON800215
223.	<i>Thrips parvispinus</i>	ON799419
224.	<i>Thrips simplex</i>	OP787975
225.	<i>Thrips subnudula</i>	OP268214
226.	<i>Thrips tabaci</i>	OP787971
ARANEAE		
227.	<i>Poecilochroa kuljitae</i>	ON713989
BACILLUS THURINGIENSIS STRAINS		
228.	NBAIR_VGA1	OP320505
229.	NBAIR BT_R28	OP355461
230.	NBAIR_BT_R32	OP356711
231.	NBAIR_Bt24	OP800130
232.	NBAIR_Bt21	OP800120
233.	NBAIR BT_R16	OP349697
234.	NBAIR BT_R13	OP349657
235.	NBAIR BT_R11	OP349646
236.	NBAIR_BT_R4	OP349598

237.	NBAIR_BTGA	OP326148
238.	NBAIR_BTBC	OP326135
239.	NBAIR_BTWGC3	OP318065
240.	NBAIR_VGA2	OP318063
241.	NBAIR BT-3	KC596016
242.	NBAIR C3	KC596013
243.	NBAIR BTEG-1	KC596012
244.	NBAIR BT D-2	KC596009
245.	NBAIR BTAN4	KY451835
246.	NBAIR MNSB2	KX713161
BACTERIAL ISOLATES (from the gut of <i>Apis mellifera</i>)		
247.	<i>Acinetobacter hwoffii</i>	OP847355
248.	<i>Bacillus proteolyticus</i>	OP835894
249.	<i>Enterobacter cloacae</i>	OP835885
250.	<i>Enterobacter cloacae</i>	OP847400
251.	<i>Enterobacter cloacae</i>	OP862733
252.	<i>Pantoea agglomerans</i>	OP847240
253.	<i>Pantoea ananatis</i>	OP835888
254.	<i>Pantoea anthophila</i>	OP862743
255.	<i>Pantoea anthophila</i>	OP862750
256.	<i>Pantoea anthophila</i>	OP835895
257.	<i>Pantoea anthophila</i>	OP847739
258.	<i>Pantoea deleyi</i>	OP847359
259.	<i>Pantoea vagans</i>	OP847360
VIRUSES		
260.	Jatropha leaf curl Gujarat virus	ON453820
MICROFLORA		
261.	White grub associated microflora	OP902526-OP902537
GENOME AND TRANSCRIPTOME SEQUENCING		
262.	12 transcriptomes, 5 EPN genomes, 4 bacterial draft genomes and 3 protein profiles in Prot Database	

5. IDENTIFICATION SERVICES

Dr Sunil Joshi

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	<i>Aphis gossypii</i> (3), <i>Lipaphis erisimi</i> , <i>Rhopalosiphum maidis</i>	Aphididae	Anand Agricultural University, Gujarat
	<i>Ceroplastes rubens</i> (2)	Coccidae	
	<i>Icerya aegyptiaca</i>	Monophlebidae	
2.	<i>Greenideoida ceyloniae</i>	Aphididae	College of Agriculture, Vellanikkara, Thrissur, Kerala
	<i>Ceroplastes ceriferus</i> , <i>C. floridensis</i> , <i>Ceroplastes</i> sp. (4), <i>Coccus hesperidum</i> , <i>C. longulus</i> , <i>Drepanococcus chiton</i> (2), <i>Hemilecanium imbricans</i> , <i>Milviscutulus mangiferae</i> (3), <i>Parasaissetia nigra</i> , <i>Protospulvinaria longivalvata</i> , <i>Pulvinaria aligarensis</i> , <i>P. psidii</i> , <i>Pulvinaria</i> sp., <i>Saissetia coffeae</i>	Coccidae	
	<i>Conchaspis angraeci</i>	Conchaspidae	
	<i>Aonidiella aurantii</i> , <i>A. taxus</i> , <i>Aulacaspis crawii</i>	Diaspididae	
	<i>Icerya</i> sp. (2)	Monophlebidae	
	<i>Ferrisia virgata</i> , <i>Ferrisia</i> sp., <i>Nipaeococcus viridis</i> , <i>Palmicultor lumpurensis</i> , <i>Phenacoccus solenopsis</i> , <i>Planococcus citri</i> , <i>P. lilacinus</i> (7), <i>Pseudococcus jackbeardsleyi</i> , <i>Rastrococcus iceryoides</i>	Pseudococcidae	
3.	<i>Dactylopius ceylonicus</i>	Pseudococcidae	Darshan R. Talhande, Maharashtra
4.	<i>Rastrococcus iceryoides</i>	Pseudococcidae	ICAR–Indian Institute of Pulses Research, Kanpur, Uttar Pradesh
5.	<i>Aphis craccivora</i> , <i>A. fabae</i> , <i>A. gossypii</i> , <i>Aphis</i> (<i>Toxoptera</i>) <i>citricidus</i> , <i>Aphis</i> (<i>Toxoptera</i>) <i>odinae</i> , <i>Cerataphis brasiliensis</i> , <i>Greenidea ficicola</i> , <i>G. heeri</i> , <i>G. psidii</i> , <i>Hyperomyzus carduellinus</i> , <i>Hysteroneura setariae</i> , <i>Macrosiphum euphorbiae</i> , <i>Myzus persicae</i> , <i>Pentalonia caladii</i> , <i>Rhopalosiphum maidis</i> , <i>Uroleucon compositae</i>	Aphididae	University of Agricultural Sciences, Bengaluru
	<i>Coccus longulus</i>	Coccidae	
	<i>Ferrisia virgata</i> , <i>Nipaeococcus viridis</i>	Pseudococcidae	
	<i>Icerya</i> sp.	Monophlebidae	
6.	<i>Aulacaspis</i> sp.	Diaspididae	Cardamom Research Station, Pampadumpara, Kerala
7.	<i>Aphis craccivora</i> (2), <i>A. spiraeicola</i> , <i>Myzus persicae</i> (2)	Aphididae	CSIR–Central Institute of Medical and Aromatic Plants, Lucknow, Uttar Pradesh
	<i>Insignorthezia insignis</i>	Coccidae	
	<i>Aspidiotus destructor</i>	Diaspididae	
	<i>Coccidohystrix insolita</i> , <i>Ferrisia virgata</i> , <i>Pseudococcus longispinus</i>	Pseudococcidae	
8.	<i>Aphis gossypii</i> (4)	Aphididae	Tamil Nadu Agricultural

			University, Coimbatore
9.	<i>Ceroplastes cerripediformis</i>	Coccidae	Indira Gandhi Krishi Vishwavidyalaya, Raipur
10.	<i>Megapulvinaria maxima</i>	Coccidae	Dr. Swaminathan, Rajasthan
11.	<i>Aphis gossypii</i>	Aphididae	ICAR–National Research Centre for Grapes, Pune
12.	<i>Aphis gossypii</i> (3)	Aphididae	University of Calicut, Malappuram, Kerala
13.	<i>Drepanococcus chiton</i>	Coccidae	Regional Agricultural Research Station, Nandyal
14.	<i>Diaspis echinocacti</i>	Diaspididae	Directorate of Plant Protection, Quarantine & Storage, Mumbai
	<i>Pseudococcus jackbeardsleyi</i>	Pseudococcidae	
15.	<i>Aphis gossypii</i> , <i>A. punicae</i>	Aphididae	College of Agriculture, Vijayapura
16.	<i>Aphis craccivora</i> (3), <i>A. gossypii</i>	Aphididae	College of Agriculture, Vellayani, Kerala
	<i>Ceroplastes cerripediformis</i> , <i>Ceroplastes</i> sp.	Coccidae	
	<i>Aonidiella aurantii</i> , <i>Aulacaspis crawii</i> , <i>Pinnaspis strachani</i> , <i>Rutherfordia major</i>	Diaspididae	
	<i>Icerya aegyptiaca</i> , <i>I. purchasi</i> , <i>I. seychellarum</i> (3)	Monophlebidae	
	<i>Ferrisia virgata</i> , <i>Phenacoccus maniboti</i> , <i>Planococcus</i> sp., <i>Rastrococcus iceryoides</i>	Pseudococcidae	
17.	<i>Aphis craccivora</i> (2), <i>A. gossypii</i>	Aphididae	Agriculture University, Jodhpur
18.	<i>Schizaphis graminum</i>	Aphididae	Aligarh Muslim University, Uttar Pradesh
19.	<i>Planococcus lilacinus</i> , <i>Rastrococcus iceryoides</i>	Pseudococcidae	Horticultural Research Station, Ambajipeta, Andhra Pradesh
20.	<i>Aphis craccivora</i> (5), <i>A. gossypii</i> (4), <i>Lipaphis erysimi</i> (3), <i>Myzus persicae</i> , <i>Rhopalosiphum maidis</i> , <i>Uroleucon compositae</i>	Aphididae	University of Agricultural Sciences, Dharwad
21.	<i>Pedroniospis beesonii</i>	Eriococcidae	Birsa Agricultural University, Ranchi, Jharkhand
22.	<i>Aphis craccivora</i> , <i>A. gossypii</i> , <i>Hyperomyzus carduellinus</i> , <i>Hysteronura setariae</i> (7), <i>Rhopalosiphum</i> sp., <i>Sitobion miscanthi</i>	Aphididae	ICAR–Indian Agricultural Research Institute, New Delhi
	<i>Pseudococcus calceolariae</i>	Pseudococcidae	
23.	<i>Perissopneumon ferox</i>	Monophlebidae	Navasari Agricultural University, Gujarat
	<i>Formicococcus robustus</i> , <i>Planococcus lilacinus</i>	Pseudococcidae	
24.	<i>Hydaphis coriandri</i>	Aphididae	Swami Keshwanat Rajasthan Agricultural University, Bikaner, Rajasthan
25.	<i>Schizaphis</i> sp.	Aphididae	Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra
	<i>Asterolecanium</i> sp., <i>Ceroplastes cerripediformis</i>	Coccidae	
	<i>Paracoccus</i> sp., <i>Planococcus</i> sp.	Pseudococcidae	
26.	<i>Eulecanium tiliae</i>	Coccidae	Dr Y.S. Parmar University of Horticulture &

			Forestry, Nauni, Himachal Pradesh
27.	<i>Megapulvinaria maxima</i>	Coccidae	Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal
	<i>Icerya purchasi</i>	Monophlebidae	
	<i>Ferrisia virgate</i> , <i>Rastrococcus iceryoides</i> (2)	Pseudococcidae	
28.	<i>Ceroplastes floridensis</i>	Coccidae	Central Silk Board, Kharsawan, Jharkhand
29.	<i>Acrythosiphon pisum</i> , <i>Aphis craccivora</i> , <i>A. fabae</i> , <i>A. gossypii</i> (2), <i>A. spiraecola</i> , <i>Hydaphis coriandri</i> , <i>Hyperomyzus carduellinus</i> , <i>Pseudoregma bambucicola</i> , <i>Rhopalosiphum maidis</i> , <i>Schuotedenia emblica</i> , <i>Smyntburodes betae</i>	Aphididae	ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, Karnataka
	<i>Fistulococcus pokfulamensis</i>	Coccidae	
	<i>Dysmicoccus brevipes</i> (3), <i>D. neobrevipes</i> , <i>Paracoccus marginatus</i> , <i>Phenacoccus madeirensis</i> , <i>P. maniboti</i> , <i>Phenacoccus parvus</i> , <i>P. solenopsis</i> (2), <i>Phenacoccus</i> sp., <i>Planococcus lilacinus</i> , <i>Rastrococcus iceryoides</i> , <i>Rastrococcus</i> sp.	Pseudococcidae	
30.	<i>Aphis gossypii</i> , <i>A. odinae</i>	Aphididae	Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka
	<i>Coccus hesperidum</i>	Coccidae	
31.	<i>Hyperomyzus carduellinus</i> , <i>Hysteroneura setariae</i> (5), <i>Rhopalosiphum</i> sp., <i>Sitobion miscanthi</i>	Aphididae	ICAR–Central Agroforestry Research Institute, Jhansi
32.	<i>Macrosiphum euphorbiae</i> , <i>Sinomegoura pyri</i>	Aphididae	ICAR–Research Complex for North East Hilly Region, Umiam, Meghalaya
	<i>Dysmicoccus neobrevipes</i> (2), <i>Ferrisia virgata</i>	Pseudococcidae	
33.	<i>Ceroplastes floridensis</i> , <i>C. rusci</i>	Coccidae	Punjab Agricultural University, Ludhiana, Punjab
34.	<i>Aphis craccivora</i> (8), <i>A. gossypii</i> , <i>Aphis (Toxoptera) aurantii</i> , <i>Greenidea psidi</i> , <i>Myzus persicae</i>	Aphididae	College of Agriculture Padannakkad, Kasaragod, Kerala
35.	<i>Icerya pilosa</i>	Monophlebidae	ICAR–Sugarcane Breeding Institute, Coimbatore
	<i>Dysmicoccus carens</i> , <i>Kiritshenkella lingnani</i> , <i>K. sacchari</i> , <i>Saccharicoccus sacchari</i> , <i>Trionymus townesi</i>	Pseudococcidae	
36.	<i>Pseudococcus longispinus</i>	Pseudococcidae	Central Coffee Research Institute, Chikmangalur
37.	<i>Aphis gossypii</i>	Aphididae	ICAR–Directorate of Floricultural Research, Pune, Maharashtra
	<i>Coccus hesperidum</i>	Coccidae	
	<i>Dysmicoccus neobrevipes</i>	Pseudococcidae	
38.	<i>Aonidiella aurantii</i> , <i>Lepidosaphes beckii</i> , <i>Pseudaulacaspis pentagona</i>	Diaspididae	Regional Plant Quarantine Station, Mumbai
39.	<i>Pseudaulacaspis pentagona</i>	Diaspididae	Plant Quarantine Station, Shamshabad, Hyderabad
40.	<i>Aphis craccivora</i> , <i>A. gossypii</i> , <i>Aphis (Toxoptera)</i> sp., <i>Ceratovacuna perglandulosa</i>	Aphididae	College of Horticulture and Forestry, Pasighat, Arunachal Pradesh
	<i>Pinnaspis buxi</i>	Diaspididae	
	<i>Formicococcus polysperes</i> , <i>Phenacoccus parvus</i>	Pseudococcidae	

41.	<i>Melanaspis sacchari</i>	Aphididae	Sugarcane Research Institute, Samastipur, Bihar
	<i>Kiritbenkella lingnani, Phenacoccus saccharifoli</i>	Pseudococcidae	
42.	<i>Planococcus citri, P. lilacinus, Planococcus</i> sp.	Pseudococcidae	ICAR–Indian Institute of Spices Research, Madikeri, Karnataka
43.	<i>Mangalorea hopeae</i>	Beesoniidae	University of Calicut, Kerala
44.	<i>Ceroplastes cerripediformis</i>	Coccidae	M S Swaminathan Research Foundation, Dindigul, Tamil Nadu
45.	<i>Ceroplastes</i> sp., <i>Parasaissetia nigra, Vinsonia stellifera</i>	Coccidae	College of Horticulture, Thrissur, Kerala
	<i>Ferrisia virgate</i> (23), <i>Paracoccus marginatus</i> (33), <i>Phenacoccus maniboti</i> (24)	Pseudococcidae	
46.	<i>Pinnaspis strachani</i>	Diaspididae	ICAR–Indian Institute of Horticultural Research, Bengaluru

Dr K. Sreedevi

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	<i>Anomala lineatopennis, A. xanthoptera, Anomala</i> sp. 1, <i>Anomala</i> sp. 2, <i>Brahmina coriacea</i> (3), <i>Brahmina crinicollis</i> (2), <i>B. flavosericea, Brahmina</i> sp. 1	Scarabaeidae	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh
2.	<i>Araecerus</i> sp.	Anthribidae	Dr. Gavas Ragesh, Kerala
3.	<i>Celosterna scabrator, Stbenias</i> sp., Undetermined Cerambycine species	Cerambycidae	College of Agriculture, Vijayapur
4.	<i>Callosobruchua maculatus</i>	Chrysomelidae	CSIR–Central Food Technological Research Institute Mysuru, Karnataka
	<i>Sitophilus oryzae</i>	Curculionidae	
	<i>Tribolium castaneum</i>	Tenebrionidae	
5.	<i>Adoretus</i> sp., <i>Anomala communis, Anomalobela bicolor, Holotrichia</i> sp., <i>Maladera</i> sp.	Scarabaeidae	ICAR–Indian Agricultural Research Institute, Wellington, Tamil Nadu
6.	<i>Anomala bengalensis, A. dimidiata, A. dorsalis, A. varicolor, Apogonia</i> sp., <i>Holotrichia consanguinea, H. nagpurensis, H. serrata, Maladera insanabilis, Pentodon</i> sp., <i>Phyllognathus dionysius, Onitis</i> sp., <i>Onthophagus</i> sp., <i>Schizonycha ruficollis</i>	Scarabaeidae	Sri Jagpal Singh, Farmer, Ghaziabad, Uttar Pradesh
7.	Bostrichid beetle	Bostrichidae	College of Agriculture, Bapatla, Andhra Pradesh
	Carabid beetle	Carabidae	
	Click beetle	Elateridae	

	<i>Onthophagus</i> sp., <i>Sisyphus</i> sp.	Scarabaeidae	
	Darkling beetle	Tenebrionidae	
8.	<i>Gametis versicolor</i> , <i>Popillia complanata</i> , <i>Popillia</i> sp.	Scarabaeidae	College of Agriculture, Vellayani, Kerala
9.	<i>Abasverus advena</i>	Silvanidae	Plant Quarantine Station, Baikampady, Mangalore
10.	<i>Apogonia</i> sp., <i>Popillia complanata</i>	Scarabaeidae	ICAR–Central Plantation Crop Research Institute, Kasaragod, Kerala
11.	Bostrichid sp., <i>Sinoxylon</i> sp.	Bostrichidae	Government College, Jodhpur, Rajasthan
12.	<i>Callosobruchus chinensis</i> , <i>C. maculatus</i> , <i>Callosobruchus</i> sp.	Chrysomelidae	Uttar Banga Krishi
	<i>Sitophilus oryzae</i>	Curculionidae	Vishwavidyalaya, Cooch Behar, West Bengal
	<i>Cryptolestes</i> sp.	Laemophloeidae	
13.	Lucanid beetle	Lucanidae	ICAR Regional Centre for North East Hilly region, Kolasib, Mizoram
	Passalid beetle	Passalidae	
	<i>Anomala</i> sp. 1, <i>Cyphochilus</i> sp., <i>Maladera</i> sp. 1, <i>Maladera</i> sp. 2, <i>Xylotrupes gideon</i> , <i>Xylotrupes</i> sp. 1	Scarabaeidae	
14.	<i>Sphenoptera indica</i>	Buprestidae	Anand Agricultural University, Gujarat
15.	<i>Trachys</i> sp.	Buprestidae	Central silk Board, Kharsawan, Jharkhand
16.	<i>Epuraea</i> sp.	Nitidulidae	Navsari Agricultural University, Gujarat
17.	<i>Trypferus</i> sp.	Cantharidae	Central Tasar Research & Training Institute, Ranchi, Jharkhand
18.	<i>Adoretus</i> sp., <i>Anomala bengalensis</i> , <i>Anomala</i> sp., <i>Holotrichia rufoflava</i> , <i>H. serrata</i> , <i>Holotrichia</i> sp.	Scarabaeidae	Sugarcane Breeding Institute, Coimbatore
19.	<i>Batocera rubus</i>	Cerambycidae	Citrus Research Station, Tinsukia, Assam
	Tenebrionid beetle	Tenebrionidae	
20.	<i>Abasverus advena</i> (Waltl), <i>Silvanus</i> sp. (3)	Silvanidae	Plant Quarantine Station, Madurai, Tamil Nadu
21.	<i>Holotrichia consanguinea</i>	Scarabaeidae	ICAR–National Research Centre for Integrated Pest Management, New Delhi
22.	<i>Adoretus</i> sp., <i>Anomala</i> sp. 1, <i>Apogonia</i> sp., <i>Holotrichia</i> sp. 1, <i>Maladera</i> sp., <i>Mimela</i> sp., <i>Sophrops</i> sp., undetermined Melolonthine species, <i>Xylotrupes</i> sp. 1	Scarabaeidae	College of Horticulture & Forestry, Pasighat, Arunachal Pradesh
23.	Bostrychid species	Bostrichidae	Central Horticultural experiment Station, Chettalli, Karnataka
	Platypodine weevils, <i>Xylosandrus</i> sp.	Curculionidae	

Dr G. Mahendiran

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	<i>Deporaus mariginatus</i>	Rhynchitidae	Navsari Agricultural University, Gujarat
2.	<i>Myloccerus undecimpustulatus</i> , <i>Myloccerus</i> sp.	Curculionidae	CSIR–Central Institute of Medicinal and Aromatic Plants, Lucknow
3.	<i>Barioscapus cordiae</i> , <i>Curculio melaleucus</i> , <i>C. notobifasiatus</i>	Curculionidae	Punjab Agricultural University, Ludhiana, Punjab
4.	<i>Cyrtozemia dispar</i>	Curculionidae	Central Integrated Pest Management Centre, Jaipur
5.	<i>Amblyrrhinus poricollis</i> , <i>Arribines tutus</i> , <i>Myloccerus discolor</i>	Curculionidae	University of Agricultural Sciences, Dharwad
6.	<i>Cyrtozemia dispar</i> , <i>Hypera</i> sp., <i>Myloccerus discolor</i>	Curculionidae	College of Agriculture, Jodhpur

Dr Ankita Gupta

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	<i>Bracon</i> sp.	Braconidae	ICAR–Central Institute for Cotton Research, Coimbatore
	<i>Eurytoma</i> sp.	Eurytomidae	
2.	<i>Anisopteromalus calandrae</i>	Pteromalidae	Punjab Agricultural University, Ludhiana
3.	<i>Cotesia ruficornis</i> , <i>Glyptapanteles obliquae</i> , <i>Meteorus</i> sp.	Braconidae	CSIR–Central Institute of Medicinal and Aromatic Plants, Lucknow
	<i>Copidosoma floridanum</i>	Encyrtidae	
	<i>Campoletis chlorideae</i> (2), <i>Charops</i> sp.	Ichneumonidae	
4.	<i>Aleiodes</i> sp., <i>Bracon</i> sp., <i>Diolcogaster</i> sp. (2), <i>Dolichogenidea</i> sp. (2), <i>Glyptapanteles</i> sp., <i>Parapanteles</i> sp.	Braconidae	Uttar Banga Krishi Viswavidyalaya, Cooch Behar, West Bengal
	<i>Copidosoma</i> sp.	Encyrtidae	
5.	<i>Chelonius formosanus</i> , <i>Microplitis manilae</i>	Braconidae	Institute of Agriculture (Palli Siksha Bhavana) Sriniketan, West Bengal
	<i>Campoletis chlorideae</i> , <i>Charops bicolor</i>	Ichneumonidae	
6.	<i>Allotropa</i> nr. <i>phenacocca</i>	Platygastrtoidea	ICAR–Indian Agricultural Research Institute, New Delhi
7.	<i>Marietta leopardina</i>	Aphelinidae	ICAR–Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat
	<i>Aenasius arizonensis</i> , <i>Homalotylus turkmenicus</i> , <i>Prochiloneurus</i> sp., <i>Pseudleptomastix mexicana</i>	Encyrtidae	
	<i>Aprostocetus</i> sp.	Eulophidae	
	<i>Cheiloneurus</i> sp.	Signiphoridae	

Dr K.J. David

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	<i>Bactrocera dorsalis</i> , <i>B. zonata</i>	Tephritidae	Chaudhary Charan Singh Haryana Agricultural University, Hisar
2.	<i>Bactrocera dorsalis</i> , <i>Zenodacus cucurbitae</i>	Tephritidae	Punjab Agricultural University, Ludhiana
3.	<i>Zenodacus diaphorus</i> , <i>Z. tau</i>	Tephritidae	ICAR–Indian Institute of Horticultural Research, Bengaluru
4.	<i>Bactrocera caryae</i> , <i>B. dorsalis</i> , <i>B. versicolor</i>	Tephritidae	Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shivamogga, Karnataka
5.	<i>Dasineura</i> sp.	Cecidomyiidae	College of Agriculture, Nagpur
6.	<i>Bactrocera aethriobasis</i> , <i>B. bhutaniae</i> , <i>B. divenderi</i> , <i>B. dorsalis</i> , <i>B. tuberculata</i> , <i>Zenodacus cucurbitae</i>	Tephritidae	Nagaland University
7.	<i>Bactrocera dorsalis</i> , <i>Zenodacus cucurbitae</i>	Tephritidae	Agrinos India Pvt. Ltd., Bangalore
8.	<i>Zodiomyia sumbaensis</i>	Conopidae	ICAR–Directorate of Cashew Research, Puttur, Karnataka
9.	<i>Leucopis</i> sp.	Chamaemyiidae	University of Agricultural Sciences, Bengaluru

Dr Salini S.

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	<i>Megacopta cribraria</i>	Plataspidae	Navsari Agricultural University, Gujarat, India
2.	<i>Clavigralla gibbosa</i>	Coreidae	Navsari Agricultural University, Gujarat, India
3.	<i>Spilostethus hospes</i>	Lygaeidae	Navsari Agricultural University, Gujarat, India
4.	<i>Nezara viridula</i> var. <i>smaragdula</i>	Pentatomidae	Navsari Agricultural University, Gujarat, India
5.	<i>Andrallus spinidens</i>	Pentatomidae	Punjab Agricultural University Ludhiana, Punjab

6.	<i>Leptocorisa oratorius</i>	Alydidae	Punjab Agricultural University Ludhiana, Punjab
7.	<i>Nezara viridula</i> var. <i>smaragdula</i>	Pentatomidae	Punjab Agricultural University Ludhiana, Punjab
8.	<i>Dolycoris indicus</i>	Pentatomidae	Punjab Agricultural University Ludhiana, Punjab
9.	<i>Coptosoma variegatum</i>	Plataspidae	Regional Research Station, Moncompu
10.	<i>Arocatus sericans</i>	Lygaeidae	ICAR–Central Institute of Cotton Research, Coimbatore
11.	<i>Oxycarenus hyalinipennis</i>	Oxycarenidae	Punjab Agricultural University, Ludhiana
12.	<i>Eysarcoris ventralis</i>	Pentatomidae	College of Agriculture, Jodhpur, Rajasthan
13.	<i>Piezodorus hybneri</i>	Pentatomidae	College of Agriculture, Jodhpur, Rajasthan
14.	<i>Sciocoris indicus</i>	Pentatomidae	College of Agriculture, Jodhpur, Rajasthan
15.	<i>Eysarcoris</i> sp.	Pentatomidae	College of Agriculture, Jodhpur, Rajasthan
16.	<i>Acrosternum gramineum</i>	Pentatomidae	College of Agriculture, Jodhpur, Rajasthan
17.	<i>Carbula socia</i>	Pentatomidae	College of Agriculture, Jodhpur, Rajasthan
18.	<i>Halys serrigera</i>	Pentatomidae	College of Agriculture, Jodhpur, Rajasthan
19.	<i>Adria parvula</i>	Pentatomidae	College of Agriculture, Jodhpur, Rajasthan
20.	<i>Carbula biguttata</i>	Pentatomidae	College of Agriculture, Jodhpur, Rajasthan
21.	<i>Dolycoris indicus</i>	Pentatomidae	College of Agriculture, Jodhpur, Rajasthan
22.	<i>Placosternum taurus</i>	Pentatomidae	College of Agriculture, Jodhpur, Rajasthan
23.	<i>Eocantbecona furcellata</i>	Pentatomidae	College of Agriculture, Jodhpur, Rajasthan

Dr Rachana R.R.

S. No.	Taxon/taxa identified	Group /family	Service provided to
1.	<i>Frankliniella schultzei</i> , <i>Scirtothrips dorsalis</i> (2), <i>Thrips palmi</i> (2), <i>T. tabaci</i>	Thripidae	University of Agricultural Sciences, Dharwad
2.	<i>Thrips hawaiiensis</i> (6), <i>T. tabaci</i>	Thripidae	University of Horticultural Sciences, Bagalkot
3.	<i>Microcephalothrips abdominalis</i>	Thripidae	BASF Pvt. Ltd., Pune

4.	<i>Thrips hawaiiensis</i> (3), <i>T. parvispinus</i>	Thripidae	University of Agricultural Sciences, Raichur
5.	<i>Thrips parvispinus</i> (28)	Thripidae	ICAR–Indian Institute of Horticultural Research, Bengaluru
6.	<i>Thrips parvispinus</i> (35)	Thripidae	ICAR–Indian Institute of Horticultural Research, Bengaluru
7.	<i>Thrips parvispinus</i>	Thripidae	Directorate of Plant Protection Quarantine and Storage, Telangana
8.	<i>Thrips hawaiiensis</i> , <i>T. palmi</i> (2), <i>T. parvispinus</i>	Thripidae	College of Horticulture, Mojerla
9.	<i>Thrips parvispinus</i> (24)	Thripidae	Directorate of Plant Protection Quarantine and Storage, Andhra Pradesh
10.	<i>Thrips hawaiiensis</i> , <i>T. parvispinus</i> (2)	Thripidae	Syngenta Pvt. Ltd., Aurangabad
11.	<i>Frankliniella schultzei</i> , <i>Microcephalothrips abdominalis</i> (6), <i>Thrips atactus</i> , <i>T. palmi</i> (2)	Thripidae	Coverta agriscience Pvt Ltd., Telangana
12.	<i>Scolothrips rhagebianus</i>	Thripidae	ICAR–National Bureau of Agricultural Insect Resources, Bengaluru
13.	<i>Bathrips melanicornis</i> , <i>Pseudodendrothrips darci</i> (2)	Thripidae	Central Silk Board, Bengaluru
14.	<i>Thrips hawaiiensis</i> , <i>T. parvispinus</i>	Thripidae	BASF Pvt. Ltd., Pune
15.	<i>Franklinothrips vespiformis</i>	Aeolothripidae	HM Clause Pvt Ltd., Bengaluru
	<i>Haplothrips</i> (<i>Haplothrips</i>) <i>gowdeyi</i>	Phlaeothripidae	
	<i>Frankliniella schultzei</i> , <i>Scirtothrips dorsalis</i> (3), <i>Thrips hawaiiensis</i> , <i>T. parvispinus</i>	Thripidae	
16.	<i>Thrips hawaiiensis</i> , <i>T. palmi</i>	Thripidae	HM Clause Pvt Ltd., Bengaluru
17.	<i>Scirtothrips dorsalis</i> (2), <i>Thrips florum</i> , <i>T. hawaiiensis</i>	Thripidae	University of Agricultural Sciences, Raichur
18.	<i>Scirtothrips dorsalis</i> , <i>Thrips palmi</i> , <i>T. tabaci</i>	Thripidae	Punjab Agricultural University, Ludhiana
19.	<i>Thrips florum</i> (2), <i>T. hawaiiensis</i> (2), <i>T. orientalis</i>	Thripidae	University of Horticultural Sciences, Shivamogga
20.	<i>Frankliniella schultzei</i> , <i>Scirtothrips dorsalis</i> , <i>Thrips hawaiiensis</i> , <i>T. palmi</i>	Thripidae	Coverta agriscience Pvt Ltd., Telangana

21.	<i>Haplothrips (Haplothrips) gowdeyi</i>	Phlaeothripidae	Coverta agriscience Pvt Ltd., Telangana
	<i>Frankliniella occidentalis</i> (2), <i>F. schultzei</i> (3), <i>Scirtothrips dorsalis</i> , <i>Thrips palmi</i>	Thripidae	
22.	<i>Diarthrothrips nimbus</i> , <i>Frankliniella schultzei</i> , <i>Thrips hawaiiensis</i> (3), <i>Thrips palmi</i> (2)	Thripidae	Krishi Vigyan Kendra, Guntur

Dr Navik Omprakash Samodhi

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	<i>Trichogramma chilonis</i> (3) <i>Trichogrammatoidea bactrae</i> (2)	Trichogrammatidae	ICAR–Central Institute for Cotton Research, Nagpur, Maharashtra
2.	<i>Trichogramma chilonis</i>	Trichogrammatidae	Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh
3.	<i>Trichogramma chilonis</i>	Trichogrammatidae	Agricultural Research Station, Banswara
4.	<i>Trichogramma achaeae</i> (2) <i>T. chilonis</i> (2)	Trichogrammatidae	CSIR–Central Institute of Medicinal and Aromatic Plants, Lucknow, Uttar Pradesh
5.	<i>Trichogramma japonicum</i> (2) <i>Trichogrammatoidea bactrae</i>	Trichogrammatidae	Regional Agricultural Station, West Godavari, Andhra Pradesh

Dr R.S. Ramya

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	<i>Carcelia</i> sp.	Tachinidae	Institute of Wood Science and Technology, Bengaluru
2.	Goniinae	Tachinidae	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya, Palampur, Himachal Pradesh
3.	<i>Exorista</i> sp.	Tachinidae	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishwavidyalaya, Palampur, Himachal Pradesh

Dr Jagadeesh Patil

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	<i>Heterorhabditis indica</i>	Heterorhabditidae	Indira Gandhi Krishi Vishwavidyalaya, Raipur
2.	<i>Steinernema surkhetense</i>	Steinernematidae	Indira Gandhi Krishi Vishwavidyalaya, Raipur

3.	<i>Meloidogyne incognita</i>	Heteroderidae	ICAR–Central Potato Research Institute, Ooty
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Dr M. Sampath Kumar

S. No.	Taxon/taxa identified	Group/Family	Service provided to
1.	<i>Neoscona theisi</i>	Araneidae	Indira Gandhi Krishi Vishwavidyalaya, Raipur
	<i>Telamonia dimidiata</i>	Tetragnathidae	
2.	? <i>Argiope</i> sp.	Araneidae	Navsari Agricultural University, Navsari
	<i>Oxyopes</i> sp. (2)	Oxyopidae	
	<i>Bianor</i> sp.	Salticidae	
3.	<i>Gasteracantha geminata</i> (2), <i>Gasteracantha</i> sp. (2)	Araneidae	Horticultural Research Station, Ambajipeta
	<i>Carrhotus viduus</i> , ? <i>Myrmarachne</i> sp., <i>Plexippus</i> sp. (2), ? <i>Telamonia</i> sp.	Salticidae	
	<i>Tetragnatha</i> sp.	Tetragnathidae	
4.	<i>Cyrtophora</i> sp., <i>Neoscona</i> sp. (3)	Araneidae	University of Agricultural Sciences, Dharwad
	<i>Oxyopes</i> sp.	Oxyopidae	
	? <i>Tetragnatha</i> sp.	Tetragnathidae	
	<i>Thomisus</i> sp. (4)	Thomisidae	
5.	? <i>Neoscona</i> sp.	Araneidae	University of Agricultural Sciences, Raichur
	<i>Tibellus pashanensis</i>	Philodromidae	
	<i>Aelurillus</i> sp.	Salticidae	
6.	<i>Eriovixia</i> sp. (3)	Araneidae	Bidhan Chandra Krishi Viswavidyalaya, Mohanpur
	? <i>Clubiona</i> sp.	Clubionidae	
	<i>Hyllus Semicupreus</i> (5), <i>Phintella</i> sp., ? <i>Telamonia</i> sp.	Salticidae	
	<i>Gnathopalystes</i> sp.	Sparassidae	
	<i>Tetragnatha</i> sp. (2)	Tetragnathidae	
	<i>Oxyopes shweta</i> (4)	Oxyopidae	
7.	<i>Argiope</i> sp., <i>Cyrtophora</i> ? <i>cicatrosa</i> (2), <i>Cyrtophora</i> sp. (2)	Araneidae	University of Agricultural Sciences, Dharwad
	? <i>Thwaitesia</i> sp.	Theridiidae	
	<i>Thomisus</i> sp.	Thomisidae	
8.	<i>Cyrtophora</i> sp., <i>Neoscona</i> ? <i>theisi</i> , <i>Neoscona</i> sp. 1, <i>Neoscona</i> sp. 2	Araneidae	University of Agricultural Sciences, Dharwad
	<i>Cheiracanthium insigne</i>	Cheiracanthiidae	
	<i>Oxyopes</i> ? <i>hindostanicus</i> , <i>Oxyopes</i> sp.	Oxyopidae	
	<i>Rhene</i> sp.	Salticidae	
	<i>Theridion</i> sp.	Theridiidae	
	<i>Misumena</i> sp., <i>Runcinia</i> sp.	Thomisidae	
9.	<i>Argiope</i> sp. (5)	Araneidae	University of Agricultural Sciences, Raichur
	<i>Thyene</i> sp.	Salticidae	
	? <i>Thwaitesia</i> sp.	Theridiidae	
	<i>Thomisus</i> ? <i>pugilis</i> , <i>Thomisus</i> sp.	Thomisidae	
10.	<i>Carrhotus viduus</i> , <i>Phintella</i> sp., ? <i>Phintelloides</i> sp., <i>Telamonia dimidiata</i> , <i>Thyene imperialis</i>	Salticidae	University of Agricultural Sciences, Dharwad
11.	<i>Argiope</i> sp., <i>Neoscona</i> sp., <i>Nephila</i> sp.	Araneidae	College of Agriculture, Vijayapura
	<i>Telamonia</i> sp.	Salticidae	

	<i>Thomisus</i> sp. (2)	Thomisidae	
12.	<i>Synageles ? venator</i>	Salticidae	Regional Plant Quarantine Station, Mumbai
13.	<i>Neoscona</i> sp.	Araneidae	Acharya N. G. Ranga Agricultural University, Tirupati

Dr P. Sreerama Kumar

S.No.	Taxon/ taxa identified	Group/ family	Service provided to
1.	<i>Schizotetranychus krungthepensis</i>	Tetranychidae	ICAR–Sugarcane Breeding Institute Research Centre, Kannur, Kerala
2.	<i>Aculops lycopersici</i>	Eriophyidae	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh

6. EXTENSION ACTIVITIES

ICAR–NBAIR participated in the survey of Southeast Asian Thrips

ICAR–NBAIR in collaboration with ICAR–National Centre for Integrated Pest Management, New Delhi and Directorate of Plant Protection, Quarantine, and Storage, Faridabad visited thrips-infested chilli fields in the states of Andhra Pradesh and Telangana to investigate the emerging thrips menace on the crop during 2–7 January 2022. Scientists interacted with the farmers of Madipadu, Achampeta and Sattenapalli areas of Telangana and Visadala, Merugupudi, Phirangipuram, Ponugupadu, Narasaraopeta, Chandavaram, Solasa and Veluru areas of Andhra Pradesh to understand their problems related to the thrips menace. Scientists'-farmers' interactive meetings were organised to disseminate the eco-friendly management practices to manage the thrips damage on chilli. Collected thrips samples from the affected fields were identified as *Thrips parvispinus* and management practices were suggested to the farmers.



Field visit and training to farmers on thrips identification

ICAR–NBAIR organised the first field release programme of the parasitoid, *Anagyrus lopezi* to tackle the invasive Cassava mealybug menace in India

ICAR–NBAIR Bengaluru have imported the beneficial parasitoid, *Anagyrus lopezi* (Hymenoptera: Encyrtidae) from the International Institute of Tropical Agriculture (IITA) with its subcentre at the Republic of Benin through International cooperation ably facilitated by Dr T. Trilochan Mohapatra, Secretary, Department of Agricultural Research and Education & Director General; Dr Ravi Prakash, Plant Protection Adviser, Directorate of Plant Protection Quarantine & Storage; Dr T.R. Sharma, Deputy Director General (Crop Science) and Dr S.C. Dubey, Assistant Director General (Plant Protection & Biosafety). The country representatives Dr Manuele Tamo, and Dr Georg Goergen, Entomologists from IITA, Benin supplied this parasitoid (Govt. of India import permit No. 17/2020- 21 dated 29.10.2020) which was received at Bengaluru on 13 August 2021. The mandatory quarantine studies on biology, safety and host specificity of *A. lopezi* at were carried out at NBAIR QC-2 quarantine facility to ensure its non-target impacts. ICAR–NBAIR has optimised the mass production and field release protocol of this parasitoid wasp in small as well as large-scale setup on cassava mealybug colonies. Further, ICAR–NBAIR has conducted the trainer's training programmes in four batches and trained the staff of State Agricultural Universities, State Horticulture Departments and Krishi Vigyan Kendras on mass production and field release techniques of *A. lopezi*. The first field release programme of the parasitoids and its distribution to the cassava farmers was organized by ICAR–NBAIR in collaboration with Tapioca and Castor Research Station, Yethapur, Salem district of Tamil Nadu on 7 March 2022. About 300 tapioca farmers from six districts of Tamil Nadu attended the event.

Shri A.K.P. Chinraj, Member of Parliament, Namakkal constituency; Dr J.P Singh, Additional Plant Protection Advisor, Government of India; Dr S.C. Dubey, ADG (Plant Protection & Biosafety); Dr M.N. Sheela, Director, ICAR–Central Tuber Crops Research Institute, Thiruvananthapuram; Dr M. Nagesh, Director (Acting), ICAR–National Bureau of Agricultural Insect Resources, Bengaluru; Dr. Subhash Chander, Director, ICAR–National Centre for Integrated Pest Management, New Delhi; Dr Harsh Vardhan Singh, Director, ICAR–National Bureau of Agriculturally Important Microorganisms, Mau; Dr A.S. Krishnamoorthy, Vice Chancellor, TamilNadu Agricultural University, Coimbatore and Mr C. Kathiravan IAS, Managing Director, Sago Serve, Salem graced the occasion. Other senior officials and scientists from ICAR-NBAIR and TNAU participated in the event and provided technical inputs to the farmers.

ICAR–NBAIR organized the campaign “Annadata Devo Bhava” at Krishi Vigyan Kendra, Namakkal

ICAR–NBAIR in collaboration with ICAR–Krishi Vigyan Kendra, Namakkal organized the campaign “Annadata Devo Bhava” as a part of Azadi Ka Amrit Mahotsav celebrations at Krishi Vigyan Kendra, Namakkal on 23 April 2022. Scientists from ICAR–NBAIR, officials from the State Department of Agriculture and Horticulture, Government of Tamil Nādu and Krishi Vigyan Kendra, Namakkal attended the programme. The successful introduction of the host-specific parasitoid, *Anagyrus lopezi* from Benin to India towards the management of the cassava mealybug was explained to the farmers. The field release technique of *Anagyrus lopezi* parasitoid for the management of cassava mealybug was demonstrated. On this occasion, the *Anagyrus lopezi* parasitoids mass-produced at ICAR–NBAIR were supplied to 50 farmers attended this programme as gratis to release in their cassava mealybug infested fields. Around 75 progressive farmers from Namakkal district participated in the Campaign.



Distribution and field release of *A.lopezi*



Training on mass production of *A.lopezi*

ICAR–NBAIR participated in the Farmers' Fair on “Natural cum Organic farming”

ICAR–NBAIR participated in the Farmers' Fair on “Natural cum Organic farming” organised at Krishi Vigyan Kendra, Namakkal as part of the 'Kisan Bhagidari Prathmikta Hamari Campaign' during Azadi Ka Amrut Mahotsav for the benefit of the farming community on 26 April 2022. A technical lecture on 'Invasive Cassava mealybug and mass production of parasitoid, *Anagyrus lopezi*' was delivered. A total of 500 farmers from various blocks of Namakkal district of Tamil Nadu attended this mega event.



Farmers meeting

ICAR–NBAIR organised farmers training cum awareness programme on classical biological control of cassava mealybug

ICAR–NBAIR organised the third “Farmers Training cum Awareness Programme on Classical Biological Control of Cassava Mealybug” on 23 September 2022 at the premises of SPAC-Starch Products India Pvt. Ltd., Poonachi village, Erode District, Tamil Nadu. More than 200 tapioca growing farmers attended the programme. Dr S.N.Sushil, Director, ICAR–NBAIR, Bengaluru, presided over the meeting and distributed the parasitoids mass-produced by NBAIR to the farmers. Officials /experts from Tamil Nadu Agricultural University, Coimbatore, Agricultural Research Station, Bhavanisagar, SPAC-Starch Products India Pvt. Ltd., Central Integrated Pest Management Centre (CIPMC), Trichy and State Departments of Horticulture and Agriculture graced the event. A technical session on mass production of the parasitoids and their and field release techniques was conducted.



Field release of *A.lopezi*

Open Day at ICAR-NBAIR

An “Open Day” was organised at the ICAR–NBAIR Hebbal campus on 4 August 2022. Around 200 Grade VI students from Presidency School, R.T. Nagar, Bengaluru visited the campus. The activities of the Bureau and the role of insects in the environment. The children visited the National Insect Museum where preserved insect specimens were exhibited to the students. Live insect predators, parasitoids, phytophagous insects and microbes like entomopathogenic fungi and nematodes were displayed to the students. The Indian National Flag was distributed to the children under 'Har Ghar Tiranga' Campaign.



Open day for school students

An “Open Day” was organised at the ICAR–NBAIR Yelahanka campus on 8 September 2022. Fifty-nine students who belong to Grade IX and X of Vishwa Vidyapeeth School, Yelahanka visited the campus. The children were introduced to the world of insects to the students by highlighting the role played by insects of economic importance. A video clipping on 'Bee Pollinators' and preserved insect specimens were displayed for the benefit of the students. The students were also explained about the black soldier fly mass rearing facility in the Yelahanka campus and the role of detritivores insects in the degradation of organic wastes into nutrient-rich compost was explained. The whitefly rearing facility was exhibited to the students and further on the pestiferous nature of whiteflies and the use of parasitoids for their management was elaborated. The students visited the 'Bee Home' in the campus and observed the bee colonies. The methods adopted to exploit the pheromone loaded in nano-materials for insect pest management was explained and the electroantennogram setup was demonstrated to the students. A wrap-up session-cum-interaction session was held at the auditorium.



Open day for school students

ICAR–NBAIR organised farmers training cum demonstration on biocontrol strategies for the management of invasive whiteflies in coconut

ICAR–NBAIR in collaboration with the Department of Horticulture, Mandya district and Horticulture Farmer Producer Company, Nagathihalli organised farmers training cum demonstration on biocontrol strategies for the management of invasive whiteflies in coconut on 7 October 2022 at Nagathihalli, Mandya district, Karnataka. The importance of biocontrol in tackling these invasive whiteflies in coconut was highlighted to the farmers. The parasitoids and entomopathogenic fungus formulations were distributed to the farmers. About 100 farmers participated in the programme. The origin, invasion, distribution, other different host plants, life cycle, nature of damage of whiteflies and their management strategies were explained to the farmers. Release of parasitoid, *Encarsia guadeloupae* and preparation and foliar application of entomopathogenic fungus, *Isaria fumosorosea* was demonstrated to the farmers.



Farmers training on RSW management

ICAR–NBAIR participated in the 'World Soil Day' celebration

ICAR–NBAIR in collaboration with ICAR–Krishi Vigyan Kendra, Krishnagiri, Regional Research Station, Paiyur and State Department of Agriculture, Krishnagiri and Tirupattur organized a field programme on World Soil Day-2022 at Regional Research Station, Paiyur, Krishnagiri, Tamil Nadu on 5 December 2022. The timely use of biocontrol agents and its compatible approaches for the control of insect pests and its beneficial effect on soil health was elaborated.

Different biocontrol technologies involving parasitoids, predators, and insect pathogens developed by the Bureau were exhibited and was well received by the farming community. A total of 200 farmers from various blocks of Krishnagiri and Tirupattur districts of Tamil Nadu attended the mega event. The programme was vividly covered in the local newspapers



World Soil Day celebration

7. AWARDS AND RECOGNITIONS

Dr T. Venkatesan

Served as Panelist, Entomological Society of India Annual Workshop, Indian Agricultural Research Institute, New Delhi, 14 October 2022.

Served as Co-Chairman for the Session “Basic research on biodiversity and natural enemies of insect pests” in XXXI Annual Review Meeting of All India Coordinated Research Project on Biological Control of Crop Pests, University of Agricultural Sciences, Bengaluru, 20–21 October 2022.

Received Best Oral presentation award for the paper entitled “Molecular changes accompanying the loss in the fertility of fall armyworm, *Spodoptera frugiperda* female moths following infection with sub-lethal dose of baculovirus” in the Seventh National Conference on Biological Control: 75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and the Way Forward organized by Society for Biocontrol Advancement at Hotel Ramada by Wyndham, Yelahanka, Bengaluru, 15–17 December 2022.

Served as Vice President for Association for the Advancement in Pest Management in Horticulture Ecosystems.

Dr P. Sreerama Kumar

Editor, SIP Newsletter, Society for Invertebrate Pathology, USA, for 2022. Ambassador, The Association of Applied Biologists, Warwick, UK, for 2022.

Dr K. Subaharan

Invited to serve as Member Policy Committee on Nanotechnology Initiatives for Karnataka, Karnataka State Higher Education Academy.

Member Board of Studies of Entomology at Annamalai University.

Received Best Poster Presentation award for the paper entitled “Essential oils for management of *Corcyra cephalonia*” in Seventh National Conference on Biological Control: 75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and the Way Forward organized by Society for Biocontrol Advancement at Hotel Ramada by Wyndham, Yelahanka, Bengaluru, 15–17 December 2022.

Received First prize in Swachhta competition- 2022 for maintaining high standards of neatness in the National Insect Museum "Azadi @ 75 Swachh Survekshan 2022" of Swachh Bharat Mission.

Dr G. Sivakumar

Received Best Poster Presentation award for the paper entitled “Optimisation of larval stage and time for harvesting *Spodoptera frugiperda* nucleopolyhedrovirus” in Seventh National Conference on Biological Control: 75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and the Way Forward organized by Society for Biocontrol Advancement at Hotel Ramada by Wyndham, Yelahanka, Bengaluru, 15–17 December 2022.

Dr K. Sreedevi

Nominated as Principal Member, Biodiversity Sectional Committee - SSD 20 of BIS, India since April 2022.

Awarded “Dr B. Vasantharaj David Award” from Applied Zoologists Research Association during the International Conference on XVIII AZRA International Conference on “Advances in Applied Zoological Researches towards Feed, Food and Nutritional Security and Safer Environment”, Bhubaneswar, Odisha, 10–12 November 2022.

Dr R. Gandhi Gracy

Received Department of Science & Technology, International Travel Grant to participate and deliver a talk at the Joint Annual Meet of Entomological Societies of America, Canada and British Columbia, at Vancouver, Canada, 13–16 November 2022.

Dr B.S. Gotyal

Received “Young Scientist Award” from the Society of Applied Zoological Research Association (AZRA) during XVIII AZRA International Conference on “Advances in Applied Zoological Researches towards Feed, Food and Nutritional Security and Safer Environment”, Bhubaneshwar, Odisha, 10–12 November 2022.

Dr Ankita Gupta

Received Best Paper award for the research paper 'Vanitha K., Ankita Gupta, Venkatesan Thiruvengadam, Arati Pannure & Ashika Thotambailu Raghavendra (2022): Biological notes on nesting biology, development and natural enemies of *Braunsapis mixta*, a pollinator of cashew, Journal of Apicultural Research, DOI: 10.1080/00218839.2022.2028965 (NAAS 8.58)' by Directorate of Cashew Research, Puttur, Karnataka.

Received First prize in Swachhta competition- 2022 for maintaining high standards of neatness in the National Insect Museum "Azadi @ 75 Swachh Survekshan 2022" of Swachh Bharat Mission.

Dr K.J. David

Received 'Prof T.N. Ananthkrishnan Foundation Award' under Senior Scientist category for the biennium 2020-21 at Chennai, Tamil Nadu, 06 August 2022.

Received Best Oral Presentation Award for the paper entitled 'Larval taxonomy of weed infesting fruit flies of India' in Seventh National Conference on Biological Control: 75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and the Way Forward organized by Society for Biocontrol Advancement at Hotel Ramada by Wyndham, Yelahanka, Bengaluru, 15–17 December 2022.

Dr S. Salini

Received Department of Science & Technology, International Travel Grant (ITS/2022/000830) to participate in the 'Seventh Quadrennial Meeting of International Heteropterists' Society' held at Barcelona, Spain, 4–8 July 2022.

Received Society for Biocontrol Advancement - Dr H. Nagaraja Memorial award for Outstanding contributions to Insect Systematics including mites and spiders, 15 December 2022.

Dr Jagadeesh Patil

Received Best Oral Presentation award for the paper entitled “Compatibility and efficacy of entomopathogenic nematodes-entomopathogenic fungi combinations against invasive pest *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera: Noctuidae) in maize” in Seventh National Conference on Biological Control: 75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and the Way Forward organized by Society for Biocontrol Advancement at Hotel Ramada by Wyndham, Yelahanka, Bengaluru, 15–17 December 2022.

Dr M. Sampath Kumar

Received Best Oral Presentation award for the paper entitled “Classical biological control of cassava mealybug in India: Introduction to the release of the host-specific parasitoid, *Anagyrus lopezi* in cassava plantations and way forward” in the International

Conference on emerging trends in insect science - 2022 (ICETIS-2022) held at Loyala college, Chennai, 7–8 April, 2022.

Received Best Oral Presentation award for the paper entitled “Classical biological control of cassava mealybug in India: prospects and way forward” in Seventh National Conference on Biological Control: 75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and the Way Forward organized by Society for Biocontrol Advancement at Hotel Ramada by Wyndham, Yelahanka, Bengaluru, 15–17 December 2022.

Dr K. Selvaraj

Received ‘Young Entomologist Award’ for the year 2020 by Entomological Society of India during Entomological Society of India Annual Lecture Meeting, 14 October 2022.

Received ‘Dr R.J. Rabindra Team Award’ for the year 2020–2022 during ICAR–National Bureau of Agricultural Insect Resources Foundation Day, 19 October 2022.

Dr U. Amala

Received ‘Best Service Worker Award under Scientific category’ during the Institute Foundation day celebration, ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 19 October 2022.

Received Best Oral Presentation award for the paper entitled, “Potter wasps keep the lepidopteran insects at bay” in the ‘Seventh National Conference on Biological Control: Seventh National Conference on Biological Control on 75 Years of Biological Control of Pests and Diseases in Agriculture: Challenges and the Way Forward’ organized by Society for Biocontrol Advancement, Bengaluru, 15–17 December 2022.

Dr Richa Varshney

Received ‘Young Woman Scientist Award 2022’ for contribution in Entomology by Agro Environmental Development Society (AEDS) Rampur, Uttar Pradesh.

Dr R.R. Rachana

Received Society for Biocontrol Advancement - Dr Abraham Verghese Award for Best Ph. D. thesis in Entomology (Bioecology, Biosystematics, Biocontrol and Biotechnology), 15 December 2022. Served as a member in the committee formed by the Ministry of Agriculture and Farmer's Welfare to develop Standard Operating Procedures (SOP) for the invasive chilli thrips, *Thrips parvispinus*.

Received Best Oral Presentation Award for the paper entitled “Does India have the pest thrips, *Pseudodendrothrips bhattii* (Kudo)?” in Seventh National Conference on Biological Control – 75 Years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward, organized by Society for Biocontrol Advancement at Hotel Ramada by Wyndham, Yelahanka, Bengaluru, 15–17 December 2022.

Dr Navik Omprakash Samodhi

Received Best Oral Presentation award for the paper entitled “Performance and field efficacy of *Trichogramma chilonis* Ishii against invasive fall armyworm *Spodoptera frugiperda* (J.E. Smith) infesting sweet corn” in Seventh National Conference on Biological Control – 75 Years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward, organized by Society for Biocontrol Advancement at Hotel Ramada by Wyndham, Yelahanka, Bengaluru, 15–17 December 2022.

Dr C. Manjunatha

Received Best Oral Presentation award for the paper entitled “Decoding molecular mechanism involved in biocontrol potential of *Bacillus thuringiensis* var. *kurstaki* strain NBAIR BtG4 by whole genome sequencing” in Seventh National Conference on Biological Control – 75 Years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward, organized by Society for Biocontrol Advancement at Hotel Ramada by Wyndham, Yelahanka, Bengaluru, 15–17 December 2022.

Received the Best Poster Presentation award for the paper entitled “Biocontrol potential and molecular characterization of lipopeptides producing *Bacillus subtilis* strain BSWG1 against *Sclerotinia sclerotiorum*” in Seventh National Conference on Biological Control – 75 Years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward, organized by Society for Biocontrol Advancement at Hotel Ramada by Wyndham, Yelahanka, Bengaluru, 15–17 December 2022.

Mr K.T. Shivakumara

Received “Young Agricultural Scientist Award – 2022” from Dr B. Vasantharaj David Foundation Excellence Awards conferred during the Fourth National Conference on “Recent Advances in Applied Entomology and Environmental Sciences”, Chennai, 1 October, 2022.

Received Best Poster Presentation award for the paper entitled “Diversity and abundance of natural enemy populations on two invasive mealybug species *Paracoccus marginatus* and *Phenacoccus solenopsis* in *Gynemna sylvestre*” in Seventh National Conference on Biological Control – 75 Years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward, organised by Society for Biocontrol Advancement at Hotel Ramada by Wyndham, Yelahanka, Bengaluru, 15–17 December 2022.

8. AIRCP 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. Parmar 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 Jyoti Bapu Agricultural University, Raichur 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. Taxonomic studies on Coccoidea (Hemiptera) with special reference to Pseudococcidae, Coccidae, Diapsididae, Monophlebidae and Rhizoecidae (01.08.2022 to 31.03.2027) – 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 Curculionids (Coleoptera) with emphasis on Dryophthorinae (01.08.2022 to 31.03.2027) – Dr G. Mahendiran
4. Digitization 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 31.03.2023) – 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 31.03.2023) – Dr Navik Om Prakash Samodhi

DIVISION OF GENOMIC RESOURCES

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

1. Studies on the molecular and functional diversity of EPN-EPB-insect tritrophicism and their utilization against soil pests (08.07.2016 to 30.12.2022) – Dr M. Nagesh
2. Biological characterization of agriculturally important insects through DNA barcodes (01.04.2020 to 31.03.2025) – Dr T. Venkatesan
3. *Bacillus thuringiensis* – Fermentation and formulation strategies for enhanced toxicity against insect pests (01.04.2017 to 31.04.2023) – Dr R. Rangeshwaran
4. Population genetic diversity in selected insect borer of economic importance (01.04.2018 to 31.03.2022) – Dr M. Mohan
5. Development of mobile apps for the biological control of important crop pests (01.04.2017 to 31.03.2023) – Dr M. Pratheepa
6. Geo Mapping of predominant insect pests and their natural enemies including invasive species in India (01.08.2022 to 31.03.2026) – Dr M. Pratheepa
7. Studies on black soldier fly and associated microorganisms for their utilization (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 R. Gandhi Gracy
9. Gene characterization, identification and validation of gene silencing approach against *Maconellicoccus hirsutus* and *Phenacoccus manihoti* (01.08.2022 to 31.03.2026) – Dr R. Gandhi Gracy
10. Identification and molecular characterization of Indian Tachinids (01.04.2020 to 31.03.2023) – Dr. R.S. Ramya
11. Development and molecular studies of improved strains of selected natural enemies for insecticide resistance (01.08.2022 to 31.03.2026) – Dr. R.S. Ramya
12. Molecular studies on the virulence of *Bacillus thuringiensis* against fall armyworm and root grubs (01.04.2021-31.03.2026) – Dr C. Manjunatha
13. Molecular diversity of economically important mealybugs and their associated natural enemies in different ecosystems (01.08.2022 to 31.3.2026) – Dr B.S. Gotyal
14. Molecular characterization of economically important plant bugs and their diversity (01.04.2020 to 31.03.2024) – Mr K. T. Shivakumara

DIVISION OF GERMPLASM CONSERVATION AND UTILISATION

III. Biodiversity conservation, behavioural studies and maintenance and utilization 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 31.03.2026) – Dr T.M. Shivalingaswamy
3. Tailoring strategies to introduce acaropathogens and predatory mites for biological control in protected and open-field crops (01.08.2022 to 31.03.2027) – 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 31.03.2023) – Dr G. Sivakumar
6. Developing controlled release formulations for major pests (03.10.2018 to 02.10.2023) – 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 31.03.2023) – Dr K. Selvaraj
9. Studies on whiteflies and associated natural enemies for their management (19.09.2016 to 31.03.2023) – 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

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. Bioersity International: Biodiversity of insect pests and natural enemies in organically grown land races of rice (01.10.2020 to 30.10.2022) – 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-SERB: 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
6. DST-SERB: Systematics studies on shoot flies of Atherigoninae (Muscidae: Diptera) from India (30.12.2020 to 29.12.2023) – Dr K.J. David
7. DST-SERB: Systematic studies on Pentatominae (Hemiptera: Heteroptera: Pentatomidae) from North East India (03.01.2020 to 03.01.2023) – Dr S. Salini
8. DST-SERB: Taxonomic studies on species complexes in selected parasitoids (Braconidae: Hymenoptera) (10.02.2022 to 09.02.2025) – Dr Ankita Gupta
9. DST-SERB: 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-SERB: 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.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. National Bee Board-DAC: Exploration of gut microbiome & quality bee products for sustainable bee keeping in India (2021-2023) – Dr T. Venkatesan
17. AMAAS: Exploitation of endosymbionts of insect pests for pest management (01.04.2017 to 31.03.2023) – Dr Mahesh S. Yandigeri

DIVISION OF GERMPLASM CONSERVATION AND UTILISATION

18. CSB-CSRTI: Development of an integrated management packages for the broad mite, *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae) in mulberry (03.11.2022 to 03.10.2024) – Dr P. Sreerama Kumar
19. NASF: Development of sustainable management tools for the invasive pest fall armyworm, *Spodoptera frugiperda* (J.E. Smith) in maize (01.11.2019 to 31.10.2023) – Dr K. Subaharan
20. DBT: Controlled release of olfactory cues for management of lesser grain weevil, *Sitophilus oryzae* a stored product pest of rice – Dr K. Subaharan
21. ATGC Biotech Pvt Ltd: Assessing the physiological and behavioural response of pheromone of FAW, pink bollworm and *Tuta absoluta* derived from biosynthetic pathway of biological organism (29.07.2021 to 29.06.2022) – Dr K. Subaharan
22. Crop G1 Agro: Assessing the efficacy of physiological and behavioural response of volatiles from host source FAW female, *Spodoptera frugiperda* (01.08.2021 to 01.07.2022) – Dr K. Subaharan
23. ICAR under NAIF Component -1: Strengthening of the institutional mechanism to protect/manage innovations/intellectual properties (IPs) generated at ICAR-NBAIR (1.4.2020 to 31.03.2025) – Dr K. Subaharan

24. GIZ-Multi Institutional: Development and pilot testing specialized knowledge products on human-wildlife conflict mitigation for agriculture and veterinary sector in India (01.09.2021 to 31.08.2022) – Dr K. Subaharan
25. 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
26. DST under ASEAN - India collaborative programme: Collection, characterization 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
27. Agrinos India Pvt Ltd: Studies on Agrinos HYT products for Nematode Management (01.08.2021 to 31.05.2022) – Dr G. Sivakumar
28. 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 31.03.2023) – 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. 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
31. CDB: Development and validation of biointensive integrated pest management strategies for coconut invasive whiteflies in Karnataka (17.12.2020 to 17.04.2023) – Dr K. Selvaraj
32. DST: Enhancing the pollination in fennel (*Foeniculum vulgare* Mill.) by syrphid fly, *Ischiodon scutellaris* Fabricius (10.02.2022 to 09.02.2025) – Dr U. Amala
33. DBT under Establishment of Biotech-KISAN Hub: Establishment of Organic Hub for supporting organic and alike farming through promotion of bio-inputs technologies in farmers' field of North East India (16.03.2022 to 16.02.2024) – Dr Richa Varshney

10. PUBLICATIONS

Peer-reviewed articles

- Agrawal A, Gracy RG, Pathak J, Nayyar N, Mohan M, Pratheepa M, Rai A, Venkatesan T. 2022. Deciphering the molecular mechanisms of insecticide resistance from the transcriptome data of field evolved spinosad resistant and susceptible populations of *Plutella xylostella*. *J Econ Entomol*. DOI:10.1093/jee/toac072.
- Amala U, Kandan A, Shivalingaswamy TM. 2022. Nesting and predatory behaviour of potter wasp, *Rhynchium brunneum brunneum* (Eumeninae: Vespidae: Hymenoptera) in an urban farm landscape. *Biocontrol Sci Technol*. 32(7): 794–810.
- Amala U, Shivalingaswamy TM. 2022. Leafcutter bees (Hymenoptera: Megachilidae) as pollinators of pigeon pea (*Cajanus cajan* (L.) Millsp., Fabaceae): Artificial trap nests as a strategy for their conservation. *Sociobiology*. DOI: 10.13102/sociobiology.v69i1.7202.
- Amala U, Subaharan K, Shivalingaswamy TM. 2022. Diversity of bee pollinators - global and Indian Perspective. *Indian J Plant Genet Resour*. 35(3): 397–400.
- Amala U, Subaharan K. 2022. Ecological implications on insect biodiversity. *Indian J Plant Genet Resour*. 35(3): 401–405.
- Amutha M, Rachana RR. 2022. A new host record for the invasive thrips, *Thrips parvispinus* Karny from India. *Indian J Entomol*. 8(3): 1–3.
- Amutha M, Rachana RR. 2022. Species diversity of thrips on cotton. *Indian J Entomol*. 10(9): 1–4.
- Bali GK, Singh SK, Chauhan VK, Joshi N, Bhat FA, Malla WA, Ramanujam B, Varshney R, Kour M, Pandit RS. 2022. An insight in proteome profiling of *Tuta absoluta* larvae after entomopathogenic fungal infection. *Sci Data*. 9: 507.
- Basavaraj K, Sreenivas AG, Badari Prasad PR, Rachana RR. 2022. First report of invasive thrips, *Thrips parvispinus* (Karny) (Thysanoptera: Thripidae) infesting chilli, *Capsicum annuum* L. in Kalaburagi, Karnataka, India. *J Exptl Entomol India*. 25(1): 375–380.
- David KJ, Hancock DL, Gracy RG, Sachin K, Swathi RS. 2022. Taxonomic notes on fruit flies of tribes Schistopterini and Eutretini (Diptera: Tephritidae: Tephritinae) in India, with description of a new species of *Rhabdochaeta* de Meijere. *J Asia Pac Entomol*. DOI: 10.1016/j.aspen.2021.101858.
- David KJ, Hancock DL, Gracy RG, Sachin K. 2022. A new genus of fruit fly in subfamily Dacinae (Diptera: Tephritidae) from India. *Zootaxa*. 5195(6): 585–597.
- David KJ, Hancock DL, Sachin K, Gracy RG, Salini S. 2022. Two new species of *Platensina* Enderlein (Diptera, Tephritidae, Tephritinae, Dithrycini) from India. *ZooKeys*. 1092: 123–146.
- Dubey SC, Sharma VD, Prajapati KV, Akhtar J, Kandan A. 2022. Phenotypic variability, race profiling and molecular diversity analysis of Indian populations of *Fusarium oxysporum* f. sp. *lentis* causing lentil wilt. *Folia Microbiol*. 67(5): 757–775.
- Gawas SM, Gupta A. 2022. Diversity of vespid wasps (Hymenoptera: Vespidae) in agroecosystem and forest ecosystem of Western Ghats region of Goa, India. *J Biol Control*. 36(1): 71–79.
- Gupta A, Hemanth Kumar HMG, Sankararaman H. 2022 First report of the genus with first host record and description of an enchanting new species of *Doddifoenus* Bouček (Hymenoptera: Pteromalidae: Leptofoeninae) from India. *Biologia*. DOI: 10.1007/s11756-022-01133-4.
- Gupta A, van Achterberg C, Fernández-Triana JL. 2022. Two new species of Braconidae (Hymenoptera) from the foothills of western Himalayas, India, with a key to Oriental species of *Pambolus* Haliday and an update to the key to world species of *Paroplitis* Mason. *J Hymenopt Res*. 90: 59–73.
- Gupta A, van Achterberg C, Pattar R, Minz KA. 2022. On the occurrence of a Palearctic species of the genus *Aphaereta* Foerster (Braconidae, Alysiinae) and description of a new species of the genus *Leiophron* Nees (Braconidae, Euphorinae) from central India. *Zootaxa*. 5209(4): 455–462.

- Gupta A, van Achterberg C, Pattar R, Navik O, Mahendiran G. 2022. Two new species of the genera *Leiophron* Nees and *Paroligoneurus* Muesebeck (Hymenoptera: Braconidae) from northern India. *Zootaxa*. 5175(5): 593–599.
- Gupta A, van Achterberg C, Pattar R, Navik O. 2022. A new species of the genus *Streblocera* Westwood (Hymenoptera: Braconidae: Euphorinae) from peninsular India. *Zootaxa*. 5175(4): 494–498.
- Gupta A, van Achterberg C, Pattar R, Navik O. 2022. A new species of the genus *Streblocera* Westwood (Hymenoptera: Braconidae: Euphorinae) from peninsular India. *Zootaxa*. 5175(4): 494–498.
- Gupta A, van Achterberg C. 2022. Review of the Indian species of the genus *Eurymeros* Bhat (Braconidae: Alysiinae) with some nomenclatural changes. *Zootaxa*. 5162(5): 576–582.
- Gupta A, Zeya SB, Pratt CF, Joshi S, Ballal CR. 2022. First description of the male of *Anagyrus almoriensis* Shafee, Alam & Agarwal (Hymenoptera: Encyrtidae) with details of new host *Pseudococcus calceolariae* (Maskell) (Hemiptera: Pseudococcidae) on *Rubus ellipticus* (Rosaceae) from Himalayas. *Zootaxa*. 5159(4): 593–600.
- Gupta A. 2022. Insect collections as a reservoir of insect genetic resources. *Indian J Plant Genet Resour*. 35(3): 406–407.
- Huded S, Pramesh D, Chittaragi A, Sridhara S, Chidanandappa E, Prasannakumar MK, Manjunatha C, Patil B, Shil S, Pushpa HD, Raghunandana A. 2022. Spatial distribution patterns for identifying risk areas associated with false smut disease of rice in southern India. *Agronomy*. 12: 2947.
- Hulagappa T, Baradevanal G, Surpur S, Raghavendra D, Doddachowdappa S, Shashank PR, Mallaiah KK, Bedar J. 2022. Diagnosis and potential invasion risk of *Thrips parvispinus* under current and future climate change scenarios. *Peer J*. DOI: 10.7717/peerj.13868. eCollection 2022.
- Jayanthi PDK, Suma A, Anuradha S, Sreedevi K, Veena NV. 2022. First report of *Euplaytpus parallelus* (Fabricius) (Coleoptera: Curculionidae: Platypodinae) on pomegranate (*Punica granatum* L.), symptoms of infestation, its attraction to ethanol-based traps and niche partitioning with scolytines. *Coleopt Bull*. 76(1): 70–72.
- Jayanthi PDK, Suma A, Anuradha S, Sreedevi K, Veena NV. 2022. First report of *Euplaytpus parallelus* (Fabricius) (Coleoptera: Curculionidae: Platypodinae) on pomegranate (*Punica granatum* L.), symptoms of infestation, its attraction to ethanol-based traps and niche partitioning with scolytines. *Coleopt Bull*. 76(1): 70–72.
- John CTD, Sanap RV, Tripathi R, Sampath Kumar M, Dharmaraj J, Maria Packiam S. 2022. Taxonomic notes on some South and Southeast Asian members of the genus *Rbene* Thorell, 1869 (Aranei, Salticidae, Dendryphantini). *Zootaxa*. 5125(4): 389–407.
- Joshi S, Gupta A, Rajgopal NN, Venkatesan T. 2022. Taxonomic notes on the genus *Cyphococcus* Laing (Hemiptera: Coccoomorpha: Coccidae), with description of a new species from India. *Zootaxa*. 5104(4): 531–544.
- Joshi S, Gupta A, Shashank PR, Pai SG, Mohan M, Rachana RR, Dubey VK, Sandeep A, Deepthy KB. 2022. Recent adventive soft scale insects (Hemiptera: Coccoomorpha: Coccidae) and mealybugs (Hemiptera: Coccoomorpha: Pseudococcidae) in India. *Zootaxa*. 5194(2): 213–232.
- Joshi S, Prathapan KD, Sreejith MM, Haseena B, Shukla SP, Kumari B, Kunhamu TK. 2022. The invasive azedarach scale *Aulacaspis crawii* (Cockerell, 1898) (Hemiptera, Diaspididae) in India. *Curr Sci*. 123(4): 527–529.

- Joshi S, Subramanian M, Smitha R, Sampath Kumar M, Mohan M. 2022. Identification keys to live and mounted mealybug (Hemiptera: Pseudococcidae) species associated with cassava in India and their present distribution. *Pest Manage Horticult Ecsyst.* 27(2): 114–127.
- Keerthi MC, Mahesha HS, Kulkarni NS, Shivakumar BG, Shivakumara KT, Bhargavi HA, Venkatesh YN, Shashikumara P, Chand S. 2022. The threat of fall armyworm invasion and its host expansion on fodder crops. *Forage Res.* 47(3): 372–375.
- Kenis M. et al. 2022. Invasiveness, biology, ecology, and management of the fall armyworm, *Spodoptera frugiperda*. *Entomol Gen.* DOI: 10.1127/entomologia/2022/1659.
- Kumar T, Dayal G, Guru R, Sreedevi K. 2022. Redescription of seven genera of the tribe Mecysolobini (Coleoptera: Curculionidae: Molytinae) from India. *Indian J Entomol.* DOI: [10.55446/IJE.2022.977](https://doi.org/10.55446/IJE.2022.977).
- Kumara GT, Navik O, Venkatesan T, Hosamani A, Patil J, Mohan M, Jalali SK. 2022. Performance and field efficacy of indigenous egg parasitoid *Trichogrammatoidea bactrae* (Hymenoptera: Trichogrammatidae) against the cotton pink bollworm *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) in transgenic Bt cotton. *Biol Control.* 170: 104902.
- Manjunatha TG, Meena BR, Krishnan N, Manjunath M, Sellaperumal C, Rai AB, Singh A, Manimurugan C, Patil J, Pandey KK, Singh J. 2022. Antimicrobial peptides producing native *Bacillus* spp. for the management of root-knot nematode *Meloidogyne incognita* infecting okra (*Abelmoschus esculentus* L. Moench). *Biol Control.* 171: 104951.
- Mhatre PH, Divya KL, Venkatasalam EP, Watpade S, Bairwa A, Patil J. 2022. Management of potato cyst nematodes with special focus on biological control and trap cropping strategies. *Pest Manag Sci.* DOI: 10.1002/ps.7022.
- Mhatre PH, Thube SH, Navik O, Venkatasalam EP, Sharma S, Patil J, Subhash S, Divya KL, Watpade S, Pandian TP, Abas Shah M, Kumar M. 2022. Outbreak and management of serpentine leaf miner, *Liriomyza huidobrensis* (Blanchard) (Diptera: Agromyzidae), on potato (*Solanum tuberosum* L.) crop in India. *Potato Res.* 65: 809–827.
- Nagesh M, Sreedevi K. 2022. Role of invertebrate diversity with special reference to insects in agrobiodiversity and ecological services – Indian efforts. *Indian J Plant Genet Resour.* 35(3): 66–68.
- Nair MM, Kumar S, Jyothisna S, Sundaram KT, Manjunatha C, Sivasamy M, Alagu M. 2022. Stem and leaf rust-induced miRNAome in bread wheat near-isogenic lines and their comparative analysis. *Appl Microbiol Biotechnol.* 106: 8211–8232.
- Olsson S, Ameen M, Bajpai S, Gudasalamani G, Gajjar C, Gupta S, Hvilshoj S, Krishnakumar J, Lobo C, Mukherjee R, Naik A, Raghavan A, Singh H, Subaharan K. 2022. Framework for a collective definition of regenerative agriculture in India. *Ecol Economy Soc INSEE J.* 5(1): 23–30.
- Pal S, Natarajan P, Gupta A. 2022. New record of *Tetrastichus epilachnae* (Giard) (Hymenoptera: Eulophidae) parasitizing *Anisolemnia dilatata* (Fab.) (Coccinellidae: Coleoptera) in West Bengal (India). *Natl Acad Sci Lett,* 45: 349–351.
- Pandey AK, Kumar A, Dinesh K, Varshney R, Dutta P. 2022. The hunt for beneficial fungi for tomato crop improvement - advantages and perspectives. *Plant Stress.* (6): 1–12.
- Pathak J, Gracy RG, Agrawal A, Srivastava S, Basavaarya BR, Mohan M, Venugopal KM, Pratheepa M, Rai A, Venkatesan T. 2022. Comparative transcriptome analysis to reveal differentially expressed cytochrome P450 in response to imidacloprid in the aphid lion, *Chrysoperla zastrowi sillemi* (Esben-Petersen). *Insects.* 13(10): 900.

- Patil J, Linga V, Vijayakumar R, Subaharan K, Navik O, Bakthavatsalam N, Priyank HM, Sekhar J. 2022. Biocontrol potential of entomopathogenic nematodes for the sustainable management of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in maize. *Pest Manag Sci.* 78: 2883–2895.
- Poorani J, Joshi S, Thanigairaj R and Diraviam J. 2022. Screening alcohol-preserved samples for cassava mealybug, *Phenacoccus manihoti* Matile-Ferrero (Hemiptera: Pseudococcidae), a recent invasive introduction to India. *Curr Sci.* 122(8): 981–984.
- Preetha P, Jesna P, Feroz Khan, Das BK, Amala U, Vijaykumar ME, Yandigeri MS. 2022. Use of black soldier fly (*Hermetia illucens*) prepupae reared on organic waste as feed or as an ingredient in a pellet–feed formulation for Nile tilapia (*Oreochromis niloticus*). *Environ Sci Poll Res.* DOI/10.1007/s11356-022-20926-3.
- Quinlan MM, Mumford JD, Benedict MQ, Wäckers F, Oliva CF, Wohlfarter M, Smagghe G, Vila E, Klapwijk J, Michaelakis A, Collins CM, Prudhomme J, Torres G, Diaz F, Saul-Gershenz L, Cook K, Verghese A, Sreerama Kumar P. 2022. Can there be a common, risk-based framework for decisions around live insect trade? *Rev Sci Tech - Off Int Epizoot.* 41(1): 219–227.
- Rachana RR, Amarendra B, Gracy RG. 2022. Studies on *Pseudodendrothrips* (Thysanoptera, Thripidae) from India, with one new species. *Zootaxa.* 5209(3): 365–372.
- Rachana RR, Amarendra B, Gracy RG. 2022. The Sericothripinae genus *Hydatothrips* (Thysanoptera, Thripidae) in India with description of a new species. *Zootaxa.* 5169(2): 177–182.
- Rachana RR, Roselin P, Amutha M, Sireesha K, Reddy NG. 2022. Invasive pest, *Thrips parvispinus* (Karny) (Thysanoptera: Thripidae)—a looming threat to Indian agriculture. *Curr Sci.* 122(2): 211–213.
- Raghavendra KV, Bhoopathi T, Gowthami R, Keerthi MC, Suroshe SS, Ramesh KB, Shivakumara KT, Subhash S, Chander S. 2022. Insects: biodiversity, threat status, and conservation approaches. *Curr.Sci.* 122(12): 1374–1383.
- Rani S, Pal S, Shivakumara KT, Rajeshwari D, Gokulkrishna D. 2022. Biodiversity of insect pest complex of Muskdana, *Abelmoschus moschatus* (L.) in northern tracts of West Bengal. *Biological Forum - an International Journal.* 14(4): 326–330.
- Ranjith M, Bajya DR, Ramya RS. 2022. Abundance and composition of arthropods in sugarcane (*Saccharum officinarum*) ecosystem. *Indian J Agric Sci.* 92(11): 1386–1390.
- Ranjith M, Bajya DR, Ramya RS. 2022. Evaluation of botanicals *Crotalaria burbia* Buch-Ham and *Anacardium occidentale* L. against termite *Odontotermes obesus* Rambur (Isoptera: Termitidae) in wheat. *Bhartiya Krishi Anusandhan Patrika.* 37(4): 357–362.
- Ranjith M, Nagaraju DK, Rachana RR, Ramya RS, Verma OP, Prakash R. 2022. New host record of *Thrips parvispinus* Karny (Thysanoptera: Thripidae) in India. *Pest Manage Hortic Ecsyst.* 28(1): 33–37.
- Reddy KVN, Gracy RG, Agrawal A, Srivastava S, Pathak J, Venkatesan T, Rana DK. 2022. Reference genes selection for expression studies in *Maconellicoccus hirsutus* (Green) (Pseudococcidae: Hemiptera) under specific experimental conditions. *Mol Biol Rep.* DOI: 10.1007/s11033-022-08120-7.
- Sahu B, Gupta A, Deole S. 2022. Natural vs agricultural landscape: potential habitat for native bees. *Pharma Innovation.* 11(11): 1512–1516.
- Sampath Kumar M, Biswamitra R, John CTD, Mahendiran G, Sekhar SS. 2022. The spitting spider, *Scytodes fusca* Walckenaer (Araneae, Scytodidae): its distribution in South India and natural history notes. *J Entomol Res.* 46(2): 347–350.

- Sandeep A, Kalleshwaraswamy CM, Selvaraj K, Hanumanthaswamy BC, Mallikarjuna HB. 2022. Species composition and host range of whiteflies (Hemiptera: Aleyrodidae) in the Malnad region of Karnataka, India. *Natl Acad Sci Lett.* 46: 11–16.
- Sandeep A, Selvaraj K, Kalleshwaraswamy CM, Hanumanthaswamy BC, Mallikarjuna HB. 2022. Field efficacy of *Isaria fumosorosea* alone and in combination with insecticides against *Aleurodicus rugioperculatus* on coconut. *Egypt J Biol Pest Control.* 32: 106.
- Saranya M, Selvaraj K, Srinivasan T, Shanmuga PS. 2022. Occurrence and status of exotic whiteflies in coconut ecosystem and their management. *Indian Coconut Journal.* June, 8–11.
- Selvaraj K, Sumalatha BV, Gundappa B, Pratheepa M. 2022. Maximum entropy modelling for predicting the potential distribution of invasive rugose spiralling whitefly, *Aleurodicus rugioperculatus* in India. *J. Agrometeorol.* 24(3): 269–275.
- Selvaraj K, Sumalatha BV, Kandan A, Rupa K, Swathi HD, Chaitra M, Ramanujam B. 2022. Entomopathogenic fungus *Isaria fumosorosea*: a potential alternative biocontrol agent for the management of invasive whiteflies in coconut. *Indian Coconut Journal.* July, 15–20.
- Selvaraj K, Sumalatha BV, Rupa K, Kandan A. 2022. *Isaria fumosorosea*: a potential biocontrol agent for rugose spiralling whitefly on coconut. *Indian Coconut Journal.* February, 25–27.
- Selvaraj K, Sumalatha BV, Swathi HD, Sundararaj R. 2022. Recent exotic invasive whiteflies succession in coconut. *Indian Coconut Journal.* January, 13–17.
- Shashank P, Naveena NL, Rajgopal NN, Elliott TA, Sreedevi K, Rathod S, Meshram NM. 2022. DNA barcoding of insects from India: current status and future perspectives. *Mol Biol Rep.* 49: 10617–10626.
- Shivakumara KT, Keerthi MC, Polaiiah AC, Gupta A, Joshi S. 2022. Incidence of invasive mealybugs, *Phenacoccus solenopsis* Tinsley and *Paracoccus marginatus* Williams & Granara de Willink (Hemiptera: Pseudococcidae) on *Gymnema sylvestre* (R. Br) and its natural enemies in the semi-arid region of India. *Int J Pest Manag.* DOI: 10.1080/09670874.2022.2088880.
- Shivakumara KT, Keerthi MC, Polaiiah AC, Thondaiman V, Manivel P, Roy S. 2022. Seasonal abundance of oleander aphid, *Aphis nerii* Boyer de Fonscolombe and its predator on *Gymnema sylvestre* (R. Br) in relation to weather parameters from India. *Int J Trop Insect Sci.* 42: 1925–1932.
- Shivakumara KT, Keerthi MC, Polaiiah AC. 2022. Efficacy of different biorational insecticides against *Aphis nerii* Boyer de Fonscolombe (Hemiptera. Aphididae) on *Gymnema sylvestre* (R. Br) under laboratory and field conditions. *J Appl Res Med Aromat Plants.* 28: 100358.
- Singh A, Saha T, Chandran N, Rachana RR, Santosh K. 2022. Influence of prevailing weather conditions on incidence of thrips on different solanaceous vegetables cultivation. *J Agromet.* 24(1): 86–89.
- Singh HS, Baradevanal G, Beer D. 2022. Evaluation of insecticides and suitable trap containers for effective fruit fly catches. *Indian J Entomol.* DOI: 10.55446/IJE.2021.379.
- Singh K, Aggarwal R, Verma PK, Verma S, Sharma S, Manjunatha C, Choudhary M, Deepika K, Rawat K. 2022. Functional analysis of SCD1 gene involved in pathogenicity of spot blotch disease of wheat causing fungus *Bipolaris sorokiniana*. *Indian Phytopathol.* 75(1): 57–66.
- Singh S, Sreedevi K, Sandhu RK, Sharma RK, Siraj M. 2022. Occurrence of cerambycid borer, *Bandara pascoei* (Lansberge) in Punjab. *Indian J Entomol.* DOI: 10.55446/IJE.2022.588.
- Sivakumar G, Mohan M, Subaharan K, Venkatesan T, Yelshetti S, Kannan M, Anandham R, Yendigiri MS, Kumari S, Elango K, Kumar PR. 2022. Gut bacteria mediated insecticide resistance in cotton leafhopper *Amrasca biguttula biguttula*. *Curr Sci.* 122(8): 958–964.

- Sivasamy M, Paramasivan J, Kumaran VV, Bharadwaj SC, Manjunatha C, Nisha R, Paneer S, Sindhu A, Sivasamy S, Peter J. 2022. Effectiveness of *Thinopyrum ponticum* derived wheat leaf rust resistance gene, Lr24 in India - a revisit. *J Cereal Res.* 14: 129–138.
- Solanki MK, Solanki AC, Rai S, Srivastava S, Kashyap BK, Divvela PK, Kumar S, Yandigeri MS, Kashyap PL, Shrivastava AK, Ali B, Khan S, Jaremko M, Qureshi KA. 2022. Functional interplay between antagonistic bacteria and *Rhizoctonia solani* in the tomato plant rhizosphere. *Front Microbiol.* 13: 990850.
- Soujanya PL, Sekhar JC, Yathish KR, Karjagi CG, Rao KS, Suby SB, Jat SL, Kumar B, Kumar K, Vadessery J, Subaharan K, Patil J, Kalia VK, Dhandapani A, Rakshit S. 2022. Leaf damage based phenotyping technique and its validation against fall armyworm, *Spodoptera frugiperda* (J.E. Smith), in Maize. *Front Plant Sci.* 13: 906207.
- Sreedevi K, Correya J, Nagesh M. 2022. Diversity of scarab fauna (Coleoptera: Scarabaeidae) - importance and implications. *Indian J Plant Genet Resour.* 35(3): 72–75.
- Sreerama Kumar P, Sreedevi K, Amala U, Gupta A, Verghese A. 2022. Shipment of insects and related arthropods into and out of India for research or commercial purposes. *Rev Sci Tech - Off Int Epizoot.* 41(1): 158–164.
- Srujana S, Bhagat D. 2022. Chemical synthesis of chitosan (CS) sodium alginate (ALG) nanoparticles. *Nanotechnol Environ Eng.* 7: 289–296.
- Srujana S, Bhagat D. 2022. Chemical-based synthesis of ZnO nanoparticles and their applications in agriculture. *Nanotechnol Environ Eng.* 7: 269–275.
- Srujana S, Bhagat D. 2022. Sensors for agricultural pest management using nanotechnology/nanomaterials. *Nanotechnol Environ Eng.* 7: 319–323.
- Subaharan K, Senthamarai Selvan P, Subramanya TM, Senthoorraja R, Manjunath S, Das T, Pragadheesh VS, Bakthavatsalam N, Mohan M, Senthil-Nathan S, Urageyala S, Samuel PP, Govindarajan R, Eswaramoorthy M. 2022. Ultrasound-assisted nanoemulsion of *Trachyspermum ammi* essential oil and its constituent thymol on toxicity and biochemical aspect of *Aedes aegypti*. *Environ Sci Pollut Res.* 29: 71326–71337.
- Sundaravalli K, Varshney R, Kandan A, Revathi K. 2022. Effect of the entomopathogenic fungus, *Lecanicillium lecanii*, on the biology and predation rate of the anthocorid predatory bug, *Blaptostethus pallenscens*, feeding on the flower thrips, *Frankliniella schultzei* Trybom (Thysanoptera: Thripidae). *Egypt J Biol Pest Control.* 32(1): 142–148.
- Sushil SN, Sampathkumar M, Mohan M, Nagaraju DK, Singh JP. 2022. Recent events of invasive and migratory pests and lessons learnt. *J Entomol.* 84: 108–120.
- Sushil SN, Stanley J, Mohan M, Selvakumar G, Rai D, Rahman A, Ramkewal, Pandey S, Bhatt JC, Gupta HS. 2022. Management of white grubs through a novel technology in Uttarakhand hills of North-West Himalayas. *J Eco-friendly Agric.* 17: 81–87.
- Thokchom S, Gupta A, Akoijam R, Devesh A. 2022. Parasites of *Leucinodes orbonalis* Guenee from Manipur. *Indian J Entomol.* DOI: 10.55446/IJE.2022.524.
- Vanitha K, Gupta A, Venkatesan T, Arati P, Ashika TR. 2022. Biological notes on nesting biology, development and natural enemies of *Braunsapis mixta*, a pollinator of cashew. *J Apic Res.* DOI: 10.1080/00218839.2022.2028965.
- Varshney R, Budhlakoti N. 2022. Biology and functional response of the predator, *Dortus primarius* (Distant) (Hemiptera: Miridae) preying on *Frankliniella schultzei* (Trybom) (Thysanoptera: Thripidae). *Egypt J Biol Pest Control.* 32:1–7.

Varshney R, Budhlakoti N. 2022. Development and fertility parameters of a predatory bug, *Dortus primarius* Distant (Miridae: Deraeocorinae) at different temperatures. *Int J Trop Insect Sci.* 42: 1769–1775.

Varshney R, Ramya RS, Omprakash N. 2022. Insect invasive species: threat posed and collaborative efforts for management. *Indian J Plant Genet Resour.* 35(3): 386–388.

Veenakumari K, Popovici OA, Sreedevi K, Prashanth M, Polaszek S. 2022. Review of the genus *Calotelea* Westwood, 1837 (Platygastroidea: Scelionidae) of India. *Syst Parasitol.* 19: 141–201.

Veenakumari K, Rajamohana K, Sreedevi K, Girish Kumar P, Mohanraj P. 2022. Replacement name for the homonym of subgenus *Trimorus* (*Neotrimorus*) (Hymenoptera: Platygastroidea: Scelionidae) with description of two new species from India. *J Nat Hist.* 56(41-44): 1709–1725.

Veenakumari K, Sreedevi K, Mohanraj P. 2022. Additions to the genus *Chakra* Rajmohana and Veenakumari, 2014 (Hymenoptera: Platygastroidea: Scelionidae) from India. *J Nat Hist.* 56(41-44): 1657–1707.

Yandigeri MS, Mahendiran G, Mohan M, Sampath Kumar M. 2022. Evaluation of different substrates for multiplication and waste reduction potential of black soldier fly, *Hermetia illucens* (Stratiomyidae: Diptera). *J Entomol Res.* 46(1): 40–46.

Books/book chapters

Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. 2022. Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward. Society for Biocontrol Advancement, Bengaluru.

Amala U, Shivalingaswamy TM. 2022. Insect Pollinator diversity, pollinator service and pollination crisis, pp. 88–94. In: Maria Packiam SJ, Soundararajan V, editors. Biodiversity and Conservation. Elite Publishing, New Delhi.

Archak S, Agarwal A, Saxena AK, Lal KK, Mishra BP, Nagesh M. 2022. Special Issue on Genetic Resources Management: Road Ahead. *Indian J Plant Genet Resour.* 35(3): 2020.

Bakthavatsalam N, Subaharan K. 2022. Promotion of entrepreneurship in production of semiochemicals for pest management. In: Haldhar SM, Sharma PT, Sarangthem I, Singh B, editors. Entrepreneurship Opportunities in Agriculture, Bhavya Books Ltd.

Ballal CR, Amala U. 2022. 'Accounting for' and 'Saving' the ecosystem services provided by insects, pp. 61–77. In: Remadevi OP, Vinaya Kumar KH, Singh RK, editors. Biodiversity, Ecosystem Services and Climate Change.

- Ballal CR, Sreedevi K, Salini S, Gupta A, Amala U, Varshney R. 2022. Biodiversity of agriculturally important insects: status, issues, and challenges, pp. 243–283. In: Kaur S, Batish R, Singh HP, Kohli R, editors. Biodiversity in India: Status, Issues and Challenges. Springer Publications, Singapore.
- David KJ, Salini S. 2022. Structural and functional diversity of fruit flies (Diptera: Tephritidae). In: Maria Packiam SJ, Soundararajan V, editors. Biodiversity and Conservation. Elite Publishing, New Delhi.
- Gracy RG, Mani M, Swathy RS, Venkatesan T, Mohan M. 2022. Biotechnological approaches in pest management in horticulture ecosystem. In: Mani M, editor. Trends in Horticultural Entomology. Springer Nature Publishers.
- Gracy RG, Srinivasamurthy K, Venkatesan T, Mohan M. 2022. Diversity and function of insect endosymbionts. In: Maria Packiam SJ, Soundararajan V, editors. Biodiversity and Conservation. Elite Publishing, New Delhi.
- Gundappa B, Mani M. 2022. Pests and their management in Guava. In: Mani M, editor. Trends in Horticultural Entomology. Springer, Singapore.
- Haldhar SM, Gupta A, Gora JS, Mani M. 2022. Pests and their management in other arid zone fruit crops (Bael, Phalsa, Ker, Lasora, Pilu, and Karonda), pp. 847–861. In: Mani M, editor. Trends in Horticultural Entomology. Springer, Singapore.
- Johnson T, Shyam M, Varatharajan R, Rachana RR. 2022. A Manual on the Collection, Identification and Biology of Thrips (Insecta: Thysanoptera), Manipur Biodiversity Board.
- Joshi S, Ballal CR. 2022. Aphids and coccids: major pests and their management. In: Maria Packiam SJ, Soundararajan V, editors. Biodiversity and Conservation. Elite Publishing, New Delhi.
- Subaharan K, Verghese A, Mohanraj P, Amala U, Sreerama Kumar P, Sushil SN. 2022. Arthropods of Veterinary and Fisheries Sectors. ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, India, v + 140 pp. ISBN 978-81-927161-6-9.
- Subaharan K, Venkatesan T, Kandan A, Ashika TR, Sushil SN. 2022. Technologies Ready for Agribusiness. Technical Bulletin No. 43 (Revised). ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, India.
- Mahendiran G, Vijaylaxmi R, Omprakash N, Veeresh Kumar. 2022. Insect taxonomy and its role in integrated pest management. pp. 107–122. In: Banik S, Halder J, editors. Plant Protection: Present Developments and Future Strategies, Today and Tomorrow's Printers and Publishers, New Delhi.
- Manjunatha TG, Patil J, Sellaperumal C, Halder J. 2022. Role of entomopathogenic nematodes in plant protection, In: Banik S, Halder J, editors. Plant Protection: Present Developments and Future Strategies.
- Mohan M, Sampath Kumar M, Joshi S, Gupta A, Shylesha AN. 2022. Classical Biological Control of Cassava Mealybug in India. First Edition. ICAR–National Bureau of Agricultural Insect Resources, Bengaluru.
- Omprakash N, Varshney R, Lalitha Y. 2022. Entrepreneurship development through mass production of parasitoids, pp. 179–189. In: Haldhar SM, Sharma PT, Sarangthem I, Singh B, editors. Entrepreneurship Opportunities in Agriculture, Bhavya Books Ltd.
- Raghavendra KV, Subash S, Omprakash N, Rao GK, Gowthami R, Sharma S. 2022. Genetic and molecular approaches for management of potato viral diseases and their vectors, pp. 361–387. In: Chakravarthy AK, editor. Genetic Methods and Tools for Managing Crop Pests, Springer, Singapore.
- Salini S, David KJ. 2022. True bugs (Hemiptera: Heteroptera) of veterinary and public health importance with emphasis on haematophagous species. In: Subaharan K, Verghese A, Mohanraj P, Amala U, Sreerama Kumar P, Sushil SN, editors. Arthropods of Veterinary and Fisheries Sectors. ICAR–National Bureau of Agricultural Insect Resources, Bengaluru.

Sanjay MB, Sivakumar G. 2022. Baculovirus for the management of insect pest, pp.148–170. In: Maria Packiam SJ, Soundararajan V, editors. Biodiversity and Conservation. Elite Publishing, New Delhi.

Shivakumara KT, Roy S, Meena RP. 2022. Integrated pest management in medicinal and aromatic plants-based cropping system. In: Singh DP, editor. Insect Pest Management in Diverse Cropping Systems. Apple Academic Press, Burlington, Canada.

Sreedevi K, Sree Chandana P, Correya JC, Shashank PR, Singh S, Veenakumari K. 2022. Economically important wood feeding insects: their diversity, damage and diagnostics. In: Sundararaju D, editor. Science of Wood Degradation and its Protection. Springer Publications, Singapore.

Subaharan K, Sowmya M. 2022. Role of semiochemicals in storage pest management. In: Recent Innovation in Stored Product Protection for Food and National Security: A Gateway of Green Agriculture Technology.

Sudhakar S, Sivakumar G, Marimuthu R, Paul PK. 2022. Handbook on Plant Protection and Pesticide Management. Skyfox Publishing Group, New Haven, United states.

Varshney R, Omprakash N, Jalali SK. 2022. Reproductive strategies in parasitoids, pp. 283–305. In: Omkar and Mishra, editors. Reproductive Strategies in Insects, CRC Press.

Venkatesan T, Chethan. 2022. Insect pests and its management in horticultural crops. In: Mani M, editor. Trends in Horticultural Entomology. Springer, Singapore.

Venkatesan T, Gracy RG. 2022. DNA barcoding and its application in the identification of insects. In: Maria Packiam SJ, Soundararajan V, editors. Biodiversity and Conservation. Elite Publishing, New Delhi.

Technical bulletins/folders/training manuals/ popular articles

David KJ, Sachin K, Hancock DL, Salini S. 2022. Mating trophallaxis in *Diarrhagma modestum* (Fabricius) (Diptera: Tephritidae: Phytalmiinae). Indian Entomologist. 3(1): 27–28.

Gupta A, Pattar R, Sampath Kumar M, Selvaraj K, Shylesha AN, Sushil SN. 2022. A pictorial guide for the identification of parasitoids attacking recent invasive insect pests. ICAR–NBAIR Publication No. 11/2022, ICAR–NBAIR, Bengaluru.

Joshi S, Sampath Kumar M, Mohan M, Shylesha AN. 2022. A pictorial guide for the identification of mealybug infesting cassava. Technical Folder No. 9, ICAR–NBAIR, Bengaluru.

Manimaran B, Berliner J, Nanjundan J, Ramya RS, Mhatre PH, Tadigiri S, Dhandapani M. 2022. Current status of malnutrition- causes and their remedies. Just Agriculture, 2(8): 2582–8223.

Pratheepa M, Subaharan K, Varshney R, Gotyal BS, Navik O, Venkatesan T, Patel NM, Shanmugam PS, Visalakshi M. ICT based mobile app BIPM on Tuta absoluta, Extension Folder No. 13/2022. ICAR–NBAIR, Bengaluru.

Rachana RR, Amarendra B. 2022. Training manual on “Classical Taxonomy of Thysanoptera”. Document No. 5/2022. ICAR–NBAIR, Bengaluru, 26 pp.

Rachana RR, Joshi S, Amarendra B, Chinnu VS. 2022. A pictorial guide for the identification of thrips infesting important crops. Technical Folder No. 08/2022. ICAR–NBAIR, Bengaluru.

Rachana RR, Raghavendra KV, Joshi S, Chander S, Dubey SC, Prakash R. 2022. Invasive chilli thrips: general guidelines for management. Technical Folder No. 02/2022. ICAR–NBAIR, Bengaluru.

Rachana RR, Ramya RS, 2022. Diagnostic characters of thrips infesting agricultural crops. Kerala Karshakan. 9(7): 37–42.

Rachana RR. 2022. Training manual on “Identification of different thrips species on Marigold”. Document No. 1/2022. ICAR–NBAIR, Bengaluru, 26 pp.

Ramya RS, Rachana RR, Manimaran B, Ranjith M, Shivakumara KT, Gotyal BS. 2022. Genome editing: the new buzz word in the fight against insect pests. Kerala Karshakan. 10(1): 28–35.

Sampathkumar M, Mohan M, Shylesha AN, Joshi S, Gupta A, Saravanan PA, Venkatachalam SR. 2022. Mass production and release technique of *Anagyrus lopezi* wasp for classical biological control of invasive cassava mealybug in cassava (tapioca) plantations. ICAR–NBAIR Publication No. 03/2022, ICAR–NBAIR, Bengaluru.

Sampathkumar M, Mohan M, Shylesha AN, Joshi S, Gupta A, Saravanan PA, Kavitha PS, Venkatachalam SR. 2022. Mass production and release technique of *Anagyrus lopezi* wasp for classical biological control of invasive cassava mealybug in cassava (tapioca) plantations (Folder in Tamil). ICAR–NBAIR Publication No. 04/2022, ICAR–NBAIR, Bengaluru.

Sampathkumar M, Sreerama Kumar P, Shylesha AN. 2022. ICAR–NBAIR joins hands with international experts to manage the parthenium weed menace in India. IOBC Global Newsletter. 110: 19–20.

Selvaraj K, Sumalatha BV, Kandan A, Kundu R, Gotyal BS, Sampath Kumar M. 2022. Training Manual on “Mass Production of Biocontrol Agents for Suppression of Invasive Whiteflies”. Document No. 12/2022. ICAR–NBAIR, Bengaluru, 52p.

Shivakumara KT, Ramya RS, Venkatesan T, Manjunatha C, Gotyal BS. 2022. Beekeeping: a status and importance in India. Food and Scientific Reports, 3(7): 55–58.

Subaharan K, Venkatesan T, Kandan A, Ashika TR, Sushil SN. 2022. Technologies ready for agribusiness. Technical Bulletin No. 43, ICAR–NBAIR, Bengaluru.

Verma OP, Siddiqui A, Nagaraju DK, Banchhor G, Sridhar V, Rachana RR, Raghavendra KV, Vijayalakshmi K, Sireesha K. 2022. Monitoring, diagnosis and management of South East Asian thrips, *Thrips parvispinus* in chilli. Directorate of Plant Protection Quarantine & Storage Welfare, Faridabad.

Verma OP, Siddiqui A, Nagaraju DK, Goswami MP, Dubey SC, Rachana RR, Raghavendra KV, Rajashekar P, Vijayalakshmi K. 2022. Management strategies for invasive thrips (*Thrips parvispinus*) in chilli (ad-hoc). Technical Booklet- IPM-01/2022. Directorate of Plant Protection Quarantine & Storage Welfare, Faridabad.

Reports

Patil J, Sivakumar G, Ramanujam B, Amala U, Selvaraj K, Sampath Kumar M, Varshney R, Ballal CR, Bakthavatsalam N. (eds). AICRP–BC Technical Programme 2020-21 and 2021-22, 97 pp.

Sivakumar G, Venkatesan T, Subaharan K, Mahendiran G, Varshney R, Omprakash N, Selvaraj K, Amala U, Sampath Kumar M, Patil J, Kandan A, Ram Kumar P, Nagesh M, Sushil SN. (eds). 2022. AICRP–BC Annual Progress Report 2021–22, ICAR–NBAIR, Bengaluru, 273 pp.

Subaharan K, Amala U, Rachana RR, Ramya RS, Bhagat D, Sreedevi K, Gupta A, Mahendiran G, Nagesh M. (eds) 2022. Annual Report 2021, English version, ICAR–NBAIR, Bengaluru, vi + 120 pp.

Newsletters

Sreerama Kumar P. (ed.) 2022. Society for Invertebrate Pathology Newsletter, 55(1), February 2022, 22 pp.

Sreerama Kumar P. (ed.) 2022. Society for Invertebrate Pathology Newsletter, 55(2), June 2022, 17 pp.

Sreerama Kumar P. (ed.) 2022. Society for Invertebrate Pathology Newsletter, 55(3), November 2022, 25 pp.

Subaharan K, Amala U, Ramya RS, Rachana RR, Nagesh M. (eds) 2022. NBAIR Newsletter, XIV(1), March 2022, 8 pp.

Subaharan K, Amala U, Ramya RS, Rachana RR, Nagesh M. (eds) 2022. NBAIR Newsletter, XIV(2), June 2022, 8 pp.

Taxonomic databases

David KJ, Salini S, Sachin K. 2022. True fruit flies of India. World Wide Web electronic publication. I C A R – N B A I R , I n d i a . https://databases.nbair.res.in/fruit_flies.

Salini S, David KJ, Akoijam R. 2022. Pentatomidae fauna of India. World Wide Web electronic publication. I C A R – N B A I R , I n d i a . https://databases.nbair.res.in/Pentatomidae_new/index.php.

Mobile Apps

Pratheepa M, Subaharan K, Varshney R. Mobile based app for non-chemical pest management of tomato pinworm, *Tuta absoluta*.

Video Documentaries

Sampathkumar M, Shylesha AN, Mohan M, Gupta A, Joshi S. 2022. *Anagyrus lopezi* parasitizing cassava mealybug. ICAR-NBAIR video documentary: 01/2022: 0.45 minutes.

Sampathkumar M, Shylesha AN, Mohan M, Gupta A, Joshi S. 2022. Documentary on classical biological control of cassava mealybug in India. ICAR-NBAIR video documentary: 02/2022: 2.44 minutes.

11. TECHNOLOGIES, PRODUCTS AND PATENTS

Technology Developed

A novel *Bacillus albus* strain NBAIR-BATP with excellent insecticidal, antagonistic and growth promotion properties for the management of pests and diseases

A novel *Bacillus albus* NBAIR-BATP strain was developed into a talc-based formulation and standardised dose for the management of fall armyworm (*Spodoptera frugiperda*), tomato pinworm (*Tuta absoluta*), Thrips species and *Fusarium* wilt of cucumber under field conditions. Results of field trials indicated more than 80-85 per cent reduction in damage caused by fall armyworm on maize during 2018-19 and 2019-2020.



B. albus strain



Bacillus albus NBAIR-BATP treated maize plants and harvested maize (inside image)

Technologies commercialized

- A volatile attractant for trapping uzi fly, *Exorista bombycis*, parasitoid pest on mulberry silkworm *Bombyx mori* based on pheromonal compounds.
- Waste to wealth: Technology on black soldier fly mediated bioconversion of farm and kitchen wastes.
- Novel insecticidal WP formulations of *Heterorhabditis indica* for the biological control of white grubs and other soil insect pests.

S. No	Technology/ Innovation	Inventors	Date
1.	Insect Taxonomy Website Creation Software Tool (InsTax Website Tool)	Dr. M. Pratheepa et. al.	22.09.2022
2.	Mobile Application Development- BIPM ON FAW – NE (IND)	Dr. M. Pratheepa et. al.	22.09.2022

Number of licensees

S. No.	Name of Institute	Name of Technology/ Know-How	Name of Contracting Party	Mode of Partnership**	Date	Revenue Earned (₹)
1.	ICAR-NBAIR	Novel insecticidal WP formulations of <i>Heterorhabditis indica</i> for the biological control of white grubs and other soil insect pests.	Zytex Biotech private limited, Mumbai, Maharashtra	MoU	03-02-2022	2,00,000
2.	ICAR-NBAIR	A volatile attractant for trapping uzi fly, <i>Exorista bombycis</i> , parasitoid pest on mulberry silkworm <i>Bombyx mori</i> based on pheromonal compounds and bisexual attractant.	JENU Associates, Belagavi	MoU	18-06-2022	3,00,000
3.	ICAR-NBAIR	Novel insecticidal WP formulations of <i>Heterorhabditis indica</i> for the biological control of white grubs and other soil insect pests	Tejparas Agro LLP, Jalgaon, Maharashtra	MoU	20-07-2022	2,00,000
4.	ICAR-NBAIR	Novel insecticidal WP formulations of <i>Heterorhabditis indica</i> for the biological control of white grubs and other soil insect pests	Silver leaf Organics, Bharuch, Gujarat	MoU	03-08-2022	2,00,000
5.	ICAR-NBAIR	Novel insecticidal WP formulations of <i>Heterorhabditis indica</i> for the biological control of white grubs and other soil insect pests	Greenkare Agro (OPC) Pvt. Ltd., Pune, Maharashtra	MoU	09-11-2022	2,00,000
6.	ICAR-NBAIR	Waste to wealth: Technology on Black Soldier Fly mediated bioconversion of farm and kitchen wastes	ABAD Group of Companies, Krishnarajapura, Bengaluru, Karnataka	MoU	09-11-2022	75,000

ICAR-NBAIR Industry Interface Meet

ICAR-NBAIR organised Industry Interface meet at Yelahanka campus on 25 March 2022. Dr K. Srinivas, Assistant Director General (ADG) (IP&TM) and Dr Sudha Mysore, CEO, Agrinnovate attended the meeting as Chief guests. Dr K. Srinivas, ADG (IP&TM) released the ICAR-NBAIR Technology catalogue and briefed on the benefits of biological control technologies in the present era of organic farming. He also suggested wide circulation of technologies in social media for wide publicity. Dr Sudha Mysore, CEO, Agrinnovate briefed about the activities of Agrinnovate and its benefits to scientific organizations and stakeholders. Dr A. Kandan, Principal Scientist & ITMU In Charge made a brief presentation on the technologies developed by the Bureau that are ready for commercialization.



NBAIR Industry Interface meeting

Dr K.L. Gurjar, Joint Director (Plant Protection), Central Insecticide Board and Registration Committee (CIB & RC), Faridabad gave a lecture on guidelines for CIB&RC registration of biopesticides through online mode to the participants. An exhibition of the technologies/ products developed by the Bureau was also organized. After the inaugural session, one-to-one interaction between the technology innovators and private entrepreneurs was held. Around 89 participants, including 20 private companies participated in the programme.

Revenue generated during 2022

The total revenue generated was ₹ 26,78,212/- through following activities.

Details	Revenue generated (₹)
Commercialisation of technologies	11,75,000
Sale of macrobials	4,83,152
Sale of microbials	9,20,690
Insect identification services	88,750
Training	10,620
Contract research	0
Sale of publications	0
Total	26,78,212

12. CONFERENCE PAPERS

Amala U, Shivalingaswamy TM. 2022. Colony establishment and resource foraging behaviour of pearl banded bee, *Hoplonomia westwoodi* (Nomiinae: Halictidae), p. 25. In: *Book of Abstracts, Asia-Pacific Conference on Beekeeping for Sustainable Agriculture, Ecosystem Services and Rural Livelihoods*, Bengaluru, India, 18–19 May 2022.

Amala U, Shivalingaswamy TM. 2022. Potter wasp keeps the lepidopteran insects at bay. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Ankitha KS, Girisha HC, Manjunatha C, Rangeshwaran R, Kandan A, Prasannakumar MK, Pramesh D, Ruqiya S, Nanditha S, Biplab D. 2022. Whole genome sequencing of antagonistic *Bacillus subtilis* strain NBAIR BSWG1 insights role of lipopeptide genes. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Ashika TR, Pattar SK, Iyappan G, Subaharan K, Venkatesan T, Kandan A. 2022. An industrial perspectives of bio-control agents: registration, protection (IP) and commercialization. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G,

Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Ashwitha G, Nayyar N, Venkatesan T, Agrawal A. 2022. Characterization of the insecticidal potential of *Spodoptera litura* NPV miRNA through its host interactions, p. 81. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Bhagat D, Sivakumar G. 2022. Chemical sensors for quality testing of biopesticides: screening of agricultural crops and commercial formulations. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Bhagat D. 2022. Sensors for biopesticides. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Chandramanu KGR, Amala U, Joshi S, Shivalingaswamy TM. 2021. *Hyperomyzus carduellinus* (Theobald) - a potential alternate aphid host for mass culturing of aphidophagous syrphid, *Ischiodon scutellaris* (Fabricius). In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.

Correya JC, Sreedevi K. 2022. Species diversity of white grub fauna (Coleoptera: Scarabaeidae) in Wayanad and Palakkad districts, Kerala, India. In: *Book of Abstracts, International Conference on Emerging Trends in Insect Science-2022 (ICETIS-2022)*, Loyola college, Chennai, Tamil Nadu, India, 07-08 April 2022.

David KJ, Sachin K, Salini S. 2022. Larval taxonomy of weed infesting fruit flies (Diptera: Tephritidae) of India. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.

Dey D, Gupta A. 2022. Status of Indian insect diversity and their role in control of invasive pests, pp. 2-3. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests*

and Diseases in Agriculture: Challenges and Way Forward, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.

Gotyal BS, Satpathy S, Ramesh BV. 2022. Host plant resistance against insect pests of jute: status and perspective. In: Rath LK, Sundaray JK, Shrivastava SK, Jayashree P. (eds) *Book of Abstracts, AZRA 2022 XVIII International Conference on Advances in Applied Zoological Researches towards Food, Feed and Nutritional Security and Safer Environment*, Bhubaneswar, Odisha, India, 10-12 November 2022.

Gotyal BS, Satpathy S, Ramesh BV. 2022. Identification of sources and mechanism of resistance against insect pest complex of jute. In: *Book of Abstracts, International Conference on Advances in Agriculture and Food System towards Sustainable Development Goals*, University of Agricultural Sciences, Bengaluru, India, 22-24 August 2022.

Gracy RG, Nagarjuna KT, Agrawal A, Venkatesan T. 2022. Biology and gene alternation studies of pink mealybug *Maconellicoccus hirsutus* (Green) against gibberellic acid, a commonly used agrochemical in grape. In: *Book of Abstracts, Joint Annual Meet of Entomological Societies of America, Canada and British Columbia*, Vancouver, Canada, 13-16 November 2022.

Gracy RG, Venkatesan T. 2022. Development of novel molecules through bioinformatics approaches for the eco-friendly pest management strategy. In: *Book of Abstracts, International Conference on Advances in Agriculture and Food System towards Sustainable Development Goals*, University of Agricultural Sciences, Bengaluru, India, 22-24 August 2022.

Gundappa B, Singh HS, Chander S. 2022. Predicting pest-prone zones for quarantine pests of mango. In: *Book of Abstracts, National Conference on Biotic Stress Management Strategies For Achieving Sustainable Climate Resilience*, New Delhi, India, 19-21 May 2022.

Gundappa B, Singh HS, Shukla PK. 2022. Field efficacy of microbials for mango thrips. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.

Gundappa B, Singh HS. 2022. Emerging threat of mango thrips in northern plains. In: *Book of Abstracts, National Seminar on Fruit production in Eastern Tropical Region of India: Challenges and Opportunities*, Bhubaneswar, India, 24-26 March 2022.

Gupta A, Pattar R. 2022. Review of rare braconid parasitoids (Hymenoptera: Braconidae) with extended host range and geographical distribution in India, p. 10. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.

Hussain B, Kishore G, Yousuf W, Sivakumar G, Venkatesan T, David KJ, Sushil SN. 2022. Incursion of new invasive insect pests on apple and selective toxicity of different insecticides on egg parasitoids. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way*

Forward, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.

Jenifer JS, Venkatesan T, Gracy RG, Subhi S, Amala U, Vijayakumar KT. 2022. Molecular characterization of gut microflora isolated from honeybee (*Apis mellifera*), p. 79. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.

Jhansilakshmi K, Helen MS, Sreerama Kumar P, Babulal. 2022. Important factors affecting severity of broad mite [*Polyphagotarsonemus latus* (Banks)] infestation in mulberry, p. 106. In: *Book of Abstracts, National Seminar on Climate Smart Sericulture - 2022: Approaches for Sustainable Sericulture*, Central Silk Board, Bengaluru, India, 06-07 October 2022.

Joshi S, Gupta A, Shashank PR. 2022. Natural enemies of some adventive sternorrhynchans from India, p. 13. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.

Kesavan Subaharan. 2022. Smell of food and love: exploiting the olfactory cues for pest management. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil

SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Kment P, Rider DA, Salini S, Schwertner CF, Cassis G. 2022. Towards a revision of *Halyomorpha* (Hemiptera: Heteroptera: Pentatomidae): poorly known relatives of the villain. In: *Book of Abstracts, International Conference, Seventh Quadrennial Meeting of International Heteropterists' Society*, Barcelona, Spain, 04–08 July 2022.

Linga V, Patil J, Subaharan K, Navik O, Sekhar JC. 2022. Temperature and moisture dependent virulence of the entomopathogenic nematodes against *Spodoptera frugiperda* (Lepidoptera: Noctuidae). In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Manjunatha C, Rangeshwaran R, Kandan A, Mohan M, Prasannakumar MK, Pramesh D, Nanditha S, Biplab D. 2022. Decoding molecular mechanism involved in biocontrol potential of *Bacillus thuringiensis* var. *kurstaki* strain NBAIR BtG4 by whole genome sequencing. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Mhatre PH, Ramya MS, Gowsikasree, Divya KL, Patil J. 2022. Compatibility of entomopathogenic nematode, *Steinernema cholasbanense* with agrochemicals used in potato crop. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Mohan M, Sushil SN, Shylesha AN, Venkatesan T, Selvaraj K, Sampathkumar M. 2022. Invasive insects - a raising threat to Indian agriculture, p. 113. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Nagesh M, Arpita G, Savithri HS, Christopher A, Jagadish P, Varshney R, Sindhu M. 2022. Comparative transcriptomics for molecular insights into tritrophism in *Galleria mellonella* larvae infected with entomopathogenic nematodes and their respective bacterial symbionts. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Nayyar N, Ashwitha G, Venkatesan T, Ramya RS, Agrawal A, Dhanyakumar O, Sivakumar G, Mohan M, Gracy RG, Ramkumar P. Molecular changes accompanying the loss in the fertility of fall armyworm, *Spodoptera frugiperda* female moths following infection with sub-lethal dose of baculovirus, p. 68. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.

Omprakash N, Patil J, Varshney R. 2022. Performance and field efficacy of *Trichogramma chilonis* Ishii against invasive fall armyworm *Spodoptera frugiperda* (JE. Smith) infesting sweet corn. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.

Patil J, Linga V, Ramanujam B. 2022. Compatibility and efficacy of entomopathogenic nematodes entomopathogenic fungi combinations against invasive pest *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) in maize. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.

Patil J, Linga V, Subaharan K, Navik O, Sekhar JC. 2022. Biocontrol potential of entomopathogenic nematodes for the sustainable management of *Spodoptera frugiperda* (Lepidoptera: Noctuidae) in maize. In: Book of Abstracts, Online Conference on IPM Strategies for Fall Armyworm (*Spodoptera frugiperda* Smith) Management, Zambia Agricultural Research Institute (ZARI) and the Ministry of Agriculture (Zambia), World Agroforestry (ICRAF), Southern African Development Community (SADC) – Plant Protection Committee, the Food and Agriculture Organisation of the United Nations' (FAO) Sub-regional Office for Southern Africa, 21-23 September 2022.

Pratheepa M, Gracy RG, Ramya RS, Venkatesan T, Jyoti P. 2022. In-silico docking studies of the phosphine resistance gene dihydroliipoamide dehydrogenase of *Tribolium castaneum* (Herbst) based on amino acid substitutions, p. 74. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.

Pratheepa M, Subaharan K, Varshney R, Nagesh M. 2022. Mobile application on BIPM on Tuta, In: *Book of Abstracts, International Conference on Recent Advances in Agricultural, Biological and Applied Sciences Research*, 08-09 August 2022.

Pratheepa M, Subaharan K, Varshney R. 2022. Mobile application in insect pest management especially for the use of biological control methods for coconut, sugarcane and rice crops. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of*

Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Prathibha PS, Jilu VS, Subaharan K, Patil J. 2022. Natural enemy complex associated with palm white grubs *Leucopholis* spp. (Scarabaeidae: Coleoptera)". In: *Book of Abstracts, 1st International Symposium on Coconut IPM 2022*, 22–26 August 2022.

Rachana RR, Amarendra B. 2022. Does India have the pest thrips, *Pseudodendrothrips bhattii* (Kudo)? In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Ramkumar P, Sivakumar G, Dhanyakumar O, Ashwitha G, Venkatesan T, Mohan M, Kannan M. 2022. Optimization of larval stage and time for harvesting *Spodoptera frugiperda* nucleopolyhedrovirus. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Ramesh BV, Gotyal BS, Sivakumar G, Satpathy S. 2022. Role of baculoviruses in integrated pest management of major lepidopteran insect pests infesting jute, *Corchorus olitorius* Linn, p. 137. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K,

Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Ramya RS, Raviprasad TN, Vanitha K, David KJ, Rajashekara H, Shivakumara KT. 2022. First record of *Senometopia quarta* (Baranov) from India along with a new host record, p. 12. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Rupa K, Kandan A, Selvaraj K, Sumalatha BV. 2022. Development of entomopathogenic fungus *Isaria fumosorosea* formulation with longer shelf-life and persistence for management of rugose spiralling whitefly, p. 104. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Ruqiya S, Girisha HC, Manjunatha C, Kandan A, Rangeshwaran R, Prasannakumar MK, Pramesh D, Ankitha KS, Nanditha S, Venu HS, Biplab D. 2022. Biocontrol potential and molecular characterization of lipopeptides producing *Bacillus subtilis* strain BSWG1 against *Sclerotinia sclerotiorum*. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National*

Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Sahu B, Minz KA, Gupta A. 2022. Species diversity, abundance and richness of pollinator bees from different agroclimatic zones of Chhattisgarh, India, p. 18. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Salini S, David KJ. 2022. Taxonomic notes on little known predators of Asopinae (Hemiptera: Heteroptera: Pentatomidae) India. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Salini S, Gracy RG, Roca-Cusachs M, David KJ. 2022. A systematic account of Halyini (Heteroptera: Pentatomidae: Pentatominae) with description of two new species from India. In: *Book of Abstracts, International Conference, Seventh Quadrennial Meeting of International Heteropterists' Society*, Barcelona, Spain, 04–08 July 2022.

Sampathkumar M, Mohan M, Shylesha AN, Joshi S, Gupta A, Venkatesan T. 2022. Classical biological control of cassava mealybug in India: Introduction to release of the host specific parasitoid, *Anagyrus*

lopezi in cassava plantations and way forward, pp. 62–63. In: *Book of Abstracts, International Conference on Emerging Trends in Insect Science–2022 (ICETIS–2022)*, Loyola college, Chennai, Tamil Nadu, India, 07–08 April 2022.

Sampathkumar M., Mohan M, Shylesha AN, Joshi S, Gupta A, Venkatesan T. 2022. Classical biological control of cassava mealybug in India: prospects and way forward, p. 114. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Selvaraj K, Rameshkumar A, Sumalatha BV, Swathi HD. 2022. Fortuitous introduction of an aphelinid parasitoid *Encarsia cubensis* of exotic Neotropical whitefly, *Aleurotrachelus atratus* in India, pp. 16–18. In: *Book of Abstracts, National Symposium on Entomology 2022: Innovation & Entrepreneurship*, 08–10 December 2022.

Selvaraj K, Sumalatha BV, Kandan A, Shylesha AN. 2022. Emerging invasive whiteflies (Hemiptera: Aleyrodidae) on coconut and their management strategies in India. In: *Book of Abstracts, 50th International Cocotech Conference and Exhibition*, Kuala Lumpur Convention Centre, Malaysia, 07–11 November 2022 (virtual).

Selvaraj K, Sumalatha BV, Kandan A, Kundu R, Swathi HD. 2022. Biointensive integrated pest management strategies for the emerging invasive whiteflies on coconut in India. In: *Book of Abstracts, International Symposium on Coconut IPM 2022, Philippine Coconut Authority*, 23–26 August 2022 (virtual).

Selvaraj K, Sumalatha BV, Shylesha AN, Venkatesan T. 2022. Conservation strategies for the potential natural enemies of invasive whiteflies in coconut, p. 50. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan

- M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.
- Selvaraj K, Sumalatha BV, Venkatesan T, Kandan A, Rupa K, Shylesha AN. 2022. Biological control of invasive rugose spiraling whitefly *Aleurodicus rugioperculatus* on coconut and oil palm in India: a success story. In: *Book of Abstracts, International Conference on Emerging Trends in Insect Science-2022 (ICETIS-2022)*, Loyola college, Chennai, Tamil Nadu, India, 07-08 April 2022.
- Selvaraj K, Sundararaj R, Sumalatha BV, Shylesha AN. 2022. Invasive whiteflies (Hemiptera: Aleyrodidae) in to the Indian sub-continent, their origin, hosts, natural enemies and distribution. In: *Book of Abstracts, Webinar on the Rugose Spiralling Whitefly*, IPM Innovation Lab, Virginia Tech, Blacksburg, 24 January 2022 (virtual).
- Selvaraj K, Venkatesan T, Jalali SK, Sumalatha BV, Sundararaj R. 2022. Dynamics in diversity of whiteflies (Hemiptera: Aleyrodidae) and their natural enemies in cotton for the sustainable crop protection.
- Shivakumara KT, Polaiiah AC, Keerthi MC, Gupta A, Joshi S, Ramya RS. 2022. Diversity and abundance of natural enemy populations on two invasive mealybug species *Paracoccus marginatus* and *Phenacoccus solenopsis* in *Gymnema sylvestre*, p. 125. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.
- Singh HS, Gundappa B. 2022. Improved consumer awareness and product branding may accelerate the IPM adoption among the farming community. In: *Book of Abstracts, National Conference on Biotic Stress Management Strategies For Achieving Sustainable Climate Resilience*, New Delhi, India, 19-21 May 2022.
- Singh HS, Gundappa B. 2022. Integrated Pest Management Strategies in Fruit Crops. In: *Book of Abstracts, National Seminar on Integrated Pest Management Strategies in Fruit Crops*, Bhubaneswar, India, 24-26 March 2022.
- Sivakumar G. 2022. Baculoviruses in biological control of crop pests, p. 125. In: Rath LK, Sundaray JK, Shrivastava SK, Jayashree P. (eds) *Book of Abstracts, AZRA 2022 XVIII International Conference on Advances in Applied Zoological Researches towards Food, Feed and Nutritional Security and Safer Environment*, Bhubaneswar, Odisha, India, 10-12 November 2022.
- Sowmya M, Subaharan K, Vinaykumar TM, Soundharya YM, Bindhu OS, Varshney R. 2022. Impact of essential oils and their major constituents on physiology and biochemical aspects of rice moth, *Corcyra cephalonica*. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.
- Sreedevi K, Sreechandana P, Correya JC, Chandel RS, Baloda AS. 2022. Diversity and distribution of predominant species of *Brahmina* Blanchard, 1851 (Coleoptera: Scarabaeidae: Melolonthinae) in India. In: Rath LK, Sundaray JK, Shrivastava SK, Jayashree P. (eds) *Book of Abstracts, AZRA 2022 XVIII International Conference on Advances in Applied Zoological Researches towards Food, Feed and Nutritional Security and Safer Environment*, Bhubaneswar, Odisha, India, 10-12 November 2022.

- Sreerama Kumar, P. 2022. Breaking new ground for biological control in mulberry: *Typhlodromus (Anthoseius) transvaalensis* to counter *Polyphagotarsonemus latus* and *Pseudodendrothrips darci*. In: Abstracts of Papers, 2022 ESA, ESC, and ESBC Joint Annual Meeting: *In-Person & Virtual, Entomological Society of America (ESA), Entomological Society of Canada (ESC) and the Entomological Society of British Columbia (ESBC)*, Vancouver, British Columbia, Canada, 13–16 November 2022.
- Srujana S, Bhagat D. 2022. RGO-ZnO nanocomposite electrochemical sensor for detection of carbofuran and methyl viologen. In: Book of Abstracts, *Bengaluru Tech Summit 2022*, 16–18 November 2022.
- Subaharan K. 2022. Biocontrol and compatible technologies for palm pest management: opportunities and way forward. In: *Book of Abstracts, Third National Conference on Oil Palm- the Way Forward for Increasing Vegetable Oil Pool through Aatma Nirbhar Bharat for Doubling the Income and Providing Social Security to Farmers, Society for promotion of oil Palm Research and Development*, Andhra Pradesh and ICAR-IIOPR, Vijayawada, Andhra Pradesh, India. 23–25 November 2022.
- Subaharan K. 2022. Chemoecological approaches in biointensive pest management. In: *Book of Abstracts, National Webinar on Integrated Pest Management: A paradigm Shift*, ICAR–NCIPM, 27–28 August 2022.
- Subaharan K. 2022. IPM in coconut with special reference to Southern India. In: *Book of Abstracts, Seminar on Advances in IPM strategies for Kerala and Karnataka*, ICAR–NCIPM, 21–23 October 2022.
- Subaharan K. 2022. Smell of food and love: exploiting the olfactory cues for pest management. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.
- Subhi S, Suman TC, Gracy RG, Jyoti P, Venkatesan T. 2022. RNA interference-mediated gene silencing in *Bemisia tabaci* for their management through oral feeding of dsRNA, p. 80. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.
- Sumalatha BV, Selvaraj K, Kandan A, Rupa K. 2022. Non-target effects of *Isaria fumosorosea* against beneficial insects associated in coconut ecosystem, p. 164. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.
- Suman TC, Gracy RG, Jyoti P, Subhi S, Mohan M, Rai A, Venkatesan T. 2022. RNAi-mediated management of jassids (*Amrasca biguttula biguttula*) through oral delivery of dsRNA, p. 75. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Varshney R, Kandan A. 2022. Interaction between the entomopathogenic fungi and larval ectoparasitoid, *Bracon brevicornis* parasitizing fall armyworm. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.*

Varshney R. 2022. Prospects of egg and larval parasitoids for the management of fall armyworm in Maize. In: *Book of Abstracts, 7th International Conference on Opportunities and Challenges in Agriculture, Environmental & Biosciences for Global Development (OCAEBGD-2022)*, 29-31 October 2022.

Varshney R. 2022. Prospects of native predatory bugs for the management of *Tuta absoluta* Meyrick in tomato. In: Rath LK, Sundaray JK, Shrivastava SK, Jayashree P. (eds) *Book of Abstracts, AZRA 2022 XVIII International Conference on Advances in Applied Zoological Researches towards Food, Feed and Nutritional Security and Safer Environment, Bhubaneswar, Odisha, India, 10-12 November 2022.*

Venkatesan T, Gracy RG, Nayyar N. 2022. Genomic approaches for the pest management: an overview of the recent developments, pp. 61-62. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.*

Venkatesan T, Gracy RG, Nayyar N. 2022. Genomic approaches for the pest management: an overview of the recent developments. In: Rath LK, Sundaray JK, Shrivastava SK, Jayashree P. (eds) *Book of Abstracts, AZRA 2022 XVIII International Conference on Advances in Applied Zoological Researches towards Food, Feed and Nutritional Security and Safer Environment, Bhubaneswar, Odisha, India, 10-12 November 2022.*

Venu HS, Shylesha AN, Rangeshwaran R, Manjunatha C, Kandan A, Amala U, Jagadish KS, Eswarappa G, Biplab D, Ruqiya S, Nanditha S. 2022. Bioefficacy and molecular characterization of *Bacillus thuringiensis* strain NBAIR-BtGa against greater waxmoth, *Galleria mellonella* L. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.*

Venugopala KM, Metri R, Venkatesan T. 2022. Molecular diagnosis of important veterinary insect pests through DNA barcodes, p. 76. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control-75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward, Society for Biocontrol Advancement, Bengaluru, India, 15-17 December 2022.*

Vinaykumar TM, Subaharan K, Sowmya M, Senthoorraja R, Senthamarai PS. 2022. Insecticidal activities of essential oils against diamondback moth, *Plutella xylostella*. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N,

Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

Visalakshi M, Patil J, Suresh M, Manishain BL. 2022. Seasonal incidence and ecofriendly management of white grub in sugarcane using entomopathogenic nematode and entomopathogenic fungus in Andhra Pradesh. In: Amala U, Gupta A, David KJ, Gracy RG, Patil J, Kandan A, Mahendiran G, Manjunatha C, Mohan M, Omprakash N, Rachana RR, Ramya RS, Varshney R, Sampath Kumar M, Selvaraj K, Sivakumar G, Sreedevi K, Sreerama Kumar P, Subaharan K, Sushil SN. (eds) *Book of Abstracts, Seventh National Conference on Biological Control–75 years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward*, Society for Biocontrol Advancement, Bengaluru, India, 15–17 December 2022.

13. MEETINGS AND DECISIONS

XXVI Research Advisory Committee Meeting

The XXVI meeting of the Research Advisory Committee (RAC) of the National Bureau of Agricultural Insect Resources was held on 19–20 April 2022 at the Conference Hall located at ICAR–National Bureau of Agricultural Insect Resources, Bengaluru.

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 S. C. Dubey	Member
Dr Sudhir Singh	Member
Mr R. Shivakumar	Member
Dr M. Nagesh	Member
Dr M. Mohan	Member-Secretary

General comments

Dr M. Nagesh, 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, commercialization and revenue generated.

Dr M. Nagesh, 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, commercialization and revenue generated.

1. Speed-up action on the following recommendations made by the 25th RAC. All the recommendations were accepted by the Council and marked to the Director for implementation. The following recommendations were, however, not fully addressed owing to the nature of the activities involved and, hence, the RAC reiterates its earlier recommendations and further recommends for speeding up action on those that were only partially implemented and to submit an action taken report for discussion in its next meeting.

2. Appropriate funding should be assured for all these long-term taxonomic activities for rapid progress in museum related activities.

3. Around 2,500 specimens including types being maintained at ICRISAT, that are identified with the help of the British Museum, should be brought back to ICAR-NBAIR or to be maintained at ICRISAT itself, with a formal collaboration. The modalities should be worked out as per ICAR guidelines.

4. An integrated taxonomic approach should be followed for pest diagnostics of different taxa, immature taxa and invasive pests.

5. Molecular markers should be linked with specific traits. If not, the insect strain differentiation should be purely based on strong bio-ecological studies.

6. A Brainstorming session on invasive pests to be conducted in the near future.

7. The techniques for testing virulence/revival of virulence of microbial insect pathogens should be worked out case by case basis (experiments), and the same should be conveyed to the industries which are buying these technologies.

8. Reporting of new hosts should be substantiated with further studies, whether the insect is completing its lifecycle or its just a host association, damage potential of the pests should be correlated with a reduction in crop yield due to pests. Analyzed data only should be presented instead of general statements / visual observations.

9. Reporting on entry pathways of invasive pests and spatio-temporal distribution of pest species should be evidence-based after conducting relevant experiments rather than hypothetical. In this regard, ICAR-NBPGR and ICAR-NBAIR should collaborate to develop the phytosanitary standard guidelines.

10. Co-existence of different whitefly species should be quantified in terms of proportion/percentage in a spatiotemporal manner by correlating with natural enemies presence, and prevailing weather conditions.

11. Proper experiments on stingless bees and other bees are required to verify the data generated under AICRP on honeybees and pollinators.

12. Scaling up of technologies should be done before commercialization, in this regard collaborate with incubators.

12. Greater emphasis should be placed on biological control of insect pests of orchard and plantation crops, and under protected cultivation.

13. A large number of pheromone formulations are already commercially available for several pests, and hence, there is a need to reconsider the worthiness of in-house synthesis of these compounds and competing with private firms. Further, there are a number of combinations of known pheromone formulations with latest technologies available in the market. How to out-compete them need to be considered by the group working on pheromones at ICAR-NBAIR. A separate interactive session to review the research on pheromone technologies to be conducted with Dr A.R. Prasad and other experts on insect chemo-ecological aspects.

14. Essential oils are not the exact sources for controlling stored grain pests due to their poor stability in the atmosphere. Hence, blending options need to be examined by taking guidance/collaboration from Dr A.R. Prasad, RAC member. Compounds alternative to methyl bromide to be explored for protection of food grains from stored grain pests.

15. Drone technology for applying biopesticides needs to be developed in collaboration with private firms, and an IT person needs to be associated.

16. One slide each on externally funded projects that are relevant to the mandate should be presented.

17. Attractive and proper packages of microbial biopesticides including Bt to be developed for display.

18. Month-wise scientific lectures by each scientist should be initiated.

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. National Insect Museum collection at ICAR-NBAIR should be further strengthened by:

i) Exploring the biodiversity rich areas of the country.

ii) Developing strong network for exchange and sharing of digitised collections with various Institutions/museums across the country.

iii) Services of other taxonomists should be taken for identifying the collections, old or new, available with the Bureau, as it is not possible for any organisation to appoint taxonomists for all the groups of insects.

II. Division of Genomic Resources

Dr T. Venkatesan presented the research achievements of the division.

Recommendations

1. Creation of barcode labels for the specimens should be developed for e-sharing of the specimens across the museums / taxonomists.

III. Division of Germplasm Conservation and Utilisation

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

Recommendations

1. Pheromone formulations should be developed for new pests such as tea mosquito bug and borers of avocado and other borers on trial-and-error basis, where the pheromone system is not known.

2. Collaboration with organizations having strength in organic chemistry, where the insect behavioural studies are combined with synthesis of new molecules / new pests, would be helpful.

3. Improvising and modernising the insect-rearing facilities

4. Quarantine facility is exclusive for insects. The exotic insect facility should meet QA II standards as claimed.

5. Provide quality pictures for databases from all scientists, and display on the webpage on a regular basis.

XLVI Institute Research Council Meeting

The XLVI Institute Research Council Meeting of the ICAR–NBAIR, Bengaluru, was held on 27, 28, 30 July 2022 and 02 August 2022 under the chairmanship of Dr M. Nagesh, Director (A), ICAR-NBAIR along with Subject matter experts Dr N.K. Krishna Kumar, Regional Representative South Central Asia, Bioversity, Dr Abraham Verghese, Former Director, ICAR-NBAIR and Dr Prashanth Mohanraj, Former Director, ICAR-NBAIR.

General comments

1. Supportive molecular data along with morphological descriptions of taxa wherever possible.

2. Tailor made training programme on the identification of each taxa, especially Mealybugs, Scales and natural enemies to be undertaken.

3. Short video clips on insect activities need to be hosted in NBAIR website.

4. Taxonomic work on additional groups may be initiated.

5. Work to be initiated in collaboration with ICAR-NBPGR, on invasive pest entry pathway.

6. Division can organize a brainstorming session along with an identified expert panel from ICAR-NBPGR, ICAR-NBFGR and DPPQ staff.

7. Quarantine facility to be maintained exclusively for Insects as per RAC representations. The work on microbials to be shifted out of quarantine facility, and the proper place for the microbials work shall be decided by the respective HODs.

8. A meaningful end to be given to the importation permit issued for whitefly parasitoid from Hawaii by HoD and Dr K. Selvaraj.

9. Brainstorming session to be conducted on Insect Genomics.



XXVI RAC Meeting in progress

14. PARTICIPATION OF SCIENTISTS IN MEETINGS

Abroad (Virtual & Physical)

Dr P. Sreerama Kumar	“2022 ESA, ESC, and ESBC Joint Annual Meeting: In-Person & Virtual”, organized by the Entomological Society of America (ESA), Entomological Society of Canada (ESC) and the Entomological Society of British Columbia (ESBC), Vancouver, British Columbia, Canada, 13–16 November 2022.
Dr R. Gandhi Gracy	“Joint Annual Meet of Entomological Societies of America, Canada and British Columbia”, Vancouver, Canada, 13–16 November 2022.
Dr S. Salini	“Seventh Quadrennial Meeting of International Heteropterists’ Society”, Barcelona, Spain, 4–8 July 2022.

India

Dr T. Venkatesan	<p>Attended a meeting on “Monitoring on the progress of the experiments and other activities of All India Co-ordinated Research Project on Biological Control”, Anand Agricultural University, Anand, 9–10 January 2022.</p> <p>Institute Technology Management Committee meeting, ICAR–National Bureau of Agricultural Insect Resources, 23 February 2022.</p> <p>Techno commercial Assessment Committee (TCAC) meeting, ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 8 February 2022.</p> <p>Meeting on “National Science Day”, ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 28 February 2022.</p> <p>Expert review meeting on Strategic area Biotechnology, genomics and allele mining in plants, animals and fisheries, 8 March 2022.</p> <p>Consortium Advisory Meeting, Punjab Agricultural University, Ludhiana, 22–24 March 2022.</p> <p>XI Internal Review Meeting on the NASF Project, 18 June 2022.</p> <p>XXIX Annual General Body Meeting of National Academy of Agricultural Sciences, New Delhi, 4–5 June 2022.</p> <p>Biosafety committee, ICAR–Agricultural Technology Application Research Institute, Bengaluru 16 August 2022.</p> <p>Meeting on Coconut Development Board funded training on “Mass production of biocontrol agents for suppression of invasive whiteflies”, ICAR–National Bureau of Agricultural Insect Resources, 16 November 2022.</p>
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	<p>XVII Internal Review Meeting on the NASF Project.</p> <p>First Annual Review meeting of Institute Biosafety Council, ICAR-NBAIR Institute, ICAR–National Bureau of Agricultural Insect Resources, Bengaluru.</p>
Dr P. Sreerama Kumar	<p>Online Meeting on “Institute Website Design Demo Based on STQC Guidelines” organized by NBAIR for M/s Attest Technologies, Coimbatore, 05 February 2022.</p> <p>“Meeting to Discuss the Collaborative Project Proposal on Development of an Integrated Management Package for the Broad Mite, <i>Polyphagotarsonemus latus</i> (Acari: Tarsonemidae), in Mulberry”, ICAR–NBAIR, Bengaluru, 25 April 2022.</p> <p>“Project Inception Meeting of the Central Silk Board-Funded Project: Development of an Integrated Management Package for the Broad Mite, <i>Polyphagotarsonemus latus</i> (Acari: Tarsonemidae), in Mulberry”, Central Sericultural Research and Training Institute, Mysuru, 16 November 2022.</p>
Dr K. Subaharan	<p>Review meeting of National Agricultural Science Fund project on Fall Army Worm management, 18 January 2022.</p> <p>Expert Committee Meeting of National Agricultural Science Fund project on Fall Army Worm management, 22 February 2022.</p> <p>Expert committee meeting of National Agricultural Science Fund project on whitefly management, 8 March 2022.</p> <p>Central Advisory Committee meeting of National Agricultural Science Fund project on whitefly management, 22–24 March 2022.</p> <p>Virtual meeting of Board of Studies of Entomology, Annamalai University, 12 May 2022.</p> <p>Meeting with ICAR–National Institute of Biotic Stress Management, Raipur on formulating a flagship project on pest surveillance.</p> <p>“Knowledge Management Workshop” organized by ICAR–Directorate of Knowledge Management in Agriculture, 23 July 2022.</p> <p>“Preliminary Kick-off meeting of the BeST cluster”, Indian Institute of Science, Bengaluru.</p> <p>“EBSCO CABI Day- an Initiative for Empowering Agricultural Research”, Bengaluru, 30 November 2022.</p>
Dr G. Sivakumar	<p>Entomological Research Association meeting, Maharana Pratap University of Agriculture and Technology, Udaipur, 10 September 2022.</p>
Dr Deepa Bhagat	<p>First Technical Expert Committee (TEC) of Plant Biotechnology, 28</p>

	<p>November 2022.</p> <p>Second Technical Expert Committee (TEC) of Plant Biotechnology, 19 December 2022.</p>
Dr K. Sreedevi	<p>Virtual Biodiversity SSD 20 Technical committee meeting online, 22 March 2022.</p> <p>State Level Technical Programme (SLTP) of Entomology discipline at Acharya N G Ranga Agricultural University (ANGRAU), Guntur, A.P. (as an expert member), 19–21 May 2022.</p> <p>Virtual Biodiversity SSD 20 P1 Technical committee meeting (as a Panel member), 5 July 2022.</p> <p>Virtual Biodiversity SSD 20 technical committee meeting (as a Principal member), 14 July 2022.</p>
Dr G. Mahendiran	<p>Virtual International Online Weevil Workers Meeting, 28–29 October 2022.</p>
Dr Ankita Gupta	<p>Virtual panel discussion meeting as an expert along with National Museum of Natural History and Odisha State Tribal Museum, Government of Odisha, organized on International Museum Day, 18 May 2022.</p> <p>Qualifying Viva Voice of Mr R. Darshan Ph.D. University of Agricultural and Horticultural Sciences, Shivamogga, 30 September 2022.</p> <p>Virtual Oral thesis Viva-voce examination of Ms Bhojeshwari Sahu, Ph.D. (Agrl. Entomology), Indira Gandhi Krishi Vishwavidyalaya, Raipur, 24 November 2022.</p>
Dr Jagadeesh Patil	<p>Virtual meet on the 'IPM strategies for Fall Armyworm (<i>Spodoptera frugiperda</i> Smith) management' organized by the Zambia Agricultural Research Institute (ZARI) and the Ministry of Agriculture (Zambia), World Agroforestry (ICRAF), Southern African Development Community (SADC)–Plant protection committee, the Food and Agriculture Organisation of the United Nations' (FAO) Sub-regional Office for Southern Africa supported by Norwegian Agency for Development Cooperation IPM FAW 2022, 21–23 September 2022.</p> <p>International Conference on Advances in Agriculture, Veterinary and Allied Sciences for Improving Livelihood and Environment Security organized by the ICAR–Indian Grassland and Fodder Research Institute Regional Research Station, Srinagar, ICAR–National Agricultural Higher Education Project Birsa Agricultural University, Ranchi, Jharkhand, 28–30 September 2022.</p>
Dr M. Sampath Kumar	<p>Farmers Fair on “Natural cum Organic farming”, Krishi Vigyan Kendra, Namakkal, 26 April 2022.</p> <p>“Meeting on World Soil Day”, Regional Research station, Paiyur, 5 December 2022.</p>
Dr K. Selvaraj	<p>International Workshop on Good Agricultural Practices in Coconut and World Coconut Day programme, Kochi, 2–4 September 2022.</p>
Dr U. Amala	<p>Expert Committee meeting, Institute of Agricultural Technologies, Bengaluru, 16 May 2022.</p>
Dr R. R. Rachana	<p>Virtual Meeting on “Chilli thrips management strategies and action plan”,</p>

	<p>14 January 2022.</p> <p>Virtual Chilli Task Force Meeting, 19 January 2022.</p> <p>Virtual Meeting on “Development of SOP for integrated management of <i>Thrips parvispinus</i>”, 9 March 2022.</p> <p>Virtual Meeting on “Development of SOP for integrated management of <i>Thrips parvispinus</i>”, 30 March 2022.</p> <p>APSA’s 2022 Asian Solanaceous Round Table meeting, ICAR–Indian Institute of Horticultural Research, Bengaluru, 13 May 2022.</p>
Dr C. Manjunatha	Pusa Krishi Vigyan Mela at ICAR–Indian Agricultural Research Institute, New Delhi, 9–11 March 2022.
Dr Gundappa	Meeting on “Actions to be taken regarding issues related to Agri-Drone Project”, 9 November 2022.
Dr T.M. Shivalingaswamy Dr U. Amala	Virtual group meet of International Union for Conservation of Nature (IUCN) Wild Bee Best Practice Members, 1 July 2022.
Dr K. Sreedevi Dr Deepa Bhagat	XXIII Group Meeting of All India Network Project on soil Arthropod Pests at CSK Krishi Vishvavidyalaya, Palampur, Himachal Pradesh, 20–21 July 2022.
Dr M. Nagesh Dr A. Kandan Dr R. Gandhi Gracy Dr Ankita Gupta Dr S. Salini Dr K. J. David Dr U. Amala Dr Navik Omprakash Samodhi	Brainstorming session on “Tea Mosquito Bug menace in Tea plantations and its management”, ICAR–Agricultural Technology Application Research Institute, Bengaluru, 19 August 2022.
Dr M. Nagesh Dr K. Subaharan Dr G. Mahendiran Dr R.R. Rachana Dr Navik Omprakash Samodhi Dr C. Manjunatha	National Workshop on Identification of Insect pests, invasive of crops and their biocontrol in North-East Region of India, organised by Directorate of Extension Education, Central Agricultural University, Imphal and ICAR–National Bureau of Agricultural Insect Resources, Bengaluru at College of Fisheries, Central Agricultural University, Lembucherra, Tripura, 2–4 March 2022.
Dr T. Venkatesan Dr K. Subaharan	First Dr V.G. Prasad Memorial Association for Advancement of Pest Management in Horticultural Ecosystems Lecture on the Foundation Day of the Association, ICAR–Indian Institute of Horticultural Research, Bengaluru, 29 July 2022.
Dr G. Sivakumar Dr K. Sreedevi Dr B. S. Gotyal	XVIII International Conference on “Advances in Applied Zoological Researches towards food, feed and Nutritional Security and Safer Environment, Bhubaneswar, Odisha, 10–12 November 2022.
Dr K. Sreedevi Dr R. Gandhi Gracy Dr G. Mahendiran Dr B. S. Gotyal Dr Jagadeesh Patil Dr S. Salini Dr K.J. David Dr U. Amala	Krishimela at University of Agricultural Sciences, Bengaluru, 5 November 2022.

<p>Dr R.R. Rachana Dr R. S. Ramya Dr C. Manjunatha Mr K. T. Shivakumara</p>	
<p>Dr S. N. Sushil Dr U. Amala</p>	<p>“Brainstorming session for future collaboration with ICAR institutes”, organised by CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 26 November 2022.</p>
<p>All the Scientists</p>	<p>Virtual Webinar on “Application of Genome editing in insect pest management” by Dr R. Asokan, Principal Scientist, ICAR–Indian Institute of Horticultural Research, Bengaluru, organised by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 20 January 2022.</p> <p>Virtual Webinar on “Entomophily – Collecting insects without a net” by Dr S. Ramani, Former Project Coordinator, All India Co-ordinated Research Project on Honey bees and Pollinators, by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 9 March 2022.</p> <p>“Plant Protection Scientists’ Meeting”, ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 20 April 2022.</p> <p>Industry Interface Meet, ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 25 March 2022.</p> <p>XXIX Research Advisory Committee meeting of ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 19-20 April 2022</p> <p>Webinar on “The progress and future of green pesticides in India” by Dr A. John Peter, Chairman, Varsha Bioscience and Technology Pvt. Ltd, Hyderabad organised by ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 29 April 2022.</p> <p>Hindi Pakhwada, ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 29 September 2022.</p> <p>Institute Foundation Day, 19 October 2022.</p> <p>XXXI Annual Review Meeting of All India Co-ordinated Research Project on Biological Control, University of Agricultural Sciences, Bengaluru, 20–21 October 2022.</p> <p>Vigilance Awareness Week, ICAR–National Bureau of Agricultural Insect Resources, Bengaluru, 30 October–6 November 2022.</p> <p>Kannada Rajyotsava celebration, 1 November 2022.</p> <p>Virtual Meeting on “Revitalising Indian Council of Agricultural Research: Aspirations and Action Plan”, delivered by Secretary, Department of Agricultural Research and Education (DARE) & Director General, Indian Council of Agricultural Research, 11 November 2022.</p> <p>World Soil Day celebration, 5 December 2022.</p>



XXXI Annual Review Meeting of All India Co-ordinated Research Project on Biological Control, 20–21 October 2022



World Soil Day Celebration, 5 Decemebr 2022



Seventh National Conference on Biological Control–75 Years of Biological Control of Pests and Diseases in Agriculture: Challenges and Way Forward, 15–17 December 2022

15. TRAININGS CONDUCTED AND CAPACITY BUILDING

S. No	Trainee(s)	Particulars of the training programme	Dates	Coordinator(s) or resource person(s)	Number of Participants	Income generation If any (in ₹)
1.	Ms Nikita L.T. M.Sc. Department of Entomology, College of Horticulture, University of Horticultural Sciences, Bengaluru	Training programme on thrips identification in marigold crop	27 January –3 February 2022	Dr R.R. Rachana	1	-
2.	Sericulture officers of APSSRDI, Hindupur	Visit cum training on scientific mass production techniques of major macrobials	8 February 2022	Dr M. Sampath Kumar Dr Richa Varshney Dr Navik Omprakash Samodhi	12	-
3.	Students from CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur	Training programme on a. Production and use of biological control agents including microbials b.Mite Taxonomy including collection, preservation, mounting and identification	2-7 May 2022	Dr C. Manjunatha Mr K.T. Shivakumara Dr M. Sampath Kumar Dr Jagadeesh Patil Dr Richa Varshney Dr Omprakash Navik Dr R. Rangeshwaran Dr P. Sreeramakumar Dr A. Kandan Dr G. Mahendiran Dr P. Sreerama kumar	10	-
4.	Dr Martin Babu, Assistant Professor, Zoology, St. Berchmans College, Chaganasseery, Kerala	Training on thrips taxonomy	23-28 May 2022	Dr R.R. Rachana	1	10620
5.	Faculty of	Trainer's	31 May 2022	Dr M. Sampath Kumar	15	-

	Entomology, Kerala Agricultural University; Officials from Department of Agriculture, Government of Kerala	training on mass production and release techniques of <i>Anagyrus lopezi</i> for the classical biological control of cassava mealybug in India Batch -V			Dr A.N. Shylesha Dr Sunil Joshi Dr M. Mohan Dr Ankita Gupta		
6.	Mr. Hatwar Nikhil Khemrajji, Ph.D. Scholar, Banaras Hindu University, Varanasi, Uttar Pradesh Mr. Nachin M. Gowda, Dept of Entomology, CCS Haryana Agrl. University, Hisar	In house training programme on identification and taxonomic characterisation of common species of fruit fly in India	4-8 July 2022		Dr K.J. David	2	
7.	Ms Arti Kumari and Ms Riemonsha Mery Syiem, Staffs of Central Agricultural University, Meghalaya	Training on mass production of major macrobials	6-9 August 2022		Dr Richa Varshney	2	-
8.	Dr Ganesan, Entomologist of Agrl. Research station, Bhavanisagar, Erode district, Tamil Nadu	Visit cum inhouse training on rearing facility of <i>A. lopezi</i> parasitoids	20 September 2022		Dr M. Sampath Kumar Dr A.N. Shylesha	1	-
9.	Officials from M/s SPAC, Poonachi, Erode district, Tamil Nadu	Training on mass production of <i>A. lopezi</i>	12 October 2022		Dr M. Sampath Kumar Dr A.N. Shylesha	4	-
10.	Farmer, Mr Patel, Eco Food producer company Ltd. Madhya Pradesh	Training on Macrobianals	3-4 November 2022		Dr Richa Varshney	1	-

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.	Trainer's training on "Mass production and release techniques of <i>Anagyrus lopezi</i> for the classical biological control of cassava mealybug in India" (Batch -V) for Kerala officials	31 May 2022	Faculty of Entomology, Kerala Agricultural University; Officials from Department of Agriculture, Government of Kerala	15	-
2.	Training programme on "Mass production of biocontrol agents for suppression of invasive whiteflies"	16-18 November 2022	Officials from Krishi Vigyan Kendras, State Agricultural Universities, State Department of Agriculture and Horticulture, Central institute (DPPQ&S) of Kerala and Karnataka	12	-
INSTITUTE IN-HOUSE TRAINING PROGRAMME					
1.	Scientific mass production techniques of major macrobials	08 February 2022	Sericulture officers of APSSRDI, Hindupur	12	-
2.	Training on thrips taxonomy	23-28 May 2022	Dr Martin Babu, Assistant Professor, Zoology, St. Berchmans College, Changanasseery, Kerala	1	10620
3.	Training on mass production of major macrobials	6-9 August 2022	Ms Arti Kumari and Ms Riemonsha Mery Syiem, Staffs of CAU, Meghalaya	2	-
4.	Visit cum inhouse training on	20 September	Dr Ganesan,	1	-

	rearing facility of <i>A. lopezi</i> parasitoids	2022	Entomologist of Agrl. Research station, Bhavanisagar, Erode district, Tamil Nadu		
5.	Training on mass production of <i>A. lopezi</i>	12 October 2022	Officials from M/s SPAC, Poonachi	4	-
STUDENTS' TRAINING PROGRAMME					
1.	Training programme on thrips identification in marigold crop	27 January–3 February 2022	Ms Nikita L.T. Sr. M.Sc. Department of Entomology, College of Horticulture, University of Horticultural Sciences, Bengaluru	1	-
2.	Training programme on a. “Production and use of biological control agents including microbials” and b. “Mite Taxonomy including collection, preservation, mounting and identification”	2–7 May 2022	Students from CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur	10	-
3.	In house training programme on Identification and taxonomic characterisation of common species of fruit fly in India	4–8 July 2022	Mr Hatwar Nikhil Khemrajji, Ph.D. Scholar, Banaras Hindu University, Varanasi, Uttar Pradesh	1	-
			Mr Nachin M. Gowda, Department of Entomology, CCS Haryana Agrl. University, Hisar	1	-
4.	Student Internship Training	1 December 2022–28 February 2023	Final year B. Tech students from Tamil Nadu Agricultural University, Coimbatore	5	-
5.	Training on Techno-preneurship in bioagents production	5–7 December 2022	Final year UG students from	35	-

	development and marketing		University of Horticultural Sciences, Bagalkot		
FARMERS' VISIT-CUM-TRAINING PROGRAMME					
1.	Training on Macrobiales	3-4 November 2022	Sanjay Singh Patel, Farmer, Madhya pradesh	1	-
2.	Training on "Mass production of beneficial Insects"	10 November 2022	Farmers from Kodaikanal, Dindigul, Tamil Nadu	20	-
3.	Training programme on "Holistic approach to human wildlife conflict mitigation using alternative crops and one health approach"	21-23 November 2022	Panchayat officials and farmers from Coorg district, Karnataka	30	

INSTITUTE VISITS				
S. No	Category	Date(s)	Institute/company they belong to	Number of visitors
1.	UG Students	21 January 2022	RKMVERI-FAR, Coimbatore	-
2.	M.Sc. (Agronomy) and M.Sc. (Genetics and Plant Breeding) students	28 March 2022	Acharya N G Ranga Agricultural University, Mahanandi	12+2 staff
3.	UG students	30 March 2022	Karunya University, Coimbatore	57+4 staff
4.	UG students	06 April 2022	Agricultural College, Bapatla	82+2 staff
5.	UG students	13 April 2022	University of Agricultural Sciences, Bengaluru	-
6.	UG students	21 April 2022	S.V. Agricultural college, Tirupati, ANGRAU	45+4 staff
7.	M.Sc. students	25 April 2022	Agricultural College, Naira	11+1 staff
8.	DAESI students	30 June 2022	ICAR Krishi Vigyan Kendra, Doddaballapur	35
9.	UG students	19 July 2022	Palar Agricultural college, Ambur, Vellore district	48+2 staff
10.	UG students	08 September 2022	Annamalai University, Chidambaram	100+2 staff
11.	UG students	08 September 2022	College of Agriculture, Phule, Maharashtra	20+2 staff
12.	UG students	14 September 2022	College of Agriculture, Pune	22+2 staff
13.	UG students	21 September 2022	Annamalai University, Chidambaram	97+3 staff
14.	Ph.D. and M.Sc. students	17 November 2022	Tamil Nadu Agricultural University, Coimbatore	37+1 staff

15.	M.Sc. (Plant Pathology, Entomology & Plantation Crops and Spices) students	22 November 2022	Dr. Y.S.R. Horticultural University, Andhra Pradesh	8+1 staff
16.	UG students	05 December 2022	University of Horticultural Sciences, Bagalkot	30+2 staff
17.	UG students	09 December 2022	SRS Institute of Agriculture and Technology, Vedasandur, Tamil Nadu	81+4 staff
18.	UG students	12 December 2022	Vanavarayar Institute of Agriculture, Pollachi, Tamil Nadu	117+4 staff
19.	M.Sc. (Entomology) students	19 December 2022	Annamalai University, Chidambaram	18+1 staff
20.	B.Sc. (Zoology & Biotechnology) students	22 December 2022	Indian Academy Degree College (Autonomous) Hennur, Bengaluru	25+2 staff

b. Capacity building programme undergone by NBAIR staff

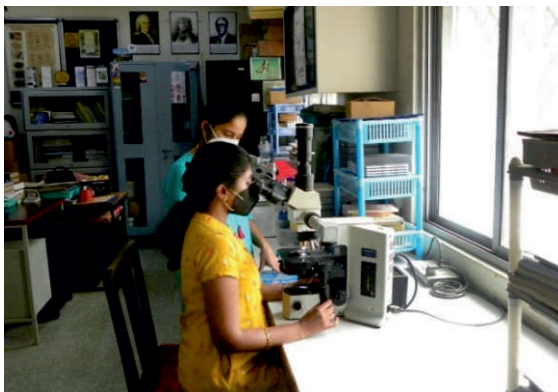
S. No	Name, Designation and Division	Name of the training programme attended	Place	Dates
1.	Ms P. Anitha, Upper Division Clerk	Online training Programme on “Pension and retirement benefits”	ICAR–National Rice Research Institute, Cuttack in collaboration with Human Resource Management unit ICAR HQs	12–14 January 2022
2.	Mr R. Maruthi Mehanth Technical Assistant	Online training Programme on “Data visualisation of agricultural research & Agri business management”	ICAR–National Academy of Agricultural Research Management, Hyderabad	17–22 January 2022
3.	Dr M. Pratheepa, Principal Scientist, Division of Genomic Resources	Online training on Metagenomic Data Analysis	ICAR–Indian Agricultural Statistical Research Institute, New Delhi	19–24 January 2022
4.	Dr B.S. Gotyal, Senior Scientist, Division of Genomic Resources	Training on Introduction to Molecular Entomology: Third hands on training	Agri Biotech Foundation, PJTS Agricultural University Campus, Rajendranagar, Hyderabad	22–27 August 2022
5.	Dr R.S Ramya Scientist, Division of Genomic Resources	Training workshop on “Integrated Omics-III (Genomics, Proteomics and Bioinformatics)”	National Centre for Biological Sciences, Bengaluru	19–23 September 2022
6.	Dr M. Pratheepa, Principal Scientist, Division of Genomic Resources	Online/offline training Programme on “Big data management and comprehensive analysis”	Centre for Development of Advanced Computing, Mohali	14–18 November 2022



Fifth Batch: Trainer's training on Mass Production and Release Techniques of *Anagyrus lopezi* for the Classical biological Control of Cassava Mealybug in India on 31.05.2022.



Training programme on Mass production of biocontrol agents for suppression of invasive whiteflies (16–18 November 2022)



Student training on classical taxonomy of Thysanoptera (23–28 May 2022)



Student training on identification and taxonomic characterisation of common species of fruit fly in India (4–8 July 2022)



Training programme for the farmers of Kodaikanal, Dindigul, Tamil Nadu on mass production of beneficial insects (10 November 2022)



Training programme on Holistic approach to human wildlife conflict mitigation using alternative crops and one health approach during (21–23 November 2022)

16. DISTINGUISHED VISITORS

Dr Trilochan Mohapatra, Secretary (Department of Agriculture Research & Education) & Director General, Indian Council of Agricultural Research, 16 May 2022.

Dr A. Vishnuvardhan Reddy, Vice Chancellor, Acharya N. G. Ranga Agricultural University, Guntur, 2 July 2022.

Dr Sanjay Kumar, Director, ICAR–Indian Institute of Seed Science, Mau, 4 July 2022.

Ms Seema Chopra, Director (Official Language), Indian Council of Agricultural Research, New Delhi, 27 September 2022.

Shri C. Lalrinsanga, Honourable Minister for Agriculture, Irrigation and Water Resources, Cooperation, Mizoram, 3 October 2022.

Shri D.V. Sadananda Gowda, Member of Parliament, Bengaluru North and Former Chief Minister, Government of Karnataka and Former Union Minister of Chemicals and Fertilizers, 17 October 2022.

Dr A.N. Mukhopadhyay, Former Vice Chancellor, Assam Agricultural University, Jorhat, 17 December 2022.

Dr J. P. Singh, Plant Protection Advisor, Directorate of Plant Protection, Quarantine & Storage, New Delhi, 17 December 2022.

Dr Tilak Raj Sharma, Deputy Director General (Crop Sciences), Indian Council of Agricultural Research, 19 October 2022.



Distinguished visitors at NBAIR

17. MERA GAON MERA GAURAV

ICAR–NBAIR organised Campaign on 'Promotion of Organic/Natural farming'

ICAR–NBAIR organised a campaign on 'Annadata Devo Bhava' under 'Azadi Ka Amrit Mahotsav' at Thowdanahalli village, Chikkaballapura district, Karnataka on 24 April 2022. The importance of organic and natural farming and information on the different plant protection inputs, viz. pheromone traps, sticky traps, macrobials like parasitoids and predators to tackle insect pest damage in different crops were explained to the farmers. The farmers were also sensitised about the importance of the conservation of macrobials. Farmers shared their problems and also experiences in managing different insect pests. Later, inputs like different traps, Trichocards, chrysopids and *Blaptostethus pallescens* were distributed to the farmers. The method of release of the predators and parasitoids was demonstrated to the participants. The method of placement of pheromone traps for the trapping of adult moths of fall armyworm infesting maize was demonstrated. Around 30 farmers growing different crops like brinjal, cabbage, grapes, maize, pomegranate and tomato attended the programme.



MGMG farmers meeting

ICAR–NBAIR organised 'Kisan Bhagidari Prathmikta Hamari' program

ICAR–NBAIR in collaboration with the Department of Sericulture, Karnataka organised 'Kisan Bhagidari Prathmikta Hamari' program as a part of 'Azadi Ka Amrit Mahotsav' at Devahanahalli, Karnataka on 26 April 2022. The 'use of microbials for the management of mites and thrips infesting mulberry and the efficacy of NBAIR-TATP strain *Trichoderma asperellum* for the management of root rot of mulberry was explained to the farmers. The root-zone application of NBAIR-TATP strain *T. asperellum* enriched with farm yard manure for the control of root rot was demonstrated. After the programme, microbial formulations were distributed to the participants. Around 50 mulberry growers participated in the programme. The queries raised by the farmers related to insect pests and disease management in mulberry were clarified.



MGMG farmers meeting



Farmers meeting



NBAIR Scientists distributing inputs to farmers

ICAR–NBAIR organised awareness programme on Protection of Plant Varieties and Farmers' Rights Act'

ICAR–NBAIR organised 'Awareness programme on Protection of Plant Varieties and Farmers' Rights Act (PPV&FR Act)' for the conservation of varieties among the farmers in Devanahalli, Karnataka on 26 April 2022. The guidelines of National Biodiversity Act for the protection of environment and conservation of plant varieties were also explained to farmers and Krishi Vigyan Kendra (KVK) personnels. Around 50 people which include farmers and KVK personnels participated in the programme.



ICAR–NBAIR organised farmers' demonstration meeting on insect pest and disease management in mulberry

ICAR–NBAIR in collaboration with Department of Sericulture, Karnataka organised a training programme for village farmer producers' organisations for mass production of various microbial bio-agents and microbial production.

units in Pavagada, Tumkur district, Karnataka on 24 May 2022. More than 25 sericulture farmers participated in the programme. The meeting was organised to create awareness to manage the economically important mulberry root rot and wilt disease caused by fungus complex like *Rhizoctonia bataticola* (= *Macrophomina phaseolina*), *Fusarium solani*, *F. oxysporum* and *Botryodiplodia theobromae* using NBAIR-TATP strain *Trichoderma asperellum*. Scientists from the Bureau demonstrated the enrichment of farm yard manure with *T. asperellum* and root zone application for the control of root rot and wilt in mulberry



Demonstration on compost making

A team of scientists from the Bureau visited guava gardens in Jalige village in Devanahalli Talk, Bengaluru district. The extent of fruit damage caused by guava fruit flies was assessed and plant protection advisory services for the sustainable management of guava fruit flies was rendered to the farmers. The farmers were also sensitised about the importance of destruction of damaged fruits so as to reduce the fruit fly infestation.



Interaction with farmers

Tribal Sub Plan

Under the Tribal Sub Plan ICAR – NBAIR, Bengaluru and ICAR-KVK, Idukki jointly organized Tribal sub plan on ensuring sustainable livelihood security of tribals in the Plamala village in Adimaly Block of Idukki, Kerala. The programme was presided over by Ms. Reena Chacko, Chairperson Bapooji Sevak Samaj, the host organization of KVK Idukki. The Director ICAR – NBAIR, Bengaluru Dr. S N Sushil, inaugurated the project launch of the scheme on ensuring sustainable livelihood security of tribals in the remote tribal village of Adimali block, Idukki district in Kerala in Plamalakudy the products developed at ICAR-NBAIR to 100 tribal farmers.



Dr. S.N. Sushil, Director, ICAR-NBAIR addressing the farmers at TSP programme

The achievements made under the Tribal Sub Plan of ICAR-NBAIR have been showcased at International Agriculture and Horti Expo at Pragati Maidan, New Delhi on 17–19 June 2022.

As a part of DAPSC and DAPST activities on “Inventorization of the diversity of selected insect pests, pollinators and natural enemies in natural farming systems (NFS) and integrated farming systems (IFS) in selected aspirational villages of tribal areas and NEH villages as a part of National Programme on IFS & NFS” was taken up in tribal aspirational villages of Araku valley in identified natural farming and IFS villages. A group of scientists comprising Dr G. Mahendiran, Dr Ankita Gupta, Dr K. J. David, Dr U. Amala, Dr Richa Varshney and Dr R. Ramya and led by Dr M. Nagesh have visited the villages viz., Santhabayalu, Kulluba and Sirsapalli of Araku Valley, Visakhapatnam, Andhra Pradesh; from 12–14 July 2022.

Practising Natural farming methods was observed in Arakku Valley. Two types of mulches for ginger (dry straw and mango twigs with leaves) fields and one field without mulch were observed. The plot with mulch had higher crop growth and suppressed weeds. To control insect pests, a mixture of cow dung+cow urine+ water (mixed and fermented for two days) locally called 'Neemashtra' is sprayed on crops post-sieving. The farmers were encouraged to sow cross-pollinated crops like cucurbits, sunflower etc., in crop borders as they would provide forage resources to the honeybees.



NEH programs

A three days training programme on “Skill Development Programme on Biomass Production of Bio-inputs for Officers, FPO members and progressive farmers” at CPGSAS, CAU (I), Umiam, Meghalaya from 17–19 August, 2022 under DBT funded project on “Establishment of organic hub for supporting organic and alike farming through promotion of bio-inputs technologies in farmer's fields of northeast India”. In collaboration with CAU Umiam Meghalaya and, TRA Nagarkata. Total 25 trainees from Department of Agriculture, Govt. of Meghalaya, Meghalaya Basin Management Agency, Bioresource Development Centre, FPO Nongpoh, Fellow farmer of Langdongdai, West Khasi Hills attended the training programme.



Hindi Pakhwada at ICAR-NBAIR

ICAR-National Bureau of Agricultural Insect resources organised Hindi Pakhwada from 14 September to 29 September 2022. As a prelude, In the inaugural ceremony of Hindi Pakhwada Dr. Deepa bhagat read the message of the Honourable Home Minister, Shri Amit Shah, Mr. Mathew, the Administrative officer shared the message of Honourable Agriculture and Farmer welfare minister Shri Narendra Tomar, similarly, Ms Srujana relayed the message of Shri Kalyan Chaudhary, Honorable Minister of State for Agriculture and Ms Shashi Shree relayed the message of Dr Himanshu Pathak, Honourable DG, ICAR, New Delhi. Dr S. N. Sushil in his remarks suggested the use of common words and sentences in Hindi which are easy to understand to promote and improve the reach and usage of Hindi as the official language in the Bureau and by respecting all the languages and using the prevalent words of those of regional or local language in the official language Hindi, there will be a gradual and inclusive growth of the official language Hindi. Under the incentive scheme for doing official work of the Bureau in the official language Shri Satender Kumar, Shri Naziya Anjum and Smt P. Anitha were awarded first, second and third prizes respectively.



Observance on Vigilance Awareness Week -2022 at ICAR-NBAIR, Bangalore

Observance on Vigilance Awareness Week – 2022 (31 October – 6 November) commenced with an Integrity Pledge by all the staff of ICAR-NBAIR. Dr T. Venkatesan, Principal Scientist, Head In-charge, Division of Genomic Resources & Vigilance Officer, ICAR-NBAIR facilitated the staff to take e-pledge as prescribed by the Under Secretary, Vigilance ICAR, New Delhi. Shri R. Valavan, Deputy Superintendent of Police, Anti-Corruption Branch, Central Bureau of Investigation, Bengaluru was invited as the Guest of Honour on 4 November 2022 and he delivered a talk on 'Corruption-Free India for a Developed Nation'.



Guest of Honor Shri. R. Valavan, Deputy Superintendent of Police, Anti- Corruption Branch, CBI, Bengaluru

Swachhata Pakhwada 2022

As per directions received ICAR-National Bureau of Agricultural Insect Resources, Bengaluru campus observed “Swachhata Pakhwada” from 16.12.2022 to 31 December 2022. The activities were shared on social media (Facebook, Twitter, Instagram, YouTube etc.) tagging to Swachhta Bharat handles Twitter: @Swachhbharat, Facebook: SBM Gramin, Instagram: Swachhbharatgrameen to generate awareness.



ICAR-NBAIR staff taking Swachhata pledge in presence of Director Dr S.N. Sushil

Swachhata pledge was undertaken at ICAR-NBAIR Main Hebbal campus and also at NBAIR research farm campus at Yelahanka. The planting of trees was done by dignitaries. The weeding out of old records, disposing of old and obsolete furniture, junk materials and whitewashing/painting was done on 17 December 2022. To promote cleanliness in laboratories and office premises surprise visit was conducted to check the cleanliness and those laboratories that were kept clean were rewarded.



Cleaning drive at ICAR-NBAIR

A cleanliness and sanitation drive was taken up on 18 December 22 in the villages adopted under the MeraGaonMeraGaurav by ICAR-NBAIR. A campaign on utilization of farm waste for growing biocontrol agents like *Trichoderma* species supplied by NBAIR



Farmers being trained in the preparation of enriched compost

Special Swachhata Campaign on 'Waste to Wealth' observed in ICAR-NBAIR on 20 December 2022, Bengaluru at both Hebbal and Yelahanka campuses. ICAR-NBAIR has taken initiatives in waste-to-wealth conversion.



Demonstration of waste to wealth by use of larvae of black soldier fly, *Hermetia illucens*

Celebration of Kisan Diwas

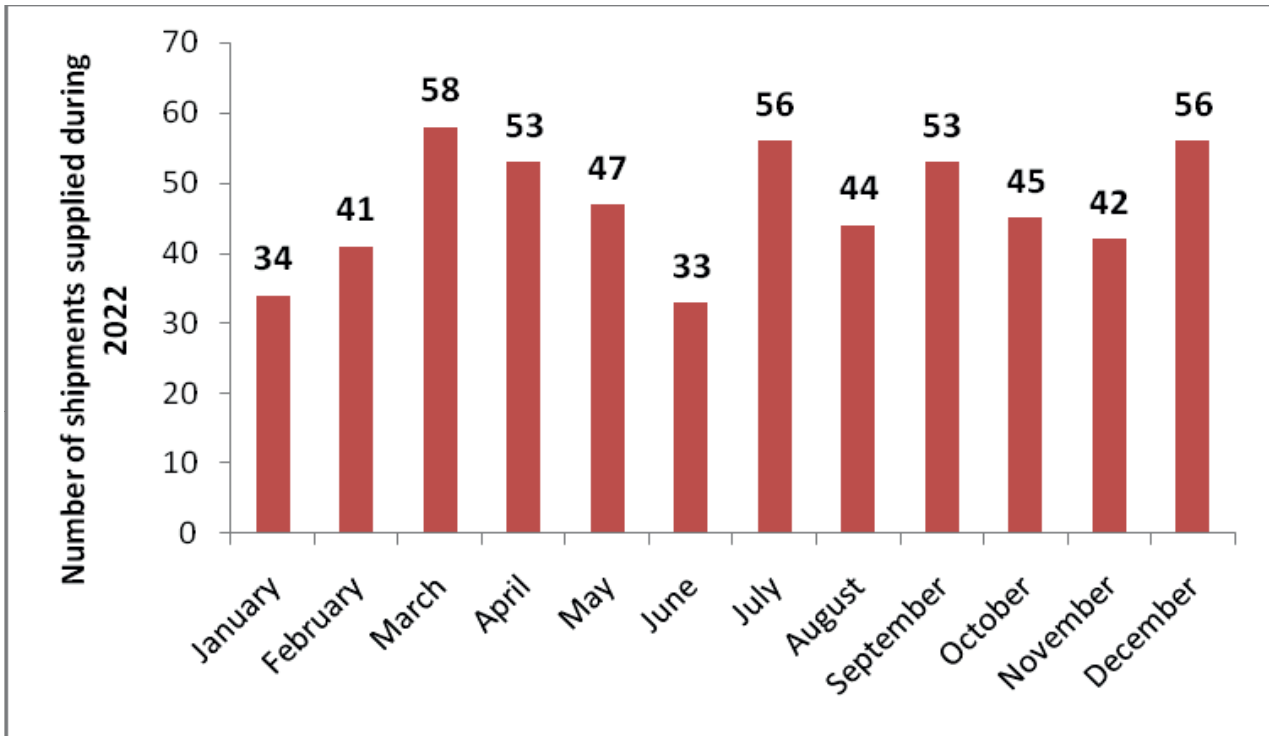
The celebration of Kisan Diwas (Farmer's Day) was organized at ICAR-NBAIR, Yelahanka campus on 23 December 2022. Dr S.V. Suresh, Vice Chancellor of University of Agricultural Sciences Bengaluru; Guest of Honour for the programme. Farmers from Doddaballapura, Chikkaballapura, and Hosakote districts of Bengaluru rural participated and shared their views. The technologies developed at ICAR-NBAIR on black soldier fly, stingless bees and the pheromones for pest management were demonstrated to the farmers.



A view of Kisan Diwas programme



Demonstration of pheromone technology developed at ICAR-NBAIR to farmers



Number of Shipments of live insects to various organisations

18. EXHIBITIONS

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

1. 'Pusa Krishi Vigyan Mela' organized at ICAR–Indian Agricultural Research Institute, New Delhi during 9–11 March 2022.

2. 'International Agriculture and Horti Expo' held at New Delhi during 17–19 June 2022.

3. “Krishi Mela 2022” organized at the University of Agricultural Sciences, Bengaluru during 03–06 November 2022.



NBAIR Stall receiving award



Visitors at NBAIR Stalls



Visitors at NBAIR Stalls

19. PERSONNEL

S. No.	Name	Designation
Director		
1.	Dr M. Nagesh	Director (Acting) (From 01.08.2021 to 11.09.2022)
2.	Dr S. N. Sushil	Director (From 12.09.2022)
Scientists		
Division of Germplasm Collection and Characterisation		
3.	Dr Sunil Joshi	Principal Scientist (Agricultural Entomology) & Head (In-Charge), Division of Germplasm Collection and Characterisation
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 Gundappa	Scientist (Agricultural Entomology) (Joined NBAIR on 18.08.2022)
Division of Genomic Resources		
24.	Dr T. Venkatesan	Principal Scientist (Agricultural Entomology) & Head (In-Charge), Division of Genomic Resources
25.	Dr K. Srinivasa Murthy	Principal Scientist (Agricultural Entomology) (Deceased on 15 March 2022)
26.	Dr R. Rangeshwaran	Principal Scientist (Microbiology)
27.	Dr M. Mohan	Principal Scientist (Agricultural Entomology)
28.	Dr M. Pratheepa	Principal Scientist (Computer Applications)
29.	Dr Mahesh Yandigeri	Senior Scientist (Microbiology)
30.	Dr R. Gandhi Gracy	Senior Scientist (Agricultural Entomology)
31.	Dr B.S.Gotyal	Senior Scientist (Agricultural Entomology) (Joined NBAIR on 01.04.2022)
32.	Dr R.S. Ramya	Scientist (Agricultural Entomology)
33.	Dr C. Manjunatha	Scientist (Plant Pathology)
34.	Dr. K.T. Shivakumara	Scientist (Agricultural Entomology)

Technical Officers / Assistants		
35.	Dr B.K. Chaubey	Chief Technical Officer
36.	Mr Satendra Kumar	Chief Technical Officer
37.	Ms L. Lakshmi	Assistant Chief Technical Officer
38.	Mr H. Jayaram	Senior Technical Officer (T6)
39.	Mr P. Raveendran	Technical Officer (T5)
40.	Dr A. Raghavendra	Senior Technical Assistant (Laboratory Technician)
42.	Mr M. Chandrappa	Senior Technical Assistant (Driver)
43.	Mr R. Narayanappa	Senior Technical Assistant (General Operator)
44.	Mr Umesh Kumar Sanjeev	Technical Assistant (Laboratory Technician)
45.	Mr R. Maruti Mehanth	Technical Assistant & Cashier (Laboratory Technician)
46.	Mr K.M. Venugopala	Technical Assistant (Laboratory Technician)
47.	Mr P. Madanathan	Technical Assistant (Driver)
48.	Mr Ramakrishnaiah	Technician (T1)
Administrative Staff		
49.	Mr J. Mathew	Administrative Officer
50.	Ms S. Kusuma	Finance & Accounts Officer
51.	Ms S. Kaveriamma	Private Secretary to Director
52.	Ms Dipanwita Deb	Assistant Administrative Officer
53.	Ms M.S. Uma	Personal Assistant
54.	Ms Naziya Anjum	Assistant
55.	Ms P. Anitha	Upper Division Clerk
Supporting Staff		
56.	Mr P. Nagaiah	Skilled Supporting Staff
57.	Ms Sanjeevini Desai	Skilled Supporting Staff