All India Co-ordinated Research Project on Biological Control of Crop Pests and Weeds







ANNUAL PROGRESS REPORT 2012-2013

Compiled and edited by

B. Ramanujam
Prashanth Mohanraj
Chandish R. Ballal
T. Venkatesan
Sunil Joshi
A.N. Shylesha
R.Rangeshwaran
K. Srinivasa Murthy
M. Mohan
K.J. David
Abraham Verghese
Honnur Basha

National Bureau of Agriculturally Important Insects (NBAII)
Bangalore 560 024

All India Co-ordinated Research Project on Biological Control of Crop Pests and Weeds

ANNUAL PROGRESS REPORT 2012-2013

Compiled and edited by

B. Ramanujam
Prashanth Mohanraj
Chandish R. Ballal
T. Venkatesan
Sunil Joshi
A.N. Shylesha
R.Rangeshwaran
K. Srinivasa Murthy
M. Mohan
K.J. David
Abraham Verghese
Honnur Basha

National Bureau of Agriculturally Important Insects
Bangalore 560 024

Cover page (Top to bottom)
Anomalococcus indicus Ayyar (Photo: J. Poorani)
Reticulaphis foveolatae (Takahashi) (Photo: Sunil Joshi)
Pseudococcus jackbeardsleyi Gimpel & Miller ((Photo: J. Poorani)
Entomopathogenic nematode (Photo: M. Nagesh)
Aphis craccivora Koch (Photo: J. Poorani)
Leptomastix dactylopii Howard (Photo: J. Poorani)
Pleotrichophorus chrysanthemi (Theobald) (Photo: Sunil Joshi)

Cover design: Sunil Joshi

Biological control of plant diseases using antagonistic organisms

2.2 Plant Disease and Nematodes antagonists

2.3 Sugarcane

2.4 Cotton

2.5 Tobacco

2.6 Rice

2.7 Pulses

2.8 Oil Seeds

2.9 Coconut

2.10 Tropical Fruits

2.11 Temperate Fruits

2.12 Vegetables

2.13 Tea Mosquito Bug

2.14 Mealy Bugs

2.15 Termites

2.16 Biological Suppression of Polyhouse crop pests

2.17 Storage Pests

2.18 Weeds

Programme for 2012-13

I. Basic research

1. National Bureau of Agriculturally Important insects

1. Biosystematic studies on agriculturally important insects
2. Biosystematics of *Trichogramma* and *Trichogrammatoidea*
3. Biodiversity of oophagous parasitoids with special reference to Scelionidae (Hymenoptera)
4. Biodiversity of economically important Indian Microgastrinae (Braconidae) supported by Molecular Phylogenetic studies
5. Biodiversity studies on aphids and mealy bugs and their natural enemies
6. Diversity and distribution of entomopathogenic nematodes in temperate and gangetic plains of India
7. Taxonomic studies on fruit flies (Diptera: Tephritidae) of India
8. Introduction and studies on natural enemies of some new exotic insect pests and weeds
9. Development of production protocols and evaluation of anthocorid and mite predators
10. Influence of elevated levels of carbon dioxide on the tritrophic interactions in some crops
11. Isolation, identification and characterization of endosymbionts of trichogrammatids and their role on the fitness attributes
12. Molecular characterization and identification of endosymbionts of chrysopid predators and their functional role on the biological attributes
13. Studies on *Trichogramma brassica* and *Cotesia vestalis* (*plutellae*) interaction with their host in cabbage
14. Nematode-derived fungi and bacteria for exploitation in agriculture
15. Mass production and exploitation of entomopathogenic nematodes against white grubs from diverse habitats
16. Mapping of the cry gene diversity in hot and humid regions of India
17. Evaluation of fungal pathogens on *Aphis craccivora* in cowpea and *Bemisia tabaci* in tomato and capsicum.
18. Mechanism of insecticide resistance in *Leucinodes orbonalis* and *Leucopholis coneophora*
19. Development of Computational Tool for Prediction of Insecticide Resistance Gene in Agriculturally Important Insects
20. *In situ* conservation of natural enemies and pollinators in pigeon pea and sunflower ecosystem
21. Polymorphism in pheromone reception in *Helicoverpa armigera*.
22. Formulations of pheromones of important borers and other crop pests and kairomones for natural enemies using nanotechnology
23. Semiochemicals for the management of coleopteran pests

2. Indian Agricultural Research Institute New Delhi

1. To carry out surveys and collection of *Trichogramma* strains from different agro-climatic zone of India.
2. To evaluate the collected *Trichogramma* strains for searching efficiency, temperature tolerance and fecundity.
3. To breed the better performing strains under laboratory conditions

2.1.3. Biodiversity of Biocontrol Agents from Various Agro Ecological Zones

1. Survey, Collection and diversity analysis of biocontrol agents from various agro ecological zones (AAU-A, AAU-J, ANGRAU, KAU, MPKV, PAU, SKUAST, TNAU, YSPUHF, CAU, JNKVV, MPUAT, OUAT, CPCRI, CTRI and UAS-Raichur)
2. Mapping of EPN diversity (AAU-A, PAU)
3. Surveillance for alien invasive pests *Brontispa longissima, Aleyrodicus digessi, Phenacoccus manihoti, Paracoccus marginatus*, *Phenacoccus madeirensis* and others (AAU-A, AAU-J, ANGRAU, KAU, MPKV, PAU, SKUAST, TNAU, YSPUHF, CAU, JNKVV, MPUAT, OUAT, CPCRI, CTRI, IIHR, UAS-Raichur)

Biological Suppression of Pests and Diseases in Field.

2.2 . Plant diseases, antagonists and nematodes

1. Screening of selected abiotic stress tolerant (i.e. drought and salinity) isolates of *Trichoderma harzianum* for their potential to produce hydrolytic enzymes under *in vitro* conditions (GBPUAT)
2. Development of oil-based formulations of selected isolates of *Trichoderma harzianum* and study of their shelf life (GBPUAT)
3. Field evaluation of groundnut oil, talc and paraffin petroleum oil based formulation of *T. harzianum* (Th-14) for the management of foliar and soil borne disease of tomato (Hybrid - Dev). (GBPUAT
4. Field evaluation of promising *Trichoderma* isolates under field conditions (GBPUAT)
5. Large scale field demonstration of biocontrol technologies (GBPUAT)
6. Monitoring for emergence of newer pests and diseases of various crops in districts Udham Singh and Nainital of Uttarakhand (GBPUAT)
7. Evaluation of fungal and bacterial antagonists against collar rot of groundnut caused by *Aspergillus* spp. and *Screlotium rolfsii* (AAU-A)
8. Evaluation of fungal and bacterial antagonists for the management of foot rot of citrus (kinnow) caused by *Phytophthora* spp. (PAU)
9. Evaluation of fungal and bacterial antagonists for the management of fusarial wilts of cucurbits (PAU)

2.3. Sugarcane

1. Monitoring the sugarcane woolly aphid (SWA) incidence and impact assessment of natural enemies on its bio suppression (MPKV, TNAU, UAS-Raichur)
2. Field evaluation of *T. chilonis* produced using Eri-silk worm eggs as factitious host against early shoot borer of Sugarcane (ANGRAU, TNAU)

2.4. Cotton

1. Monitoring diversity and out breaks for invasive mealy bugs on cotton (ANGRAU, MPKV, PAU, TNAU).
2. Monitoring the diversity and outbreaks of sap sucking pests, mirids and their natural enemies in *Bt* cotton (MPKV, UAS-Raichur)

2.5. Tobacco

1. Survey and record of bio control agents (insects, pathogens) on *Orobanche* spp. (CTRI)
2. Natural enemies of aphids infesting different types of tobacco cultivated in different regions of the country (CTRI).

2.6. Rice

1. Seasonal abundance of predatory spiders in rice ecosystem (ANGRAU, KAU, TNAU)
2. Evaluation of IPM for upland rice pest and diseases (CAU)
3. Field evaluation of *Trichogramma chilonis* (produced using Eri-silk worm eggs as factitous host) against Rice stem borer (CAU).

2.7. Pulses

1. Evaluation of NBAII liquid formulations (PDBC-BT1 and NBAII-BTG4) and IARI *Bt* against pigeon pea pod borer (*Helicoverpa armigera*) and legume pod borer (*Maruca testulalis*) (AAU-A, ANGRAU, MPKV, PAU, TNAU, JNKVV, UAS-Raichur)
2. Influence of crop habitat diversity on diversity of natural enemies in pigeon pea through FLD/OFD. (ANGRAU, MPUAT)

2.8. Oil Seeds

1. Biological suppression of safflower aphid, *Uroleucon compositae* (ANGRAU, MPKV)
2. Evaluation of entomopathogens and botanicals against soybean pests' complex (MPKV, MPUAT)
3. Screening of EPN (Entomopathogenic Nematodes) against *Spodoptera litura* (Fab.) on soybean (JNKVV)

2.9. Coconut

1. Surveillance and need-based control of coconut leaf caterpillar, *Opisina arenosella* in Kerala (CPCRI)

2. Scaling up and utilization of *M. anisopliae* through technology transfer (CPCRI)

3. EPN for red palm weevil management (CPCRI)

2.10. Tropical Fruits

1. Field evaluation of *Metarhizium anisopliae* against mango hoppers (ANGRAU, MPKV)
2. Survey and record of incidence of papaya mealybug and its natural enemies on papaya and other alternate hosts (KAU, MPKV, TNAU, OUAT)
3. Extent of parasitism of *Acerophagus papayae* on tapioca in different agro climatic zones of Kerala (KAU)
4. Biological suppression of mealy bugs, *Maconellicoccus hirsutus* and *Ferrisia virgata* with *Scymnus coccivora* on custard apple (MPKV)
5. Economic analysis of impact of release of *Acerophagus papayae* on papaya production, seed production, papaine industry, mulberry and tapioca (TNAU)
6. Bio-efficacy of EPNs against Citrus trunk borer, *Anoplophora versteegi* (CAU)
7. Natural enemies associated with mango pulp borer (OUAT)

2.11. Temperate Fruits

1. Survey for identification of suitable natural enemies of codling moth (SKUAST)
2. Field evaluation of mass released *Trichogramma embryophagum* against codling moth, *Cydia pomonella* on apple (SKUAST)
3. Observations on the natural enemies of seed infesting *Eurytoma* of apricots in Laddakh (SKUAST)
4. Evaluation of entomopathogenic fungi and EPNs for the suppression of Apple root borer, *Dorysthenes hugelii* under field conditions (YSPUHF).
5. Evaluation of predatory mite in combination with horticultural mineral oils (HMO) for the management of phytophagous mites on apple (YSPUHF).

2.12. Vegetables

1. Developing bio intensive IPM package for the pests of Cole crops (PAU, SKUAST, and YSPUHF)
2. Evaluation of microbial pesticides against diamond back moth, *Plutella xylostella* (CAU)
3. Field evaluation of thelytokous and arrhenotokous strains of *Trichogramma pretiosum* against *Helicoverpa armigera* on tomato (MPKV)
4. Evaluation of different BIPM modules against shoot and fruit borer, *Leucinodes orbonalis* in brinjal (OUAT, JNKVV, MPKV)
5. Biological suppression of onion thrips, *Thrips tabaci* with predatory anthocorid and microbial agents (IIHR, MPKV)
6. Identification of major aphid parasitoids and their extent of parasitism in mustard and cabbage (MPUAT)
7. Validation of BIPM of major insect pests in tomato at farmer's field (MPUAT)
8. Evaluation of anthocorid predator *Blaptostethus pallescens* against mite, *Tetranychus urticae* on brinjal and okra (OUAT, PAU)
9. Evaluation of entomopathogens against sucking pests of capsicum (JNKVV)

2.13. Tea Mosquito Bug

1. Evaluation of *Beauveria bassiana* against Tea mosquito bugs in tea (AAU-J)
2. Natural enemies associated with cashew tea mosquito bug (OUAT)

2.14. Mealy Bugs

1. Survey for mealy bugs and its natural enemies on horticultural crops – papaya, hibiscus, tapioca, brinjal, tomato, okra (AAU-J)
2. Survey and record of incidence of papaya mealy bug and its natural enemies on papaya and other alternate hosts (OUAT)
3. Mass production of *Spalgis epius* (IIHR)

2.15. Termites

1. Testing the bioefficacy of entomopathogenic fungi in suppression of termite incidence in sugarcane (ANGRAU)
2. Testing of bio-efficacy of entomopathogenic fungi for suppression of Termite incidence in maize (MPUAT)

2.16. Biological Suppression of Polyhouse crop pests

1. Evaluation of anthocorid predator, *Blaptosthetus pallescens* against spider mites of carnation/rose in poly houses (ANGRAU)
2. Evaluation of biocontrol agents against sap sucking insect pests of carnation in polyhouses (ANGRAU)
3. Evaluation of Biological Control Agents against Mites in Carnation under protected condition (TNAU)
4. Evaluation of predatory mite, *Neoseiulus longispinosus* against phytophagus mite in carnation under polyhouse condition (YSPUHF, SKUAST)
5. Biological suppression of thrips on capsicum in polyhouse (IIHR)
6. Biological management of root knot nematode infesting tomato, gerbera in poly houses (ANGRAU, MPKV, SKUAST)

2.17. Storage Pests

1. Evaluation of anthocorid predators against storage pests in rice (AAU-J)

2.18. Weeds

1. Release and establishment of Cecidocharus connexa in Jagdalpur area of Chhattisgarh (DWSR)
2. Natural enemies' complex in different weeds (DWSR)

2.19. Enabling large scale adoption of proven bio control technologies

1. Rice- AAU-J (Adat model)
KAU (Adat model)
OUAT (Large scale adoption of proven bio control technologies)

2. Sugarcane

i. Large scale demonstration of biocontrol for suppression of plassey borer, *Chilo tumidicostalis* using *Trichogramma chilonis* (ANGRAU)
ii. Demonstration of temperature tolerant strain (TTS) of *Trichogramma chilonis* against early shoot borer (ESB) in *Suru* planting of sugarcane (MPKV, PAU)
iii. Use of *Trichogramma chilonis* for the suppression of stalk borer, *Chilo auricilius* in collaboration with sugar mills (PAU)
iv. Demonstration on the use of *Trichogramma japonicum* for the suppression of top borer, *Scirpophaga excerptalis* (PAU)
v. Large-scale Demonstration on the use of *T.chilonis* against early shoot borer and internode borer of Sugarcane in Farmers' field (OUAT, ANGRAU)

3. Maize

i. Demonstration of Biological control of maize stem borer, *Chilo partellus* using *Trichogramma chilonis* and *Cotesia flavipes*

4. Coconut

i. Large area field validation of integrated biocontrol technology against *Oryctes rhinoceros* (CPCRI)

2. EXPERIMENTAL RESULTS

2.1. Basic Research

2.1.1. National Bureau of Agriculturally Important Insects

Biosystematic studies on agriculturally important insects

i. New taxa described

Poropoea bella Hayat & Poorani (Trichogrammatidae) and *Zaplatycerus notialis* Hayat & Poorani (Encyrtidae) were described from Karnataka. *Coccipolipus synonychae* (Acari: Podapolipidae) was described as a parasite of the giant bamboo ladybird, *Synonycha grandis*. *Lohiella longicornis* (Noyes & Hayat) (Encyrtidae) was recorded for the first time from India (Karnataka) and the hitherto unknown male was described. Three new species of Coccinellidae were studied from South India and Uttarakhand. *Anagyrus qadrii* and a fortuitously introduced species of *Anagyrus* were recorded as parasitoids of the Madeira mealybug in and around Bangalore. The latter is being described as b content on Indian insects

An image gallery for agriculturally important insects of India, with particular emphasis on pests of crops, was hosted on NBAII's website and 510 species have been featured so far with over 3000 photographs and details of the current taxonomic position, hosts/ associated habitat, and pest status. This site and "Featured Insects", the site on insect bioagents, have been included in ID Source, a worldwide compendium of web-based identification aids for pest organisms, hosted by USDA and Colorado State University. An interactive LucID Phoenix key to the genera of Mymaridae of India was prepared with fact sheets, diagnostics and illustrations for the 28 genera known so far.

ii. Micrograstrinae (Braconidae)

Described 12 new species of Braconidae: 3 (Indian) and 9 (Afro-tropical): *Micro murkyi* Ankita Gupta, *Glyptapanteles hypermnestrae* Gupta and Pereira, *Dolichogenidea kunhi* Gupta & Kalesh, *Apanteles minatchy* Rousse & Gupta, *Distatrix yunae* Rousse & Gupta, *Dolichogenidea lumba* Rousse & Gupta, *Dolichogenidea uru* Rousse & Gupta, *Exoryza safranum* Rousse & Gupta, *Glyptapanteles chidra* Rousse & Gupta, *Nyereria ganges* Rousse & Gupta, *Nyereria mayurus* Rousse & Gupta and *Wilkinsonellus narangahus* Rousse & Gupta. An international catalogue containing revised microgastrinae (Hymenoptera: Braconidae) fauna of Reunion Island (Indian Ocean), key to all genera and species is provided, thirty four (34) species belonging to 13 genera were recorded along with description of nine (9) new species and new distribution records for 12 species was published.

Revised Indian *Microplitis* Foerster (Hymenoptera: Braconidae): The wasp species of the genus ***Microplitis*** are larval endoparasitoids of economically important agricultural pests, particularly *Helicoverpa* and *Spodoptera* spp. Two species, *M. bageshri* Sathe, Inamdar & Dawale and *M. dipika* (Bhatnagar) were considered *incertae sedis* in the publication. New combination given for *Snellenius maculipennis* (Szepligeti) which is placed into synonymy with *Microplitis*.

Molecular characterization: DNA barcode done for 6 species- GenBank Accession Nos. obtained: *Apanteles galleriae* Wilkinson JN790942; *Fornicia ceylonica* Wilkinson JN613568; *Apanteles hyposidrae* Wilkinson JQ308797; *Apanteles machaeralis* Wilkinson JQ844449; *Apanteles mohandasi* Sumodan & Narendran J**X083405** and *Apanteles taragamae* Viereck JX083404**.**

iii. Biosystematic studies of *Trichogramma*

Surveys were conducted in agricultural and natural ecosystems in parts of South and Western India as well as the Andaman and Nicobar islands for their *Trichogramma/ Trichogrammatoidea* fauna. The areas surveyed in these regions were (i) Southern India: Andhra Prasdesh (Hyderabad), Tamil Nadu (Kotagiri and Ootacamund) and Karnataka (Balehonnur, Mudigere, Chikkabelegere, Kudregundi, Tumkur, Anekal, Mandya, Bengaluru, Mysore, Chintamani, Chikkaballapur, Nandi hill, Chintamani and Doddaballapur), (ii) Western India: Maharashtra (Nasik, Kohlapur, Panhala). Urban areas were also surveyed for these parasitoids. In addition to the collection of insect eggs, sentinel cards, yellow pan traps and pit fall traps were also laid for the collection of trichogrammatids.

Trichogramma rabindrai was collected from fallow agricultural fields while *Trichogrammatoidea bactrae* was collected from citrus orchards in the Andaman islands. This is the first record of *Trichogramma rabindrai* from outside Karnataka / Madhya Pradesh.This is the first record of *T. bactrae* from the eggs of *Prosotas nora* (Lepidoptera:Lycaenidae)itrus. In addition to morphological studies *Trichogramma rabindrai* r new species were studied from a molecular perspective.

iv. Platygastridae

Surveys were conducted for Platygastroidea in five states and union territories, viz., Andaman and Nicobar Islands (South Andaman, Middle Andaman and Little Andaman), Andhra Prasdesh (Hyderabad), Maharashtra (Nasik, Kohlapur, Panhala), Tamil Nadu (Kotagiri and Ooty). In Karnataka collections were extensively made from six different districts, *viz*., Chikkamagalur (Balehonnur, Mudigere, Kudgregundi, Chikkabelegere) Ramanagara (Magadi), Mandya, Bengaluru (Kengeri, Hebbal, Hessaraghatta, Attur, Devanahalli) and Chikkabalapur (Nandi Hills, Chintamani). Different crops viz. sugarcane, rice, maize, pulses, vegetables and fruits in addition to forest and uncultivated fields were surveyed for insect eggs. A total of 1850 parasitoids were collected, curated and preserved for future studies. So far 41 genera under five subfamilies were recorded from India and an additional eleven genera are added, raising the total to 52 genera.

A new genus *Dvivarnus* Rajmohana and Veenakumari is described under the subfamily Teleasinae. One new species under this genus *Dvivarnus punctatus* Veenakumari and Rajmohana was described.

Under the subfamily Sceliotrachelinae three new species were described. *Plutomerus veereshi* Veenakumari, Buhl and Rajmohana*, Fidiobia virakthamati* Veenakumari, Buhl and Rajmohana and *F. nagarajae* Veenakumari, Buhl and Rajmohana were described. The species of *Fidiobia* are the first representatives of the genus from India.

v. Biodiversity of aphids, Coccinnellids and their natural enemies

A total of 296 field trips were conducted in Karnataka (Mandya, Bangalore, Kolar, etc.). Major surveys were conducted in and around Bangalore. Several aphids, mealybugs, scales and their natural enemies, from aphids and coccids collected from these areas, a total of 2490 slides of 1298 specimens were made by following standard procedure. There were twenty four new records during these surveys. Species of aphids viz., *Pleotrichophorus chrysanthemi* (Theobald) and *Reticulaphis foveolatae* (Takahashi) and species of invasive mealybug viz., *Pseudococcus jackbeardsleyi* Gimpel and Miller were recorded for the first time from India. Similarly, *Lohiella longicornis* (Noyes & Hayat) was recorded for the first time from India parasitizing *Drepanococcus chiton* (Green) which is also a new host association.

A total of 260 specimens of were identified for different SAUs, ICAR Institutes and private organizations.

vi. Taxonomic studies on fruit flies (Diptera: Tephritidae) of India

Surveys: In total, 80 collection trips were made in Karnataka, Kerala, Tamil Nadu, Maharashtra, Andaman and Nicobar islands for the collection of fruit flies. 81 species were collected/studied in 33 genera and five subfamilies namely Dacinae, Tephritinae, Trypetinae, Phytalmiinae and Tachiniscinae. About 2400 specimens of fruit flies were added to NBAII collection.

New taxa described and new synonyms proposed: Four new species of *Euphranta* Loew are described from India namely *E. dysoxyli* David, *E. diffusa* David, *E. thandikudi* David and *E. hyalipennis* David & Freidberg and a new species from Sri Lanka, *E. neochrysopila* David, Freidberg, Hancock & Goodger. An illustrated key to 12 species of *Euphranta* from India was published. *E. dissoluta* (Bezzi) and *E. burtoni* Hardy are synonymised with *E. crux* (Fabricius)

New records for India: Four species of tribe Adramini namely *Coelotrypes latilimbatus* (Enderlein), *Dimerinogophrys parilis* (Hardy), *Dimeringophrys pallidipennis* Hardy, *Hardyadrama excoecariae* Lee and an undescribed species of *Coelopacidia* are newly recorded from India. *Ortalotrypeta isshikii* (Matsumura) and subfamily Tachinscinae is recorded for the first time from India.

vii. Diversity and predator - prey interactions with reference to predatory anthocorids and mites

An undescribed species of *Montandoniola* was recorded on *Butea monosperma, Anthocorini* gen. et. sp. from Ficus tree, *Orius maxidentex* recorded for the first time from Andaman Nicobar islands, an undescribed species of *Blaptostethoides* sp. from sugarcane, *Xylocoris afer* was recorded for the first time in India. In Karnataka, *Cardiastethus pseudococci pseudococci* for the first time from mango inflorescence, *Cardiastethus affinis* for the first time as a predator of *Hemiberlesia lataniae* on Agave. Gen Bank accession no.s were obtained for laboratory reared *Blaptostethus pallscens* and laboratory reared *Cardiastethus exiguus* (papaya population); the accession numbers being JQ 609281 and KC886281, respectively.

The reduction in population of gall thrips *Gynaikothrips uzeli* infesting Ficus in May June months was due to the presence of the eulophid parasitoid, *Thripastichus gentilei* (Del Guercio) and from October November months till March due to the anthocorid predator *Montandoniola indica.*

A method has been standardised to rear *Montandoniola indica* a predator of pepper gall thrips *Liothrips karnyi* using UV irradiated *C. cephalonica* eggs as prey and bean pods as ovipositional substrates. The nymph could feed on a total of 27.3 *C. cephalonica* eggs, while adult on 56 eggs.

Cardiastethus affinis, preda*Hemiberlesia lataniae*) infesting agave was amenable to production using *Corcyra cephalonica* eggs. The morphometrics and biology was studied. During the nymphal stage, *C. affinis* could feed on 63 eggs and the adult male and female 197 and 374 eggs, respectively.

Xylocoris (*Proxylocoris*) *afer* (Reuter) was recorded for the first time in India from dry fruits of *Ficus* and *Lagestromia*. It could be reared on *Corcyra* eggs. The biology of this predator was studied.

Blaptostethus pallescens was evaluated against the pupal stage of thrips (exposed and under soil) *Frankliniella schultzei.* The predator could cause 75 to 94% mortality of the pupal stages of *F. schultzei. B. pallescens* was field evaluated against mulberry thrips in Salem. After three releases, the thrips count could reduce from a pre-count of 94.8 to a post count of 20.5, while the corresponding figures in the control were 40.8 and 21.7 thrips per leaf.

Studies on *Trichogramma*

Continuous rearing of *T. embryophagum* for 151 generations on ESW eggs resulted in 92.2% parasitism and 70.7% adult emergence. Five releases of *T. chilonis* reared on Eri silk worm eggs were made @ 10 cards per release at 10 days intervals against paddy borers in AP. The expenditure incurred for plant protection in the chemical control plot was Rs 2000 per acre and biological control Rs 786 per acre. The yield was 33.3, 35.7 and 35 bags (70 kg/bag) per acre in control, bio-control and chemical control plot, respectively. The savings in bio-control plot was Rs 1214 per acre. Six day old parasitized (by *T. chilonis*) eggs of ESW can be effectively stored for a maximum period of one week, resulting in 50% adult emergence and 87.7% female progeny.

viii. Papaya mealybug, *Paracoccus marginatus*

Recurring incidence of papaya mealybug was observed in few locations in Karnataka, Penukonda, Kothanur from Andhra Pradesh, Andaman and Nicobar Islands, Salem and Erode districts of Tamil Nadu. A total of 43 requests for *Acerophagus papayae* were received from April 2012 to February 2013. Recovery of *Anagyrus loecki*, and *Pseudleptomastix mexicana* were also recorded from samples of papaya mealybugs from Erode,Salem, Yelahanka and R.T Nagar of Bangalore showing that the parasitoids are still active in field under low populations. *Acerophagus papayae* was found to be parasitized by *Marietta lepordina (Hymenoptera: Aphelinidae)* and *Chartocerus sp. (*Hymenoptera: Signiphoridae). *2-5 per cent parasitization was found on the papaya mealybug from Parthenium and Sida acuta* weed source where as on papaya *Chartocerus sp.* was dominant but the percent parasitization was also between 2-5%.

Study on the biology of *Anagyrus kamali* and mass production

Biology of the endoparasitoid *Anagyrus kamali* of Pink Hibiscus Mealybug *Meconellicoccus hirsutus* was studied. The culture obtained from Andaman Islands was used for the study. *M. hirsutus* was maintained on potato sprouts and pumpkin. Although *A. kamali* parasitized 2nd instar nymphs there was a marked preference towards the 3rd and adult female mealybugs. The total developmental period of *A. kamali* on the 2nd stage nymph ranged from 25-29 days in case of males and 30-32 days in case of females. Development was faster in later stage nymphs (22 days) and in adult female (20-21days). Longevity of males and female parasitoids varied between 30-32 days and 38-42 days respectively. Water feeding or starved adults could not survive for more than 36 -48 hours. Temperature of 22-25°C was found to be optimum for survival of the parasitoid. At temperature > 25°C the longevity of adults decreased drastically.

Madera mealybug *Phenacoccus madeirensis*

P. madeirensis was recorded on 7.5 ha cotton crop from Bandipur and Gundlupet on *Cestrum nocturnum* , C. *diurnum*, *Acalypha*, *Hibiscus rosa chinensis, Lantana camara, Clerodendron viscosum, Solanum melongina* and *S. tuberosum*, *Crossandra* sp. Tapioca and mulberry plants from different parts of Karnataka and Tamil Nadu were found to be the alternate hosts of *P. madeirensis*. Several natural enemies were observed feeding on *P. Madeirensis.* Main predators were *Cacoxenus perspicax* (drosophillidae: Diptera) and several cecidomiidae. *Cryptolaemus montruzieri and Scimnus sp.* Were *predominantly* feeding on *P. Madeiriensis. Anagyrus loecki, A. qadrii and Anagyrus near Sinope?* (Under taxon description by Poorani*)* were found predominantly parasitising the mealybug.

ix. Studies on *Trichogramma brassicae* and *Cotesia vestalis* (*plutellae*) interaction with *their* host in cabbage

Eighteen populations of *Cotesia vestalis,* the parasitoid of the diamondback moth was collected from different geographical locations of the country, while *Trichogramma brassicae* was collected from Karnataka region. The populations of the parasitoids were characterized for genetic variations and associated endosymbionts.

Yeast and bacterial endosymbionts were isolated, characterized and gene sequences submitted to the Gen bank. The evolutionary relationship between the symbionts across the different populations of the parasitoids was established. The role of endosymbionts in the fitness costs and benefits of the parasitoids in terms of biological attributes and insecticide resistance was determined. *Wolbachia,* an alpha proteobacterium was found to play a major role in the alteration of sex ratio, feminization and contributed enhanced biological attributes (percent parasitisation, longevity and fecundity). The role of *Enterobacter cancerogenous* in the degradation of pesticide Indoxocarb was established.

x. Laboratory rearing of *Leucinodes orbonalis* and insecticide resistance monitoring studies

Brinjal shoot and fruit borer, *Leucinodes orbonalis* is one of the most destructive pests on brinjal in India and many other South and Southeast Asian countries. Farmers spray brinjal crop with insecticides of different brands belonging to different groups indiscriminately. For monitoring insecticide resistance, a sound insect rearing system is

essential. Hence, an attempt has been made to address the deficiencies in existing artificial diets for rearing *L. orbonalis* larvae. The nutritional and phagostimulancy improvements in diet combinations developed herein are useful for rearing of *L. orbonalis* larvae under laboratory conditions. For insecticide resistance monitoring in *L. orbonalis*, the filter paper residue assay was found simple, precise and consistent in larval mortality. Four *L. orbonalis* populations collected from Bangalore, Guntur, Dharmapuri & Coimbatore were subjected to dose mortality bioassays against three insecticides to estimate resistance ratio. The study revealed up to six fold variation in insecticide susceptibility with respect to the insecticides fenvalerate, phosalone and Emamectin benzoate in the populations of *L. orbonalis* tested. Quantification of midgut carboxylesterase from these four populationsof *L. orbonalis* revealed significantly elevated activity in larvae collected from Guntur region.

xi. Culturable microflora associated with *Amrasca biguttula biguttula* (Cotton leafhoppers) and *Nilaparvata lugens* (Brown Planthopper of rice)

Culturable microflora associated with the sixteen populations of *Amrasca biguttula biguttula* (Cotton leafhoppers) of various cotton growing areas of the country were characterized through morphological and molecular methods. The microflora identified through 16S rDNA analysis were as S*erratia marcescens*, *Lysinibacillus sphaericus*, *Proteus mirabilis, Staphylococcus pasteuri*, *Enterococcus silesiacus,*, *Bacillus* sp., *Bacillus amyloliquefaciens*, *Pantoe anthophila*, *Pantoea* sp*., Enterobacter asburiae, Ralstonia pickettii*, *Bacillus anthracis*, *Methylobacterium komagatae, Ralstonia solanacearum*, *Ralstonia pickettii, Agrobacterium* sp., *Bacillus anthracis*, *Enterobacter cowanii*, *Bacillus megaterium*,*Erwinia persicina*, *Erwinia persicina*, *Pseudomonas geniculata*, *Stenotrophomonas maltophilia, Methylobacterium komagatae*, *Naxibacter varians*, *Bacillus atrophaeus*, *Stenotrophomonas maltophilia*, *Hymenobacter gelipurpurascens*, *Staphylococcus gallinarum*, *Stenotrophomonas maltophilia*, *Bacillus cereus*, *Bacillus subtilis, Brevibacterium halotolerans, Stenotrophomonas maltophilia*, *Xanthomonas* sp, *Stenotrophomonas maltophilia, Enterobacter hormaechei, Microbacterium oxydans* and *Stenotrophomonas maltophilia.*

The culturable bacteria associated with *Nilaparvata lugens* of Hyderabad population were identified through 16S rDNA analysis as *Stenotrophomonas* sp., *Serratia marcescens*, *Staphylococcus sciuri*, *Acinetobacter gyllenbergii*, *Acinetobacter bereziniae*, *Serratia marcescens* and *Serratia* sp.

xii. Selection of superior strain of predators *viz*., *Chrysoperla zastrowi arabica* (Stephens) and *Cryptolaemus montrouzieri* (Mulsant) from different agro-ecosystems and their molecular characterization.

Genetic stocks of twelve different geographical populations of *C. z. arabica* and 6 different populations of *C. montrouzieri* were maintained. Studies on biological attributes of different populations of *C. montrouzieri* at variable temperatures (32-40 ºC) revealed that most of the populations survived for 60 days and Coimbatore and Shimoga population survived for 70 days and were able to reproduce and laid fertile eggs. Such progenies were selected and were further reared. Further, 15 days old larvae of *C. montrouzieri* collected from different geographical areas were also exposed to variable temperature and the larvae were survived for 8-10 days and there was no difference in longevity among the population.

A study was undertaken to select the acephate tolerant population of *C. montrouzieri*. Among four populations, survival of Bangalore (24%) and Pune (17 %) populations were comparatively more than other populations. Similarly 20 days old larvae of the four populations were exposed to field recoomended dosage of Acephate (0.67g/l) and mortality after 24 hrs was recorded. Survival of Bangalore (37%) and Pune (26%) were relatively more than other populations. Such selected populations were maintained on mealybugs.

Studies on fixing field release schedule of pesticide tolerant and susceptible strain of *C. z. arabica* revealed that there was 84 % survival in pesticide tolerant strain and 33 % in susceptible population and 84%, 98% and 98% on 1, 2 and 3 days after spray, respectively. In case of susceptible population, it is 66%, 72% and 84% on 1, 2 and 3 days after spray. Base on this study, it was decided to release the predators along with pesticide on the same day against pests of cotton.

Field evaluation of pesticide tolerant strains against sucking pests of cotton revealed that two releases of PTS (Cza-8) at 15 days interval in combination with two sprays of acephate (0.67g/li) (13.4aphids/plant) was effective against *A. gossypii*, *Thrips tabaci* and also had highest cotton yield (1533 kg/ha). This was significantly superior to susceptible population and on par with 4 sprays of acephate (0.67g/l). Similarly, an acephate tolerant strain of *C. montrouzieri* was selected and transferred to mass production lab. PCR amplification of cytochrome c oxidase (COI) gene of *Chrysoperla z. arabica viz.*, Cza-8 and Cza-6 was done and sequenced (524 bp) which will be useful for the development of DNA barcode of chrysopid predators. Sequence of COI gene of Cza-8 was submitted to GenBank and the Acc. No. is GU817334 (524 bp). Pesticide tolerant strain of *C. z. arabica* (Cza-8) (tolerant to Op, ocl and synthetic pyrethroids) was mass produced and 12,000 nos. were supplied to Mr. Banergee, NGO for field release against sucking pests of capsicum at Varanasi, Uttar Pradesh. Mass produced and supplied 5,000 nos. of pesticide tolerant strain of *C. z. arabica* (group) against tea mosquito bug, *Helopeltis antonii* on tea at Amalgamated plantations Pvt. Ltd, Jorhat, Assam. In this project, a pesticide tolerant population of *C. z. arabica* was successfully selected and is transferred to mass production laboratory.

xiii. Genetic diversity, biology and utilization of entomopathogenic nematodes (EPN) against cryptic pests

- **Surveys for white grubs and entomopathogenic nematodes:** Conducted surveys in rootgrub endemic sugarcane areas of north Karnataka and Maharashtra for grubs, eggs and infected cadavers. Recorded endemicity of *Holotrichia serrata, H. consanguinea, Anamola spp., Leucopholis lepidophora, Lepidiota mansueta, Phyllophaga calciata, Phyllognathus dionycius* species. Identified endemic fields of farmers and conducted *in situ* field evaluation studies in Maharashtra. Three new isolates of *Heterorhabditis* spp. and *S. abbasi* were recorded from diseased grubs collected from north Karnataka-Maharashtra border and added to NBAII collections. Totally eight new EPN strains isolated and catalogued.

- **Molecular identification and DNA Barcoding for EPN:** Identity of 10 different geographical isolates of *S. abbasi, S. feltiae, H. indica* and *H. bacteriophora* were validated and confirmed using COI, ITS and SSU RNA gene sequences and RFLP studies were carried out. DNA Barcoding for eight *Steinernema abbasi*, *Heterorhabditis indica*, *Heterorhabditis bacteriophora* were generated for the first time from India for NBAII isolates using COI gene.

- **Morphometric analysis of NBAII isolates of EPN, and development of identification key:** Morphometric data for infective juveniles, males and females of 1st generation *S. carpocapsae, S. feltiae, S. glaseri, S. riobrave, Heterorhabditis indica* and *H. bacteriophora* based on the NBAII isolates were recorded and analyzed. Based on the identification key developed previously, IJs, females and males of *Steinernema* and *Heterorhabditis* isolates were analyzed for identification.

- Biology and development of *Heterorhabditis indica* strain NBAII 101 was studied *in vivo* with larvae of *Galleria mellonella, Spodoptera litura, L. lepidophora, M. subfasciatus* as hosts. At 28° C *in vivo*, the duration of the life cycle from egg hatch to egg hatch, duration of juvenile stages, and proportions of males, females and juveniles were recorded.

- Predominant whitegrub species in sugarcane of Kolhapur region (Maharashtra) are *Phyllophaga calciata, Leucopholis lepidophora, Anomala* species. LD50 and LT50 values for *H. indica, H. bacteriophora, S. abbasi, S. carpocapsae, S. tami, S. glaseri* were worked out against *Phyllophaga*. Grub populations of *Lepidiota mansueta* Burmeister (Coleoptera: Scarabaeidae) from Majauli, Assam, were screened for susceptibility to EPN isolates. NBAII isolates of *H. indica, S. abbasi* and *S. glaseri* were effective at $2.5x10^9$ IJs/ha causing a mortality of 80-96% in soil column assay in 7days.

- Effect of EPN formulations on incidence of *Myllocerus subfasciatus* grubs in brinjal : Application of wettable powder preparations/formulations of *H. indica, S. abbasi and S. glaseri* at 2.0 $x10^{13}$ IJs/ha at transplanting reduced incidence of grubs of *Myllocerus subfasciatus* in brinjal (Purple Round) by 44-68% in field and improved yield by 18-24% over control.

- Field evaluation of methods of delivery of EPN against brinjal ash weevil grubs: Application of WP formulations of three entomopathogenic nematodes compared to use of *Galleria* cadaver preparations reduced incidence of grubs, *Myllocerus subfasciatus* in brinjal by 68% and increased yield by 24%.

- Effect of combination of EPN with entomopathogenic fungi on the incidence of *Myllocerus subfasciatus:* Field evaluation of combinations of EPN and *Beauvaria bassiana* and *Metarhizium anisopliae* against brinjal ash weevil grubs indicated that *H. indica* in combination with *M. anisopliae* gave 73% control of grubs in soil observed at 90 and 120days of crop growth.

- Field demonstration of efficacy of EPN formulations against whitegrubs in sugarcane in western Maharashtra: Demonstrated efficacy of EPN formulations against *Leucopholis burmeisteri, Phyllophaga* sp., and *Phyllognathus dionycius* in sugarcane (3 acres each) in 3 villages in Malkapur area of Kolhapur district of Maharashtra.

- Demonstrated field efficacy of EPN formulations against whitegrubs, *Lepidiota mansuata* and *Holotrichia* species in sugarcane in western UP. WP formulations of *H. indica* and *S. abbasi* reduced 30-48% grubs in 2 locations in UP in 45-60 days.

- WP formulations of *H. indica* NBAII Hi01, *S. abbasi* NBAII Sa01, *S. carpocapsae* NBAII Sc04, *S. glaseri* Sg01 recovered tillering, cane length, reduced grubs by 48-64% & persisted for240days in west UP, Maharashtra, Belgaum.

- LC and LT for *H. indica* NBAII Hi01, *H. bacteriophora* NBAII Hb05 and *S. abbasi* NBAII Sa01 against cryptic pests – coffee stem borer, sod webworm (*Herpetogramma phaeopteralis* Guenee) in turf were worked out under lab conditions.

a. Supply of EPN formulations to AICRP centres for field trials: Mass produced *H. indica, S. abbasi* and *S. carpocapsae* and supplied their sponge and talc formulations to 14 centres of AICRP Biological control of crop pests, diseases, weeds & nematodes and 10 centres of AICRP white grub and soil arthropod pests.

b. Technology transfer and commercialization: Transferred technologies related to *in vivo* production, down-stream processing and development of formulations of *Heterorhabditis indica* strain NBAIIHi1, and their field use for the management of whitegrubs, on sale to three entrepreneurs including Camson Biotech Ltd., Bangalore, and FARMER, Ghaziabad and generated revenue worth Rs. 3.5 lakhs.

c. Revenue generation through licensing of technologies: IP protected technologies on *in vivo* production, downstream processing and development of WP formulation of *H indica* were licensed to Ms. Camson Biotech, Bangalore and FARMER, Ghaziabad on non-exclusive basis and revenue to the tune of Rs.3.5 lakhs was generated.

d. Supply of live insect derived germplasm/bioagents: Pure cultures of *Heterorhabditis indica, S. carpocapsae* and *Steinernema abbasi* to Dr. Gavas Ragesh, Entomologist, Cashew Research Station, KAU, were supplied with the assurance of submitting MTA for research purpose.

e. Organization of national/international meeting/Brain storming Session: Brain storming session on *Roadmap for Entomopathogenic Nematode Research and Application/Utilization in IPM* on 20/4/2012, NBAII, Bengaluru.

xiv. Mapping of the *cry* gene diversity in hot and humid regions of India

Sampling was conducted in the North East Andamans and Western Ghats and a total of 109 isolates were characterized for crystal production, the crystal shapes expressed were of bipyramidal, square, rhomboidal and irregular.

Seven isolates were characterized for the coleopteran specific *cry*3A gene and partial sequences submitted to GenBank. The complete coding sequence (1.9kb) of *cry*3A and was amplified in 2 isolates. SDS PAGE analysis showed presence of the 73kDa protein corresponding to *cry*3a. Another coleopteran toxic cry gene (*cry*8a) was characterized 8 isolates. Sequence analysis of vip3A gene (broad spectrum lepidopteran activity) was completed in 8 isolates and the same were submitted to GenBank. Further studies were carried out to purify the *vip*3A protein SDS-PAGE analysis revealed the 90kDa protein in two of the isolates. Crude preparations of *vip*3A protein obtained form 20 isolates were analyzed for toxicity against second instar larvae of *Spodoptera litura* and the protein from two of the isolates (EG1 and BtAN4) showed high toxicity with a LC_{50} value of 9.09 and 9.92 µg/ml respectively. Evaluation of liquid formulation of NBAII-EG1 against pigeon pea pod borer (*Helicoverpa armigera*) showed that the per cent pod damage

was 11.20% with 2% spray of NBAII-EG1 and was on par with insecticide spray (11.11% pod damage).

xv. Evaluation of fungal pathogens on *Aphis craccivora* in cowpea and *Bemisia tabaci* in tomato and capsicum.

A field trial for evaluation of entomofungal pathogens on cowpea aphid (*Aphis craccivora*) in cowpea (variety, KBC-2) was carried out with nine isolates of entomopathogenic fungi (*B. bassiana* Bb-36, Bb-68 & Bb-9, *M. anisopliae* Ma-42, Ma-41& Ma-6 and *L. lecanii* Vl-8, Vl-12 & Vl-32) during kharif, 2012. Three rounds of foliar sprays of oil formulations of fungal pathogens at a spore dose of $1x10^8$ cfu/ml were applied at monthly intervals during September-November 2012. Among the nine isolates tested, Ma-6 & Ma-41 of *M. anisopliae*, Vl-32 of *L. lecanii* and Bb-68 of *B. bas*siana reduced 65.60-76.61% of aphids/plant. Ma-6 & Ma-41 isolates also showed significantly higher yields (29.59 & 27.87grams/plant respectively) compared to control (20.89grams/plant). No significant difference in the natural population of coccinnellids was observed in the fungal treated plots and untreated control indicating the safety of fungal pathogens to the natural enemy of cowpea aphid (coccinellids).

Evaluation of entomofungal pathogens on *Bemisia tabaci* infestation in tomato (variety, NS501) and capsicum (var. Indria) was carried out in the polyhouse at NBAII Farm, Attur with nine isolates of entomopathogenic fungi (*B. bassiana* Bb-36, Bb-68 & Bb-9, *M. anisopliae* Ma-42, Ma-41& Ma-6 and *L. lecanii* Vl-8, Vl-12 & Vl-32) during June-October, 2012. The trial was laid out in RBD with three replications for each treatment with 24 plants. Four rounds of foliar sprays with oil formulations of fungal pathogens at a spore dose of $1x10^8$spores/ml were applied at 15 days intervals during July-September, 2012. Among the nine entomofungal pathogens tested, foliar spray with *B. bassiana* (Bb-9 isolate) reduced 69.29 & 71.17% white fly population in tomato & capsicum respectively followed by *L. lecanii* (Vl-8 isolate) which reduced 62.45% & 66.67% white fly population in tomato & capsicum respectively.

xvi. Management of pests with pheromone nanogels

Novel nanogels were synthesized in collaborations of Dept., of Org. Chem., IISc using supramolecular self-assembly principles to increase the field-life of various nanogel-absorbed pheromones employed to disrupt the lifecycle of harmful crop pests such as *Bactrocera dorsalis* (Hendel); *Helicoverpa armigera* (Hubner) (Lepidoptera, Noctuidae); *Scirphophaga incertulas* (Walker) (Lepidoptera, Pyralidae); *Leucinodes orbonalis* (Guenee) (Lepidoptera: Pyralidae); *Xylotrechus quadripes* (Chevrolat) (Coleoptera: Cerambycidae), and others. Also, nanogels were used to prolong the effectiveness of kairomones, which can control pests by attracting their natural predators and parasitoids. These novel materials allow for the slow release, and therefore extended effectiveness, of absorbed pheromones or kairomones. Thus, they can deliver pheromones or kairomones at the *right place*, *right time*, and at the *right dosage* for effective pest control. Furthermore, these proven approaches can be scaled up for deployment in the agricultural field in a cost-effective and environmentally friendly fashion.

xvii. Non target effect of Chitosan alginate nanoparticles on the biology of *Chrysoperla zastrowi sillemi* (Esben-Peterson) (Neuroptera: chrysopidae).

The biosafety of nanoparticles, in terms of their effects on the natural enemies had been established. Non-target effects of chitosan alginate nanoparticles on the biology of the

Chrysoperla zastrowi sillemi (Esben-Peterson) were studied through the F1 generations, and it was concluded that there were no lethal effects, as established with histopathogy analysis. The experiment was conducted to feed larval stage of *C. Zastrowi* with two treatments, one control fed with *Corcyra Cephalonica* Stainton and second *C. Cephalonica* Stainton mixed with chitosan alginate nanoparticles (CANPs) ratio 1:1. The adults were fed with pollen and pollen mixed with CANPs ratio 1:1. The results were statistically non significant revealed that survival percentage of larva, pupa, male and female are at par on control and treatment (**Table 1**), revealed no deleterious effect of CANPs on natural enemies *C. zastrowi* Sillemi. This was further supported by histopathology results on microscopic examination of larval stage, no change was observed in the head and mouth parts, in midgut of control and treatment male insects. When comparing the smooth muscle of control and treatment female insects, no abnormal change was detected. The scientific analysis obtained from the experiment will improve the basis for decision making under scientific uncertainty and thereby contribute to a socially robust development and application of chitosan alginate nanoparticles as the carrier for various agromaterials.

Table 1: Non target effect on the developmental stages of *C. zastrowi* sillemi on treatment of control and CANPs under laboratory condition

Observations	Survival			
	Larva	Pupa	Male	Female
Group 1	92.35[a]	94.57[a]	60.41[a]	31.94[a]
Group 2	87.49[a]	92.77[a]	50.69[a]	19.43[a]
SEd	3.69	3.6	9.82	6.42
CD (P=0.01)	10.4	10.16	27.68	18.09
CV %	10.06	9.42	43.29	61.21

2.1.2. Indian Agricultural Research Institute, New Delhi

1. Survey and collection of *Trichogramma* strains from different agro-climatic zone of India.

Surveys were conducted in Punjab, Haryana and Bihar to collect locally available Trichogrammatids by using *Corcyra cephalonica* egg cards. Efforts were also made to collect eggs of the prevalent insect pest species of different crops grown in the region. The samples were brought to laboratory and incubated for parasitoid emergence. The Trichogrammatids emerged were reared under laboratory conditions on *C. cephalonica* eggs (**Table 2& 3**).

2. Evaluation of *Trichogramma* strains for searching efficiency, temperature tolerance and fecundity.

All the populations could tolerate temperatures up to 30^{o}C under laboratory conditions. Fecundity using ten pairs of each population was estimated. No significant differences were observed among the populations. However, significant differences were observed amongst the population of different Taluks. Populations collected from different nearby villages were pooled and allowed to interbreed to obtain a sizable population. They were reared continuously for 9 generations and then isofemale lines were maintained. These were than evaluated for fecundity. It was found that the isofemale lines had relatively lower fecundity, *viz*., Sirsa, Haryana (61), Ballabhgarh, Haryana (85), Nawanshahr, Punjab (98), Morinda, Punjab (98) and Silao, Bihar (46). Searching efficiency of the strains could not be estimated under laboratory/net-house conditions (**Table 4**).

Table 4: Fecuntity of *Trichogramma* strains collected from different locations

Village	Avg.Fecundity*	Avg.	Village	Avg.Fecundity*	Avg.
Sirsa, Haryana			**Ballabhgarh, Haryana**		
Chakarian	60	61	Khera	80	85
Handi Khera	62		Machgarh	90	
Baidwala	61		Sotai	85	
Sikandarpur	64		Panhera Khurd	82	
Bajekan	58		Dayalpur	88	
Nawanshahr, Punjab			**Morinda, Punjab**		
Gujjarpur Kalan	100	98	Bamnara	101	98
Mahalon	96		Dholan Majra	100	
Mehandpur,	98		Kanjla,	98	
Durgapur	96		Kishanpur	96	
Kulam	100		Ranjian	95	
Silao, Bihar					
Nanad	44	46			
Chorsua	49				
Sipah	48				
Sohsarai	44				
Silao	45				

*Average fecundity of ten pairs

Table 2: Name of Insect/ microbial agent: *Trichogramma* spp.

Geographical & other details			
Scientific name of the insect	*Trichogramma* spp	*Trichogramma* spp	*Trichogramma* spp
Common name of the insect	*Trichogramma* spp	*Trichogramma* spp	*Trichogramma* spp
Location	*Handi Khera, Baidwala, Sikandarpur, Chakarian and Bajekan*	*Handi Khera, Baidwala, Sikandarpur, Chakarian and Bajekan*	*Khera, machgarh, Sotai, Panhera Khurd and Dayalpur*
Taluk, district & Agro-climatic zone	Sirsa, Sirsa is located in Western Zone (HR-2) agro-climatic zone	Sirsa, Sirsa is located in Western Zone (HR-2) agro-climatic zone	Ballabhgarh, Faridabad is located in North-west plain agro-climatic zone.
Distance from the HQ	257 Km	257 Km	50 Km
Date of survey	11/08/2012	11/08/2012	16/09/2012
Host crop/ sole crop/ intercrop/ etc.	Cotton sole crop	Cotton sole crop	Tomato sole crop
Stage of the crop	Reproductive stage	Reproductive stage	Fruiting stage
Stage of the insect pest	Adults	Adults	Adults
Weather parameters recorded (max, min temp; rainfall, no. of rainy days)			
GIS data	*Sirsa* is located between 29.14-30.0 North *latitude* and 74.29-75.18 East longitudes.	*Sirsa* is located between 29.14-30.0 North *latitude* and 74.29-75.18 East longitudes.	28.35255 Latitude 77.3294 Longitude
Pesticide usage pattern	Two sprays of indoxacarb	Two sprays of indoxacarb	One spray of deltamethrin

Table 3: Name of Insect/ microbial agent: *Trichogramma* spp.

Geographical & other details			
Scientific name of the insect	*Trichogramma* spp	*Trichogramma* spp	*Trichogramma* spp
Common name of the insect	*Trichogramma* spp	*Trichogramma* spp	*Trichogramma* spp
Location	*Gujjarpur Kalan, Mahalon, Mehandpur, Durgapur and Kulam*	Bamnara,Dholan Majra, Kanjla, Kishanpur and Ranjian	*Nanad, Chorsua, Sipah, Sohsarai and Silao*
Taluk, district & Agro-climatic zone	Nawanshahr, Nawanshahr and is located in undulating plain agroclimatic zone	Morinda, Rupnagar and is located in undulating plain agro-climatic zone	Silao, Nalanda, and agro-climatic zone is BI-3 south Bihar alluvial plain zone
Distance from the HQ	326 Km	278 Km	1096 Km
Date of survey	25/08/2012	26/08/2012	02/09/2012
Host crop/ sole crop/ intercrop/ etc.	Sugarcane sole crop	Sugarcane sole crop	Tomato sole crop
Stage of the crop	Vegetative stage	Vegetative stage	Fruiting stage
Stage of the insect pest	Adults	Adults	Adults
Weather parameters recorded (max, min temp; rainfall, no. of rainy days)			
GIS data	31.06539 Latitude *and* 76.04339 *Longitude*	30.79013 Latitude *and* 76.48255 *Longitude*	25.11449 Latitude and 85.41389 Longitude
Pesticide usage pattern	No insecticide applied	No insecticide applied	Two sprays of metasystox

3. Breeding for better performing strains (Laboratory studies)

The field collected strains were maintained under laboratory conditions using *C. cephalonica* eggs. The better performing strains were used for further crossings. The details of the crosses made and breeding performance has been presented.

TCS-31 (male) x TFC (female) DA 27°C			
	No. of adults emerged	F2	F3
1	No parasitization		
2	35	Par.	Par.
3	54	Par.	Par.
4	51	Par.	Par.
5	29	Par.	Par.
6	78	Par.	Par.
7	62	Par.	Par.
8	59	Par.	Par.
9	No parasitization		
10	35	Par.	Par.
11	29	Par.	Par.
12	51	Par.	Par.
13	46	Par.	Par.
14	16	Par.	Par.
15	No parasitization		

Out of 15 pairs selected there was no parasitization in three pairs. In F3 generations 12 pairs were selected and shifted to 30°C.

TCS-31 (female) x TFC (male) | DB | 27°C			
	No. of adults emerged	F2	F3
1	72	Par.	Par.
2	26	Par.	Par.
3	49	Par.	Par.
4	35	Par.	Par.
5	65	Par.	Par.
6	49	Par.	Par.
7	70	Par.	Par.
8	34	Par.	Par.
9	No parasitization		
10	No parasitization		
11	39	Par.	Par.
12	56	Par.	Par.
13	62	Par.	Par.
14	No parasitization		
15	No parasitization		

Out of 15 pairs selected there was no parasitization in four pairs. In F3 generations 11 pairs were selected and shifted to 30°C.

TCS-31 (male) x TFC (female) DA 30°C				
	No. of adults emerged	F2	F3	F4
1	18	Par.	Par.	Par.
2	48	Par.	Par.	Par.
3	32	Par.	Par.	Par.
4	82	Par.	Par.	Par.
5	37	Par.	Par.	Par.
6	30	Par.	Par.	Par.
7	70	Arrhenotoky		
8	58	Arrhenotoky		
9	No parasitization.			
10	35	Par.	Par.	Par.
11	42	Par.	Par.	Par.
12	No parasitization			
13	39	Par.	Par.	Par.
14	41	Par.	Par.	Par.
15	No parasitization			

Out of 15 pairs selected there was no parasitization in three pairs and in F2 generation out of 13 sets there was arrhenotoky in two sets. The culture of all sets is maintained and is running in F4 generation.

TCS-31 (female) x TFC (male) DB 30°C				
	No. of adults emerged	F2	F3	F4
1	No parasitization			
2	52	Arrhenotoky		
3	79	Par.	Par.	Par.
4	No parasitization			
5	35	Par.	Par.	Par.
6	25	Arrhenotoky		
7	No parasitization			
8	No parasitization			
9	47	Arrhenotoky		
10	59	Arrhenotoky		
11	41	Par.	Par.	Par.
12	52	Par.	Par.	Par.
13	No parasitization			
14	No parasitization			
15	52	Par.	Par.	Par.

Out of 15 pairs selected there was no parasitization in six pairs and in F2 generation out of 9 sets there was no parasitization in four sets. The culture of all sets is maintained and is running in F4 generation.

TFC (male) x TCSHF (female) | CA | 27°C				
	No. of adults emerged	F2	F3	F4
1	89	Par.	Par.	Par.
2	31	Par.	Par.	Par.
3	83	Par.	Par.	Par.
4	86	Par.	Par.	Par.
5	72	Par.	Par.	Par.
6	No parasitization			
7	75	Par.	Par.	Par.
8	69	Par.	Par.	Par.
9	102	Par.	Par.	Par.
10	112	Par.	Par.	Par.
11	No parasitization			
12	32	Par.	Par.	Par.
13	71	Par.	Par.	Par.

Out of 13 pairs selected there was no parasitization in two pairs. The higher fecundity set was selected for higher temperature i.e. 30°C. In F4 generations 15 pairs were selected and shifted to 30°C.

TFC (female) x TCSHF (male) CB 27°C					
	No. of adults emerged	F1	F2	F3	F4
1	78	Par.	Par.	Par.	Par.
2	86	Par.	Par.	Par.	Par.
3	105	Par.	Par.	Par.	Par.
4	108	Par.	Par.	Par.	Par.
5	111	Par.	Par.	Par.	Par.
6	65	Par.	Par.	Par.	Par.
7	90	Par.	Par.	Par.	Par.
8	84	Par.	Par.	Par.	Par.
9	72	Par.	Par.	Par.	Par.
10	98	Par.	Par.	Par.	Par.
11	27	Par.	Par.	Par.	Par.
12	62	Par.	Par.	Par.	Par.

In all the pairs parasitization was there. The higher fecundity set was selected for higher temperature i.e. 30°C. In F4 generations 12 pairs were selected and shifted to 30°C.

TFC (male) x TCSHF (female) CA 30°C										
	No. of adults emerged	F2	F3	F4	F5	F6	F7	F8	F9	F10
1	47	Arrhenotoky								
2	98	Arrhenotoky								
3	75	Arrhenotoky								
4	41	Arrhenotoky								
5	59	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
6	83	Arrhenotoky								
7	42	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
8	No parasitization									
9	104	Arrhenotoky								
10	48	Arrhenotoky								
11	79	Arrhenotoky								
12	67	Arrhenotoky								
13	No parasitization									
14	No parasitization									

Out of 14 pairs selected there was no parasitization in three pairs but in F2 generation there was no parasitization in 10 sets, because of arrhenotoky. The higher fecundity set was selected in F10 generation and shifted to 32°C

TFC (female) x TCSHF (male) CB 30°C									
	No. of adults emerged	F2	F3	F4	F5	F6	F7	F9	F10
1	No parasitization								
2	34	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
3	No parasitization								
4	33	Arrhenotoky							
5	No parasitization								
6	85	Arrhenotoky							
7	55	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
8	41	Arrhenotoky							
9	48	Arrhenotoky							
10	82	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
11	35	Arrhenotoky							
12	No parasitization								
13	49	Arrhenotoky							
14	51	Arrhenotoky							
15	42	Arrhenotoky							

Out of 15 pairs selected there was no parasitization in four sets but in F2 generation there was no parasitization in 8 sets, because of arrhenotoky. The higher fecundity set was selected in F10 generation and shifted to 32°C.

TFC (male) x TCSHF (female) CA 32°C										
	No. of adults emerged	F2	F3	F4	F5	F6	F7	F8	F9	F10
1	No parasitization									
2	45	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
3	No parasitization									
4	No parasitization									
5	No parasitization									
6	No parasitization									
7	70	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
8	50	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
9	30	Arrhenotoky								
10	61	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
11	43	Arrhenotoky								
12	45	Arrhenotoky								
13	21	Arrhenotoky								
14	47	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
15	No parasitization									

Out of 15 pairs there was no parasitization in six pairs in F1 generation and in F2 generation out of 9 sets there was no parasitization in 4 sets because of arrhenotoky. The culture of all the sets is maintained and is running in F10 generation at 32°C.

TFC (female) x TCSHF (male) CB 32°C										
	No. of adults emerged	F2	F3	F4	F5	F6	F7	F8	F9	F10
1	39	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
2	66	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
3	37	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
4	Arrhenotoky									
5	33	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
6	55	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
7	39	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
8	Arrhenotoky									
9	47	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
10	51	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
11	78	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
12	36	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
13	63	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
14	18	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.	Par.
15	22	Arrhenotoky								

Out of 15 pairs selected there was no parasitization in two pairs in F1 generation and in F2 generation there was arrhenotoky in one set only, showing males in F1 generation. The culture of all the sets is maintained and running in F10 generation at 32°C.

Par. = Parasitization

TRA (female) x TCS-31 (male) EA 27°C			
	No. of adults emerged	F2	F3
1	95	Par.	Par.
2	28	Arrhenotoky	
3	69	Par.	Par.
4	12	Arrhenotoky	
5	52	Par.	Par.
6	86	Par.	Par.
7	72	Par.	Par.
8	32	Par.	Par.
9	78	Par.	Par.
10	59	Par.	Par.
11	No parasitization		
12	26	Par.	Par.
13	65	Par.	Par.
14	No parasitization		
15	39	Par.	Par.

Out of 15 pairs selected there was no parasitization in two pairs. In F2 generation out of 13 sets there was no parasitization in two sets. The culture of all the sets is maintained and running in F3 generation at 27°C. Par. = Parasitization

TRA (male) x TCS-31 (female) EB 27°C			
	No. of adults emerged	F2	F3
1	52	Arrhenotoky	
2	72	Par.	Par.
3	No parasitization		
4	35	Arrhenotoky	
5	79	Par.	Par.
6	84	Par.	Par.
7	85	Par.	Par.
8	33	Arrhenotoky	
9	46	Arrhenotoky	
10	63	Par.	Par.
11	75	Par.	Par.
12	No parasitization		
13	71	Par.	Par.
14	82	Par.	Par.
15	43	Par.	Par.

Out of 15 pairs selected there was no parasitization in two pairs. In F2 generation there was no parasitization in four sets because of arrhenotoky. The culture of all the sets is maintained and running in F3 generation.

2.1.3. Biodiversity of Biocontrol Agents from Various Agro Ecological Zones

1. Survey, Collection and diversity analysis of biocontrol agents from various agro ecological zones (AAU-A, AAU-J, ANGRAU, KAU, MPKV, PAU, SKUAST, TNAU, YSPUHF, CAU, JNKVV, MPUAT, OUAT, CPCRI, CTRI and UAS-Raichur)

AAU-A

Location **:** Anand, Kheda, Baroda and Ahmedabad districts
Year of commencement **:** 2012-13
Season and year **:** *Kharif* 2010 (Second year)

Experimental details

1. ***Trichogramma*:** The geographical population to be collected from different crop ecosystems by placing sentinel cards with eggs of *Corcyra cephalonica* / original host eggs.

2. ***Chrysoperla*:** Five geographic populations (at least 20 in each population) are to be collected.

3. ***Cryptolaemus*:** Five geographic populations (at least 20 in each population) are to be collected.

4. The cadavers of insects infected by entomopathogens are to be collected.

5. **Insect-derived EPNs:** Collect 250cc soil samples (root zone depth) from different area of survey

6. Soil samples for isolation of antagonistic organisms

Results

1. *Trichogramma*: During 2012-13, trichocards with eggs of *Corcyra cephalonica* were placed in cotton, paddy, maize, sugarcane, groundnut and castor fields for parasitism by *Trichogramma* in different geographical areas and collected after 3 days and observed for emergence of *Trichogramma*. Similarly, eggs of host insects were collected at fortnightly intervals from cotton (*H. armigera*), paddy and castor (*A. janata*). As *Trichogramma* were collected in very low numbers they were multiplied separately in the laboratory.

2. *Chrysoperla*: Populations of the green lacewing, *Chrysoperla zastrowi sillemi* (Esben-peterson) were collected from different geographic locations.

3. *Cryptolaemus*: Diversity of coccinellids from various crop ecosystems of the region was studied. Natural populations of *C. montrouzieri* were not observed throughout the year as the incidence of cotton mealybug, the host insect was not noticed.

4. Entomopathogens: Cadavers of 5 dead insects were collected from the field. The larvae were surface sterilized, rinsed with sterile distilled water, suspended in 3 ml. sterile

distilled water and crushed with sterile glass rod. Wet mount of the suspension was observed under phase contrast microscope. The results obtained are presented in **Table 5**.

Table 5 : Entomopathogen diversity from dead insect cadavers

Sr. No.	Insect	Dominant Entomopathogens/ microbes recorded
1	*Helicoverpa armigera*	HearNPV
2	*Helicoverpa armigera*	HearNPV
3	*Helicoverpa armigera*	Saprophytic *Bacillus* sp.
4	*Helicoverpa armigera*	Saprophytic *Bacillus* sp. & *Cocobacillus*
5	*E. vitella*	Saprophytic *Bacillus* sp.

5. Spiders: Spiders (478) specimens were collected from the rice ecosystem in 37 villages in Anand district, Gujarat by pitfall traps as well as general collection following standard procedure (**Table 6**).

Table 6: Spiders collected from rice field in Anand district, Gujrat.				
Jahangirpura				
Sr. No.	**Specimen No.**	**Family**	**Genus**	**Species**
1	1a1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
2	1a2	Araneidae	*Neoscona*	*theisi* ♀
3	1b1	Tetragnathidae	*Tetragnatha*	*javana* ♀
4	1b2	Araneidae	*Neoscona*	*theisi* ♂
5	1b3	Tetragnathidae	*Leucauge*	sp. ♀ (Abd. pressed)
6	1b4	Araneidae	*Cyrtophora*	*cicatrosa* ♀(Abd.pressed)
7	1c1	Araneidae	*Cyrtophora*	sp. ♀ juv.
8	1c2	Araneidae	*Argiope*	*anasuja* ♀ (Abd. pressed)
9	1c3	Araneidae	*Neoscona*	*theisi* ♀
10	1d1	Araneidae	*Neoscona*	*theisi* ♀ juv.
11	1d2	Tetragnathidae	*Tetragnatha*	*javana* ♀
12	1d3	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
13	2a1	Araneidae	*Argiope*	sp. ♀ juv.
14	2c1	Araneidae	*Argiope*	*anasuja* ♀
15	2c2	Araneidae	*Gibbaranea*	*bituberculata* ♀ juv.
16	2c3	Araneidae	*(Cepthseparated)*	(Abd. crushed)
17	2c4	Tetragnathidae	*Tetragnatha*	*javana* ♀ juv.
18	2d1	Araneidae	*Neoscona*	*theisi* ♀
19	2d2	Araneidae	*Neoscona*	*excelsus* ♀
20	2e1	Lycosidae	*Pardosa*	*pseudoannulata* ♂
Gopalpura				
21	3a1	Araneidae	*Argiope*	*anasuja* ♀ (Abd. broken)
22	3a2	Araneidae	*Argiope*	sp. ♀ (no Abd.only cepth)
23	3b1	Tetragnathidae	*Tetragnatha*	*javana* ♀ juv.
24	3c1	Araneidae	*Neoscona*	sp. ♀ juv.
25	3c2	Araneidae	*Neoscona*	*mukerjei* ♀ (Abd.crushed)
26	3c3	Araneidae	*Cyrtophora*	*cicatrosa* ♀
27	3d1	Araneidae	*Cyrtophora*	sp. ♀ (only cepth.)
28	3d2	Araneidae	*Argiope*	sp. ♀ (Abd. crushed)

29	3d3	Araneidae	*Cyrtophora*	*cicatrosa* ♀
30	3d4	Araneidae	*Argiope*	sp. ♀ juv.
31	3d5	Araneidae	*Larinia*	sp. ♀
32	3e1	Araneidae	*Neoscona*	sp. ♀(Abd. detached & decayed)
33	3e2	Araneidae	*Argiope*	*anasuja* ♀
34	4a1	Araneidae	*Neoscona*	sp. ♀ juv. (Abd. crushed)
35	4b1	Tetragnathidae	*Tetragnatha*	*javana* ♂ juv.
36	4d1	Araneidae	*Argiope*	sp. ♀ juv.
37	4d2	Araneidae	*Cyrtophora*	*cicatros*a ♀
38	4d3	Araneidae	*Neoscona*	*theisi* ♀ juv.
39	4e1	Araneidae	*Neoscona*	*theisi* ♀
40	4e2	Araneidae	*Neoscona*	*theisi* ♀ juv.
Lalpura				
41	5a1	Araneidae	*Argiope*	*anasuja* ♀
42	5a2	Araneidae	*Neoscona*	*theisi* ♀
43	5a3	Araneidae	*Cyrtophora*	*cicatrosa* ♀
44	5b1	Oxyopidae	*Oxyopes*	sp. ♀ (Abd. broken)
45	5b2	Araneidae	*Araneus*	sp. ♀ juv. (Abd. broken)
46	5b3	Araneidae	*Neoscona*	sp. ♀ juv.
47	5b4	Araneidae	*Neoscona*	*excelsus* ♀
48	5b5	Lycosidae	*Pardosa*	sp. ♀ juv.
49	5c1	Araneidae	*Neoscona*	*theisi* ♀ juv.
50	5c2(1)	Tetragnathidae	*Tetragnatha*	sp. ♀ juv.(elongated one)
51	5c2(2)	Araneidae	*Neoscona*	sp. ♀(small black coloured)
52	5d1	Araneidae	*Neoscona*	*theisi* ♀ juv. damaged
53	5d2	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv. (Abd. damaged)
54	6a1	Araneidae	*Argiope*	sp. ♀ juv.
55	6a2	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
56	6d1	Araneidae	*Argiope*	sp. ♀ juv. (Abd.damaged)
57	6d2	Araneidae	*Argiope*	sp. ♀ juv.
58	6d3	Araneidae	*Argiope*	sp. ♀ juv. (only cepth)
59	6e1	Araneidae	*Argiope*	*anasuja* ♀(Abd.detached)
Khadol				
60	7a1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
61	7a2	Oxyopidae	*Oxyopes*	sp. ♀
62	7b1	Araneidae	*Neoscona*	*theisi* ♀ juv.
63	7b2	Araneidae	*Argiope*	sp. ♀ juv.
64	7b3(1)	Araneidae	*Neoscona*	*theisi* ♀ (Abd. detached)
65	7b3(2)	Araneidae	*Neoscona*	*excelsus* ♀ juv.
66	7b4	Araneidae	*Cyrtophora*	sp. ♀ (only cepth)
67	7b5	Araneidae	*Neoscona*	*theisi* ♀ juv.
68	7c1	Lycosidae	*Pardosa*	sp. ♀ sub adult
69	7e1	Araneidae	*Neoscona*	*theisi* ♂
70	7e2	Araneidae	*Neoscona*	*theisi* ♀
71	7e3	Oxyopidae	*Oxyopes*	sp. ♀
72	8b1	Lycosidae	*Pardosa*	*birmanica* ♂
73	8b2	Oxyopidae	*Oxyopes*	sp. ♀ (Abd. crushed)

74	8b3	Araneidae	*Neoscona*	*theisi* ♀
75	8c1	Araneidae	*Cyrtophora*	cicatrosa ♀
76	8c2	Araneidae	*Neoscona*	*theisi* ♀
77	8c3	Oxyopidae	*Oxyopes*	*swetae* ♂
78	8c4	Lycosidae	*Pardosa*	*pseudoannulata* ♀
79	8d1	Lycosidae	*Pardosa*	*altitudis* ♀
80	8d2	Lycosidae	*Pardosa*	sp. ♀ juv.
81	8e1	Araneidae	*Cyrtophora*	*cicatrosa* ♀ (Abd. crushed)
82	8e2	Araneidae	*Neoscona*	*theisi* ♀ sub adult
Asodar				
83	9a1	Oxyopidae	*Oxyopes*	sp. ♀ juv.
84	9a2	Oxyopidae	*Oxyopes*	sp. ♀ juv.
85	9a3	Araneidae	*Neoscona*	*theisi* ♀ juv.
86	9b1	Araneidae	*Argiope*	*anasuja* ♀
87	9b2	Oxyopidae	*Oxyopes*	*ratnae* ♂
88	9b3	Araneidae	*Cyrtophora*	*cicatrosa* ♀
89	9b4	Araneidae	*Cyrtophora*	*cicatrosa* ♀ (Abd. detached)
90	9b5	Araneidae	*Argiope*	*anasuja* ♀ sub adult
91	9b6	Araneidae	*Argiope*	sp. ♀ juv.
92	9b7	Araneidae	*Cyrtophora*	*cicatrosa* ♀
93	9c1	Araneidae	*Cyrtophora*	sp. ♀ (Abd. totally crushed)
94	9c2	Araneidae	*Neoscona*	*theisi* ♀
95	9d1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
96	9d2	Araneidae	*Neoscona*	*theisi* ♂
97	9d3	Araneidae	*Cyrtophora*	*cicatrosa* ♀
98	9e1	Araneidae	*Argiope*	*anasuja* ♀
99	10a1	Araneidae	*Neoscona*	*theisi* ♂
100	10a2	Araneidae	*Neoscona*	*theisi* ♀ juv.
101	10c1	Araneidae	*Neoscona*	sp. ♀ (S.A. Abd. detached)
102	10c2	Tetragnathidae	*Leucauge*	*decorate* ♀
103	10c3	Araneidae	*Argiope*	sp. ♀ juv.
104	10c4	Araneidae	*Neoscona*	sp. ♀juv.
105	10c5	Araneidae	*Argiope*	sp. ♀juv.
106	10d1	Tetragnathidae	*Leucauge*	*decorate* ♀
107	10e1	Oxyopidae	*Oxyopes*	*ratnae* ♂
108	10e2	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv. (Abd. detached)
109	10e3	Araneidae	*Argiope*	sp. ♀ cepth. only
Bodal				
110	11b1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
111	11b2	Araneidae	*Argiope*	sp. ♀ subadult
112	11c1	Araneidae	*Neoscona*	sp. ♀ juv. (Abd. crushed)
113	11c2	Araneidae	*Araneid spider*	(dried with fungus)
114	11d1	Araneidae	*Neoscona*	*theisi* ♂ juv.
115	11d2	Araneidae	*Argiope*	*anasuja* ♀
116	11d3	Oxyopidae	*Oxyopes*	*swetae* ♀

117	11e1	Araneidae	*Cyrtophora*	*cicatrosa*♀
118	12a1	Tetragnathidae	*Leucauge*	sp.♀ juv.
119	12a2	Araneidae	*Neoscona*	*theisi* ♀ juv.
120	12a3	Araneidae	*Neoscona*	*theisi* ♀ juv.
121	12b1	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
122	12b2	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
123	12c1	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
124	12d1	Araneidae	*Neoscona*	*theisi* ♀
125	12d2	Oxyopidae	*Oxyopes*	sp. ♀ juv.
126	12d3	Araneidae	*Neoscona*	sp. ♀ juv.
Davol				
127	13a1	Araneidae	*Argiope*	sp. ♀ juv.
128	13a2	Araneidae	*Cyrtophora*	*cicatrosa* ♀
129	13a3	Araneidae	*Neoscona*	*theisi* ♂
130	13a4	Oxyopidae	*Oxyopes*	*swetae* ♀ (Abd. broken)
131	13a5	Araneidae	*Cyrtophora*	*cicatrosa* ♀
132	13c1	Araneidae	*Neoscona*	*theisi* ♀ juv.
133	13c2	Araneidae	*Neoscona*	*theisi* ♀ juv.
134	13d1	Oxyopidae	*Oxyopes*	*ratnae* ♂
135	13d2	Araneidae	*Cyrtophora*	*cicatrosa* ♀
136	13d3	Araneidae	*Argiope*	sp. ♀ juv.
137	13e1	Araneidae	*Neoscona*	sp. ♂ juv. (only cepth)
138	13e2	Araneidae	*Cyrtophora*	*cicatrosa* ♀ (cepth detached)
139	13e3	Araneidae	*Neoscona*	sp. ♀ spiderling
140	14a1	Araneidae	*Cyrtophora*	sp. ♀ juv. (only cepth)
141	14a2	Araneidae	*Neoscona*	sp. ♀ spiderling
142	14b1	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
143	14b2	Araneidae	*Cyrtophora*	*cicatrosa* ♀
144	14b3	Oxyopidae	*Oxyopes*	*ratnae* ♂
145	14c1	Oxyopidae	*Oxyopes*	*ratnae* ♀
146	14c2	Araneidae	*Cyrtophora*	*cicatrosa* ♀
147	14d1	Araneidae	*Argiope*	*aemula* ♀subadult
148	14d2	Araneidae	*Argiope*	sp. ♀ subadult
149	14d3	Tetragnathidae	*Lieucange*	*celebesiana* ♀
150	14e1	Araneidae	*Argiope*	*anasuja* ♀
151	14e2	Araneidae	*Cyrtophora*	*cicatrosa* ♀
152	14e3	Araneidae	*Cyrtophora*	*cicatrosa* ♀
153	14e4	Araneidae	*Cyrtophora*	*cicatrosa* ♀
Pamol				
154	15a1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
155	15a2	Araneidae	*Cyrtophora*	*cicatrosa* ♀
156	15a3	Araneidae	*Cyrtophora*	*cicatrosa* ♀
157	15a4	Salticidae	*Marpissa*	sp. ♂
158	15b1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
159	15d1	Araneidae	*Argiope*	*anasuja* ♀
160	15e1	Oxyopidae	*Oxyopes*	*swetae* ♀
161	15e2	Araneidae	*Argiope*	*anasuja* ♀ Abd. detached
162	16a1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
163	16a2	Araneidae	*Neoscona*	*theisi* ♀

164	16d1	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
165	16d2	Araneidae	*Cyrtophora*	*cicatrosa* ♀
Valasan				
166	17a1	Tetragnathidae	*Tetragnatha*	sp. ♀ juv.
167	17a2	Araneidae	*Neoscona*	*theisi* ♀
168	17a3	Oxyopidae	*Oxyopes*	sp. ♀ juv.
169	17b1	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
170	17b2	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
171	17c1	Araneidae	*Neoscona*	*theisi* ♀ juv.
172	18a1	Araneidae	*Argiope*	sp. ♀ only cepth.
173	18a2	Araneidae	*Larinia*	sp. ♀
174	18a3	Araneidae	*Argiope*	sp. ♂ juv.
175	18a4	Araneidae	*Neoscona*	*theisi* ♀
176	18b1	Araneidae	*Neoscona*	*theisi* ♀
177	18b2	Araneidae	*Cyrtophora*	*cicatrosa* ♀
178	18b3	Oxyopidae	*Oxyopes*	sp. ♀ juv.
179	18b4	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
180	18c1	Araneidae	*Neoscona*	*theisi* ♀ juv.
181	18c2	Tetragnathidae	*Leucauge*	*decorata* ♀
182	18c3	Araneidae	*Argiope*	sp. ♀ juv.
183	18c4	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
184	18c5	Oxyopidae	*Oxyopes*	*swetae* ♀
185	18e1	Araneidae	*Neoscona*	sp.♀ juv.
Morad				
186	19a1	Araneidae	*Cyrtophora*	*cicatrosa* ♀ abd.damaged
187	19a2	Araneidae	*Neoscona*	sp.♀ only cepth.
188	19b1	Tetragnathidae	*Leucauge*	*decorata* ♀
189	19b2	Tetragnathidae	*Leucauge*	*celebesiana*. ♂
190	19b3	Araneidae	*Neoscona*	sp.♀ only cepth.
191	19c1	Araneidae	*Gea*	*corbetti* ♀
192	19c2	Oxyopidae	*Oxyopes*	*swetae* ♀
193	19c3	Araneidae	*Neoscona*	*theisi* ♀
194	19d1	Araneidae	*Neoscona*	*theisi* ♀
195	19d2	Tetragnathidae	*Leucauge*	*decorata* ♀
196	19e1	Araneidae	*Argiope*	sp. ♀ only cepth.
197	19e2	Araneidae	*Argiope*	*anasuja* ♀ abd. detached
198	20a1	Araneidae	*Neoscona*	*theisi* ♀
199	20a2	Salticidae	*Phidippus*	*pateli* ♀
200	20a3	Araneidae	*Neoscona*	*theisi* ♀
201	20a4	Tetragnathidae	*Tetragnatha*	sp. ♀ juv.
202	20b1	Tetragnathidae	*Leucauge*	sp. ♀ juv.
203	20d1	Araneidae	*Neoscona*	*theisi* ♀ abd. detached
204	20d2	Araneidae	*Neoscona*	*theisi* ♀
205	20d3	Tetragnathidae	*Tetragnatha*	sp. ♀ *spiderling*
206	20e1	Salticidae	*Phidippus*	*pateli* ♂
207	20e2	Oxyopidae	*Oxyopes*	*swetae* ♂
208	20e3	Araneidae	*Argiope*	sp. ♀ only cepth.
209	20e4	Oxyopidae	*Oxyopes*	*swetae* ♀
Bandhani				
210	21a1	Araneidae	*Cyrtophora*	*cicatrosa* ♀

211	21b1(i)	Araneidae	*Cyrtophora*	*cicatrosa* ♀
212	21b1(ii)	Araneidae	*Larinia*	*tyloridia* ♀
213	21b2	Araneidae	*Neoscona*	*theisi* ♀
214	21c1	Araneidae	*Neoscona*	*theisi* ♂
215	21c2	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
216	21e1	Araneidae	*Cyrtophora*	sp. ♀ juv. dried specimen
217	21e2	Araneidae	*Cyrtophora*	sp. ♀ juv.
218	22a1	Tetragnathidae	*Zygeilla*	*malanostoma* ♀
219	22a2	Araneidae	*Neoscona*	sp. ♂ juv.
220	22a3	Araneidae	*Argiope*	sp ♀ juv. abd. only
221	22d1	Araneidae	*Cyrtophora*	*cicatrosa* ♀ juv.
222	22d2	Araneidae	*Cyrtophora*	*cicatrosa* ♀
223	22d3	Araneidae	*Cyrtophora*	*cicatrosa* ♀
224	22d4	Araneidae	*Cyrtophora*	sp. ♀ only cepth.
225	22d5	Araneidae	*Neoscona*	*theisi* ♀
226	22e1	Araneidae	*Neoscona*	*excelsus* ♀
227	22e2	Clubionidae	*Clubiona*	sp. ♂ juv.
228	22e3	Araneidae	*Cyrtophora*	sp. ♀ only cepth.
229	22e4	Araneidae	*Cyrtophora*	sp. ♀ only cepth.
Mehlav				
230	23a1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
231	23b1	Tetragnathidae	*Tetragnatha*	*javana* ♀ juv.
232	23c1	Tetragnathidae	*Tetragnatha*	sp. ♀ juv
233	23d1(i)	Tetragnathidae	*Tetragnatha*	sp. ♂ juv
234	23d1(ii)	Araneidae	*Larinia*	sp. ♀ (2 nos.)
235	24a1	Araneidae	*Cyrtophora*	*cicatrosa* ♀ abd. crushed
236	24a2	Araneidae	*Argiope*	sp ♀ juv. abd. only
237	24a3	Araneidae	*Argiope*	sp ♀ abd. only
238	24b1	Araneidae	*Neoscona*	sp. Echdysis only
239	24b2	Araneidae	*Neoscona*	*theisi* ♀ abd. crushed
240	24e1	Tetragnathidae	*Leucauge*	*celebesiana* ♀
241	24e2	Araneidae	*Cyrtophora*	*cicatrosa* ♀
Khanpur				
242	25a1	Araneidae	*Argiope*	*anasuja* ♀
243	25a2	Oxyopidae	*Oxyopes*	*ratnae* ♀
244	25b1	Araneidae	*Neoscona*	*theisi* ♀
245	25d1	Sparassidae	*Olios*	sp ♀ abd. decayed
246	25d2	Araneidae	*Argiope*	*anasuja* ♀
247	25d3	Araneidae	*Argiope*	*anasuja* ♀
248	25e1(i)	Araneidae	*Neoscona*	*theisi* ♀ abd. decayed
249	25e1(ii)	Araneidae	*Neoscona*	*theisi* ♀
250	25e2	Araneidae	*Neoscona*	*theisi* ♀
251	26a1	Araneidae	*Argiope*	*anasuja* ♀
252	26d1	Araneidae	*Neoscona*	*theisi* ♀
253	26d2	Araneidae	*Neoscona*	*theisi* ♀
254	26e1	Araneidae	*Neoscona*	*theisi* ♀ abd. only & crushed
255	26e2	Araneidae	*Neoscona*	*theisi* ♀
Pratappura				
256	27a1	Araneidae	*Neoscona*	sp. ♂ juv

257	27a2	Araneidae	*Neoscona*	*theisi* ♀
258	27a3	Araneidae	*Neoscona*	*theisi* ♀
259	27d1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
260	27e1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
261	27e2	Araneidae	*Neoscona*	*theisi* ♀
262	28a1	Araneidae	*Neoscona*	*theisi* ♀
263	28a2	Araneidae	*Neoscona*	*theisi* ♀
264	28a3	Sparassidae	*Olios*	*wroughtoni* ♂
265	28c1	Araneidae	*Neoscona*	*theisi* ♂
266	28d1	Sparassidae	*Olios*	*wroughtoni* ♂
267	28d2	Araneidae	*Argiope*	*anasuja* ♀ juv.
268	28d3	Tetragnathidae	*Tetragnatha*	*mandibulata* ♀
269	28d4	Araneidae	*Neoscona*	*theisi* ♂
270	28e1	Araneidae	*Neoscona*	*theisi* ♀
Khambholaj				
271	29a1	Araneidae	*Argiope*	*sp.* ♀ *juv*
272	29a2	Araneidae	*Neoscona*	*theisi* ♀
273	29a3	Araneidae	*Argiope*	*anasuja* ♀
274	29c1	Araneidae	*Neoscona*	*theisi* ♀ *only abd.*
275	29c2	Araneidae	*Neoscona*	*theisi* ♀ *only cepth*
276	29c3	Araneidae	*Neoscona*	*theisi* ♀ *juv.*
277	29c4	Araneidae	*Neoscona*	*theisi* ♀ *abd. only*
278	29d1	Tetragnathidae	*Leucauge*	*celebesiana* ♀
279	29d2	Araneidae	*Neoscona*	*theisi* ♀ *juv.*
280	29e1	Araneidae	*Neoscona*	*theisi* ♀
281	29e2	Araneidae	*Argiope*	*sp.* ♂
282	30a1	Araneidae	*Neoscona*	*theisi* ♂
283	30b1	Araneidae	*Neoscona*	*theisi* ♀
284	30e1(i)	Araneidae	*Neoscona*	*theisi* ♀
285	30e1(ii)	Araneidae	*Neoscona*	*theisi* ♂
286	30e1(iii)	Araneidae	*Argiope*	*anasuja* ♀ *subadult*
Shilli				
287	31b1	Araneidae	*Neoscona*	*theisi* ♀
288	31e1	Araneidae	*Larinia*	*sp.* ♀
289	31e2	Araneidae	*Neoscona*	*theisi* ♀
290	32a1	Araneidae	*Neoscona*	*sp. destoyed*
291	32b1(i)	Araneidae	*Argiope*	*sp.* ♂
292	32b1(ii)	Araneidae	*Argiope*	*sp.* ♀ *juv.*
293	32b2	Araneidae	*Neoscona*	*sp.* ♀ *juv. abd. detached*
294	32c1	Araneidae	*Neoscona*	*theisi* ♀
295	32c2	Araneidae	*Argiope*	*sp.* ♀ *juv. abd. crushed*
296	32c3	Araneidae	*Neoscona*	*theisi* ♂
297	32e1(i)	Araneidae	*Neoscona*	*sp.* ♀ *only cepth.*
298	32e1(ii)	Araneidae	*Cyrtophora*	*cicatrosa* ♀
299	32e2	Araneidae	*Neoscona*	*theisi* ♀ *abd. only*
Ahima				
300	32c1	Araneidae	*Neoscona*	*theisi* ♀
301	32c2	Araneidae	*Neoscona*	*theisi* ♂ *juv.*
302	32c3	Araneidae	*Argiope*	*anasuja* ♂ *subadult*
303	33d1	Araneidae	*Cyrtophora*	*cicatrosa* ♀

304	34a1	Araneidae	*Neoscona*	*theisi* ♀
305	34b1	Araneidae	*Neoscona*	*theisi* ♀ *only cepth.*
306	34b2	Araneidae	*Neoscona*	*theisi* ♀
307	34b3	Tetragnathidae	*Tetragnatha*	*virescens* ♀
308	34b4	Araneidae	*Cyrtophora*	*sp.* ♀ *only cepth.*
309	34c1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
310	34e1	Araneidae	*Neoscona*	*theisi* ♀
311	34e2	Araneidae	*Neoscona*	*theisi* ♀ *juv.*
312	34e3	Araneidae	*Neoscona*	*theisi* ♀
Bhatiyel				
313	35a1	Araneidae	*Neoscona*	*theisi* ♀
314	35a2	Araneidae	*Neoscona*	*theisi* ♀
315	35d1	Araneidae	*Argiope*	*sp.* ♀ *dried*
316	35e1	Araneidae	*Neoscona*	*theisi* ♀
317	36b1	Araneidae	*Neoscona*	*theisi* ♀
318	36d1	Araneidae	*Neoscona*	*theisi* ♀
319	36e1	Araneidae	*Neoscona*	*theisi* ♀
Sandeser				
320	37b1	Araneidae	*Neoscona*	*theisi* ♂ *dried*
321	37d1	Araneidae	*Neoscona*	*theisi* ♂
Anklav				
322	38d1	Oxyopidae	*Peucetia*	*sp.* ♂
323	38e1	Araneidae	*Argiope*	*sp.* ♂ *very young*
324	38e2	Araneidae	*Neoscona*	*theisi* ♀ *juv.*
325	38e3	Oxyopidae	*Peucetia*	*sp.* ♀
Ambasar				
326	39a1	Araneidae	*Argiope*	*anasuja* ♀ *juv.*
327	39a2	Araneidae	*Argiope*	*anasuja* ♀ *subadult*
328	39c1	Araneidae	*Neoscona*	*theisi* ♀
329	40b1	Oxyopidae	*Peucetia*	*sp.* ♂
330	40b2	Araneidae	*Neoscona*	*theisi* ♀
331	40c1	Araneidae	*Neoscona*	*theisi* ♀
332	40e1	Araneidae	*Neoscona*	*theisi* ♀ *subadult*
333	40e2	Oxyopidae	*Peucetia*	*sp.* ♂
Navakhal				
334	41a1	Araneidae	*Neoscona*	*sp.* ♂ *juv. decayed*
335	41d1	Araneidae	*Argiope*	*sp.* ♀ *juv.*
336	41e1	Araneidae	*Cyrtophora*	*cicatrosa* ♀ *juv.*
Sunav				
337	42b1	Araneidae	*Argiope*	*sp.* ♀ *juv.*
338	42b2	Araneidae	*Neoscona*	*theisi* ♀
339	42c1	Araneidae	*Argiope*	*anasuja* ♀
340	42e1	Araneidae	*Argiope*	*anasuja* ♀ *subadult*
341	43a1	Araneidae	*Argiope*	*anasuja* ♀ *subadult*
342	43a2	Araneidae	*Neoscona*	*theisi* ♀ *juv.*
343	43a3	Araneidae	*Argiope*	*sp.* ♀ *juv.*
344	43b1	Araneidae	*Argiope*	*anasuja* ♀
345	43c1	Araneidae	*Neoscona*	*theisi* ♀
346	43c2	Araneidae	*Argiope*	*sp.* ♀ *juv.*
347	43d1	Araneidae	*Neoscona*	*theisi* ♀

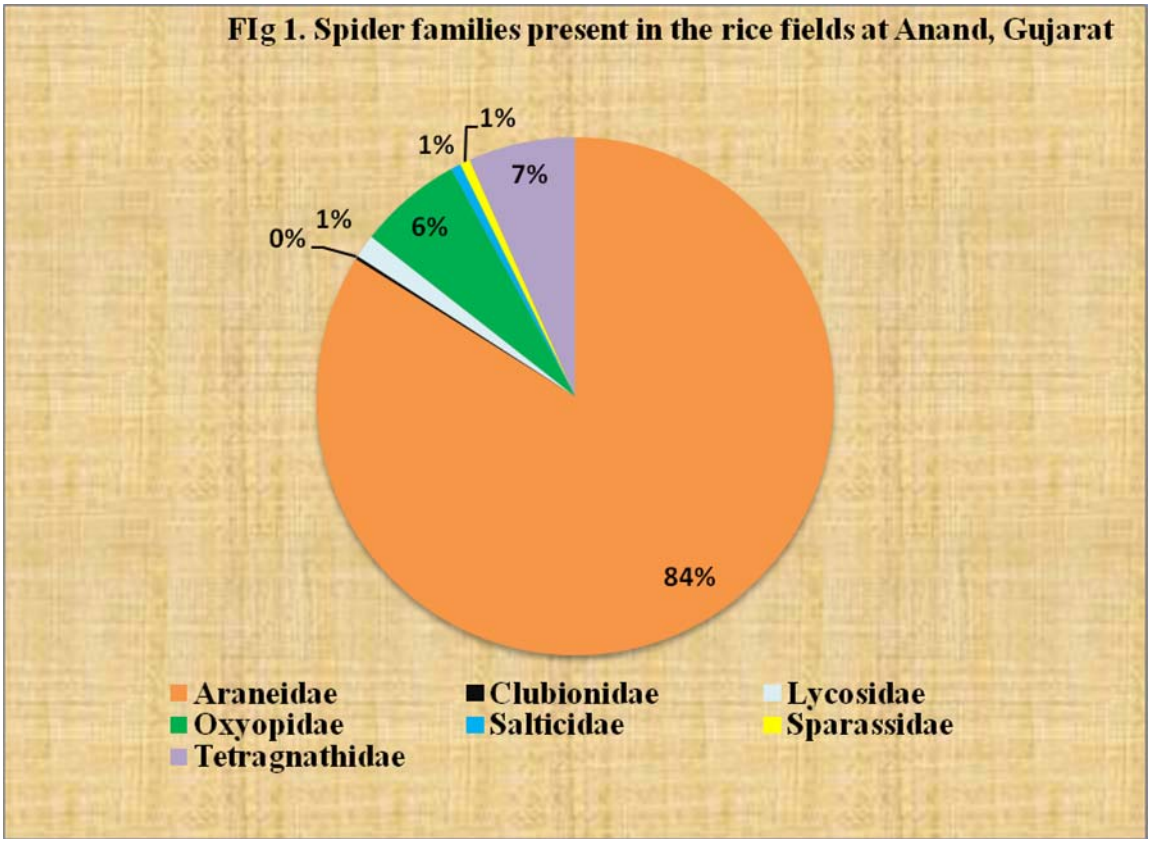
348	43d2	Araneidae	*Neoscona*	*theisi ♀ only cepth.*
Kashor				
349	44a1	Araneidae	*Argiope*	*sp. ♀ only cepth.*
350	44a2	Araneidae	*Argiope*	*sp. ♀ only cepth.*
351	44b1	Araneidae	*Neoscona*	*theisi ♀*
352	44d1	Araneidae	*Argiope*	*anasuja ♀*
353	44e1	Araneidae	*Neoscona*	*theisi ♀*
354	45a1	Araneidae	*Argiope*	*anasuja ♀*
355	45b1	Araneidae	*Neoscona*	*theisi ♀*
356	45c1	Araneidae	*Argiope*	*anasuja ♀ subadult*
357	45d1	Araneidae	*Argiope*	*sp. ♀ abd. decayed*
358	45d2	Araneidae	*Neoscona*	*theisi ♀*
359	45e1	Araneidae	*Neoscona*	*theisi ♀*
Piplav				
360	46c1	Araneidae	*Argiope*	*sp. ♀ juv.*
361	46c2	Araneidae	*Argiope*	*anasuja ♂*
362	46d1	Araneidae	*Neoscona*	*theisi ♀ subadult*
363	46d2	Araneidae	*Neoscona*	*theisi ♂ subadult*
364	46e1	Araneidae	*Argiope*	*anasuja ♀ abd. detached*
365	47a1(i)	Tetragnathidae	*Tetragnatha*	*mandibulata ♀*
366	47a1(ii)	Araneidae	*Argiope*	*sp. ♀ juv.*
367	47b1	Araneidae	*Argiope*	*sp. ♂ only cepth.*
368	47c1(i)	Oxyopidae	*Peucetia*	*sp. ♂*
369	47c1(ii)	Araneidae	*Argiope*	*sp. ♀ cepth. only*
370	47c2	Oxyopidae	*Oxyopes*	*swetae ♂*
371	47e1	Araneidae	*Argiope*	*anasuja ♀ abd. broken*
Virol				
372	48a1	Tetragnathidae	*Tetragnatha*	*mandibulata ♂*
373	48a2	Araneidae	*Argiope*	*sp. ♀ juv.*
374	48b1	Araneidae	*Neoscona*	*theisi ♀*
375	48c1	Araneidae	*Larinia*	*sp. ♀ juv.*
376	49a1	Araneidae	*Argiope*	*anasuja ♂*
377	49b1	Araneidae	*Argiope*	*anasuja ♀ juv.*
378	49c1	Araneidae	*Neoscona*	*theisi ♀ juv.*
379	49d1	Tetragnathidae	*Tetragnatha*	*javana ♀*
380	49e1	Araneidae	*Cyrtophora*	*cicatrosa ♀ juv.*
Jesherwa				
381	50a1	Araneidae	*Argiope*	*sp. ♀ only cepth.*
382	50a2	Araneidae	*Neoscona*	*theisi ♀*
383	50b1	Araneidae	*Neoscona*	*theisi ♀ juv.*
384	50b2	Araneidae	*Neoscona*	*theisi ♀ juv.*
385	50e1	Araneidae	*Neoscona*	*theisi ♀ juv. abd. detached*
386	50e2	Araneidae	*Argiope*	*sp. ♀ decayed*
387	51a1	Araneidae	*Neoscona*	*theisi ♂*
388	51b1	Araneidae	*Cyrtophora*	*cicatrosa ♀*
389	51b2	Araneidae	*Larinia*	*tyloridia ♀*
390	51c1	Araneidae	*Argiope*	*sp. ♀ juv.*
391	51d1	Araneidae	*Neoscona*	*theisi ♀ juv.*
392	51e1	Araneidae	*Neoscona*	*theisi ♀*

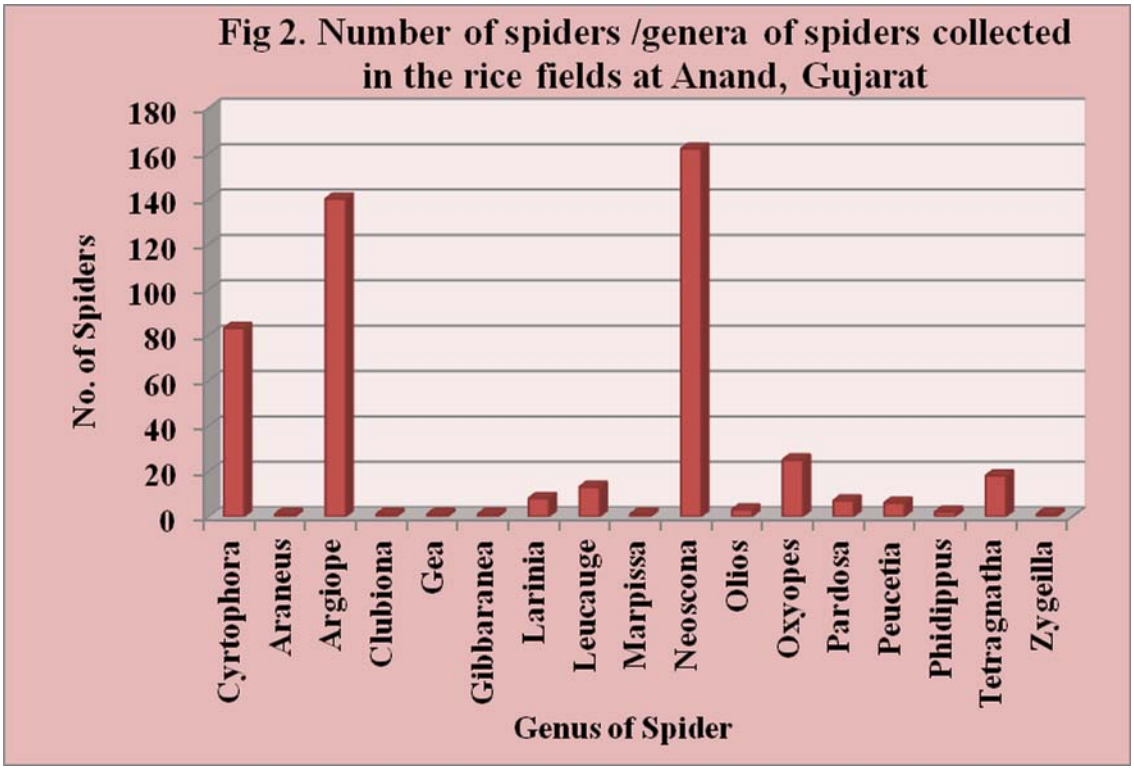
Amod				
393	52a1	Araneidae	*Argiope*	*anasuja* ♀
394	52b1	Araneidae	*Argiope*	*pradhani* ♀
395	52b2	Araneidae	*Argiope*	*sp.* ♀ *only cepth.*
396	52c1	Araneidae	*Neoscona*	*theisi* ♂
397	52d1	Araneidae	*Argiope*	*anasuja* ♀ *subadult*
398	53a1	Araneidae	*Neoscona*	*theisi* ♂
399	53a2	Araneidae	*Neoscona*	*theisi* ♀
400	53b1	Araneidae	*Cyrtophora*	*cicatrosa* ♀ *subadult*
401	53c1	Araneidae	*Neoscona*	*theisi* ♀
402	53d1(i)	Araneidae	*Neoscona*	*theisi* ♀
403	53d1(ii)	Araneidae	*Neoscona*	*theisi* ♀ *juv.*
Petlad				
404	54c1(i)	Araneidae	*Neoscona*	*theisi* ♀ *subadult*
405	54c1(ii)	Araneidae	*Neoscona*	*theisi* ♂ *juv.*
406	54d1	Araneidae	*Argiope*	*anasuja* ♂
407	54e1	Araneidae	*Argiope*	*anasuja* ♂
408	55a1	Araneidae	*Neoscona*	*excelsus* ♀
409	55a2	Araneidae	*Cyrtophora*	*cicatrosa* ♀
410	55b1	Tetragnathidae	*Leucauge*	*sp.* ♀ *decayed*
411	55c1	Araneidae	*Neoscona*	*theisi* ♀ *only cepth.*
412	55d1	Araneidae	*Argiope*	*sp.* ♀ *only cepth.*
413	55e1	Araneidae	*Larinia*	*sp.* ♀ *juv.*
Palaj				
414	56b1	Araneidae	*Argiope*	*sp.* ♀ *abd detached*
415	56c1	Araneidae	*Argiope*	*anasuja* ♀
416	56d1	Araneidae	*Neoscona*	*theisi* ♂ *juv.*
417	56d2	Araneidae	*Cyrtophora*	*cicatrosa* ♀ *juv.*
418	56e1	Araneidae	*Cyrtophora*	*cicatrosa* ♀ *juv.*
419	57a1	Araneidae	*Neoscona*	*theisi* ♂ *juv.*
420	57b1	Araneidae	*Neoscona*	*theisi* ♀ *juv.*
421	57b2	Araneidae	*Argiope*	*anasuja*♂
422	57d1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
423	57e1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
Golana				
424	58b1	Araneidae	*Argiope*	*anasuja* ♀
425	58d1	Araneidae	*Argiope*	*anasuja* ♀ *subadult*
426	58e1	Araneidae	*Argiope*	*anasuja*♂ *legs broken*
427	59a1	Araneidae	*Argiope*	*anasuja* ♀
428	59b1	Araneidae	*Neoscona*	*sp.* ♀
429	59c1	Araneidae	*Argiope*	*anasuja* ♀
430	59c2	Araneidae	*Argiope*	*anasuja* ♀ *subadult*
Fatepur				
431	60a1	Oxyopidae	*Peucetia*	*sp.* ♀*juv.*
432	60a2	Araneidae	*Argiope*	*anasuja* ♀*juv*
433	60d1	Araneidae	*Argiope*	*anasuja* ♀ *subadult*
434	60d2	Araneidae	*Argiope*	*anasuja* ♀ *subadult*
435	61a1	Araneidae	*Argiope*	*anasuja* ♀ *subadult*
436	61b1	Araneidae	*Argiope*	*sp.* ♀
437	61d1	Araneidae	*Argiope*	*anasuja* ♀

Pariej				
438	62a1	Araneidae	*Argiope*	*sp.* ♀
439	62a2	Araneidae	*Argiope*	*anasuja* ♂
440	62b1	Araneidae	*Argiope*	*anasuja* ♀
441	63a1	Araneidae	*Argiope*	*sp.* ♀ *juv.*
442	63b1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
443	63c1	Araneidae	*Argiope*	*sp.* ♂*juv.*
444	63d1	Araneidae	*Argiope*	*sp.* ♀ *subadult*
Tol				
445	64a1	Araneidae	*Argiope*	*pradhani* ♀
446	64b1	Araneidae	*Argiope*	*anasuja* ♀
447	64c1	Araneidae	*Argiope*	*sp.* ♀ *only cepth*
448	64d1	Araneidae	*Argiope*	*sp.* ♀ *abd broken*
449	64d2	Araneidae	*Argiope*	*sp.* ♀ *juv.*
450	65c1	Araneidae	*Argiope*	*sp.* ♀ *juv.*
451	65d1	Araneidae	*Argiope*	*sp.* ♀
452	65e1	Araneidae	*Argiope*	*sp.* ♀
Tarapur				
453	66a1	Araneidae	*Argiope*	*sp.* ♀
454	66b1	Araneidae	*Argiope*	*sp.* ♀ *only cepth*
455	66c1	Araneidae	*Argiope*	*sp.* ♀
456	66c2	Araneidae	*Argiope*	*anasuja* ♂
457	66d1	Araneidae	*Argiope*	*anasuja*♀
458	67a1	Araneidae	*Argiope*	*sp.* ♀ *only cepth*
459	67b1	Araneidae	*Argiope*	*anasuja* ♀ *subadult*
460	67b2	Araneidae	*Argiope*	*sp.* ♀ *juv*
461	67d2	Araneidae	*Argiope*	*sp.* ♀ *only cepth*
462	67e1	Araneidae	*Argiope*	*anasuja* ♂
463	67e2	Araneidae	*Argiope*	*anasuja* ♀
Isharwada				
464	68a1	Araneidae	*Argiope*	*sp.* ♀ *only cepth*
465	68b1	Araneidae	*Argiope*	*anasuja* ♀
466	68c1	Araneidae	*Argiope*	*sp.* ♀ *juv*
467	68e1	Araneidae	*Argiope*	*sp.* ♀ *juv*
468	69a1	Araneidae	*Argiope*	*anasuja* ♂
469	69a2	Araneidae	*Argiope*	*sp.* ♀ *juv*
470	69e1	Araneidae	*Cyrtophora*	*cicatrosa* ♀
471	69e2	Araneidae	*Cyrtophora*	*cicatrosa* ♀
Sojitra				
472	70a1	Araneidae	*Argiope*	*anasuja* ♀
473	70b1	Araneidae	*Argiope*	*sp.*♀ *only cepth*
474	70c1	Araneidae	*Argiope*	*sp.* ♀ *juv. abd. detached*
475	70d1	Tetragnathidae	*Tetragnatha*	*mandibulata* ♀ *juv.*
476	71a1	Araneidae	*Argiope*	*anasuja* ♂
477	71a2	Araneidae	*Argiope*	*sp.* ♀ *juv*
478	71d1	Oxyopidae	*Oxyopes*	*swetae* ♀

The specimens were identified by Dr.B.H.Patel and are preserved at Biocontrol Research Laboratory, AAU, Anand. The collection contains spiders in 7 families (**Fig.1**),

distributed over 17 genera. The genus *Neoscona* was the most abundant in the rice ecosystem as a whole **(Fig.2**).





8. Anthocorids

During the regular surveys no anthocorids were found on thrips and mites infested plants.

9. Isolation of native *Bt* isolates from soil

Bacillus thuringiensis was isolated from the soil samples recorded in **Table 7.** Fried egg like colonies were selected and suspension of each isolate was prepared and observed under a phase contrast microscope for the presence of parasporal bodies. A total of 114 types of Bt were isolated from the 28 villages and only 18 were found effective against *H. armigera.*

Table 7. Culturable bacterial biomass and type of pathogenic *Bt*

No.	Village	Total Bacterial count on Nutrient agar (CFU/gm average)	*Bt* colonies on MY agar (confirmed on Morphological basis)	*Bt* colonies showing effective mortality against *H. armigera* (*In-vitro*)
1	Anand	$3X10^3$	6	1
2	Vidyanagar	$5X10^4$	8	2
3	Vadaseel	$7X10^3$	7	2
4	Umreth	$6X10^5$	6	3
5	Boriyavi	$1X10^4$	0	0
6	Sarsa	$4X10^3$	12	1
7	Vadtaal	$5X10^4$	3	0
8	Sunav	$6X10^3$	4	0
9	Sojitra	$6X10^4$	8	0
10	Petlad	$7X10^6$	9	0
11	Borsad	$3X10^3$	5	0
12	Dahemi	$4X10^3$	3	1
13	Davol	$6X10^5$	5	2
14	Kanbha	$6X10^5$	4	3
15	Bochasan	$5X10^5$	0	0
16	Bhadran	$4X10^5$	6	0
17	Ras	$2X10^5$	3	0
18	Kathana	$7X10^4$	2	0
19	Gundel	$2X10^3$	0	0
20	Golana	$3X10^3$	0	0
21	Undel	$6X10^4$	0	0
22	Dhuwaean	$6X10^2$	2	0
23	Khambat	$6X10^2$	3	0
24	Wadgam	$3X10^4$	4	1
25	Tarapur	$5X10^6$	6	1
26	Lunej	$2X10^3$	8	1
27	Nar	$6X10^4$	0	0
28	Bhalej	$2X10^6$	0	0
Total			**114**	**18**

AAU-Jorhat

Locations: Jorhat, Golaghat, Sivsagar, Kamrup and Dibrugarh districts

1. *Trichogramma*

Sentinel egg cards of *Corcyra cephalonica* were placed in rice, sugarcane, castor , tea maize and vegetables (okra, brinjal, tomato, and cole crops) during 2012 -13 for parasitisation by *Trichogramma* in different geographical areas. The cards were collected after 2 days from the fields and observed in the laboratory for the emergence of trichogrammatid spp. The recovery of trichogrammatid spp. (unidentified) was made only from rice and sugarcane. However, the recovery of *Trichogramma* spp. from tea eco system as reported earlier is still in progress in biocontrol Laboratory, AAU, Jorhat. The live culture of trichogrammatids recovered from castor have been sent to NBAII for confirmation during April' 2012. However, the recovery of trichogrammatids could not be made from okra, cabbage, brinjal and tomato.

2. *Chrysoperla*

The survey of chrysopids was made in sugarcane, papaya, cabbage and okra in Golaghat, Kamrup and Jorhat district. The field collected population of chrysopids from papaya and sugarcane have been sent to NBAII, Bangalore for identification during September, 2012. No chrysopid was found in okra and cabbage during the observation period.

3. Coccinellids

a. *Cryptolaemus*

Five geographical locations were surveyed for collection of *Cryptolaemus* sp. in different crops like papaya, sugarcane and in *kharif* as well as *rabi* vegetables during 2012-2013. But the activity of *Cryptolaemus* was not observed in any location.

b. Other coccinellids collected from different *rabi* vegetables infested by aphids and whiteflies were *Coccinella septempunctata*, *Micraspis* sp. *Brumoides* sp. and *Menochilus sexmaculatus*.

4. Entomopathogens

The cadavers of French bean leaf folder and Banana leaf and fruit scarring beetle infected by entomopathogens have been collected from Jorhat and were identified as *Nomuraea reliyi* and *Beauveria bassiana*, respectively, by Department of Plant Pathology, AAU, Jorhat.

5. Spiders

Spiders collected from different types of habitat such as grasses, moist places, under stones , pebbles, dead leaves, humus, bushes, on the bark and branches of trees, houses and huts have been sent to NBAII, Bangalore for detailed identification during Sept. and Feb.'2012-13

6. Insect derived EPN

Soil samples collected from brinjal, tomato, tea, sugarecane, pea, coriander and cabbage from different geographical locations were collected to isolate local EPN. Insects (*Corcyra* larvae) suspected to be affected by EPN were isolated and placed in 50 cc soil in polythene bags and sent to NBAII, Bangalore, for identification in March, 2013. The EPN

infected insects have also been kept for isolation of EPN in the biocontrol Laboratory with the help of nematologist, Department of Nematology, AAU, Jorhat.

7. Soil samples for isolation of antagonistic organisms

Soil samples were collected from a depth of 15 cm from the upper surface of soil including rhizosphere and rhizoplane from five different places and the composite samples were thoroughly mixed and 250 gm of such soil samples were sent to NBAII, Bangalore for isolation of antagonistic organisms during March'2013.

8. Anthocorids

No anthocorid predators were detected on plants (chilli, okra, and French bean) infested with thrips and mites.

ANGRAU

Bio Control Agents from various crop ecosystems like cotton, redgram, sugarcane, sunflower, sorghum, maize, brinjal, tomato and rice were collected and sent to NBAII (**Table 8**).

Table 8. Collections included the following insects

Crop	**Name of the insect**	**Crop**	**Name of the insect**
Rice	*Tetrastichus sp.*	**Maize**	*Trichogramma*
	Telenomus sp.		Anthocorids
	Trichogramma sp.		Unknown dipterans
	Mirids		*Braconid*
	Coccinellids		*Cheilomenes*
	Brachymeria		*Paederus*
	Coccinellids		*Brachymeria*
	Trichomalopsis		*Mallada*
	Paederus	Sunflower	*Trigona laeviceps*
	Ophionea		Unknown Ichneumonid
	Xanthopimpla		*Brachymeria*
	Charops		*Paederus*
Redgram	*Campoletis*		Unknown Dipteran
	Odontomyia laeviceps	Brinjal	Unknown grey beetles
	Syrphids		Unknown dipterans
	Gryon sp.		Unknown wasps
	Apanteles		Coccinella
	Cotesia		*Aphidius*
	Bracon	Tomato	*Trichogramma*
	Spiders (unknown)		*Chrysopa*
	Eucelatoria bryani		*Campoletis chloridae*
Castor	*Trichogramma*		Bracon
	Snellenius maculipennis		Coccinellasp
	Euplectrus	Papaya	*Acerophagus*
	Cremastus		*Anagyrus*
	Bracon		Unknown hymenopteran
	Diastatrix papilio		
	Mirids		
	Telenomus		

MPKV

The natural enemies including parasitoids, predators and micro-organisms associated with insect pests of crops were collected from 22 field and horticultural crops around Pune region in western Maharashtra as per the protocol given in the technical programme of 2012-13. The specimens were brought to the laboratory, reared up to adult emergence, identified locally and maintained for record, whereas unidentified specimens of bioagents were sent to NBAII, Bangalore and IARI, New Delhi for identification.

1. *Chrysoperla*

At least 20 live individuals (eggs/ larvae/ adults) were collected from five geographic locations in cotton, pigeon pea and maize.

2. *Cryptolaemus*

Live individuals (larvae/ adults) were collected from five locations in custard apple, guava, papaya and mulberry.

3. Spiders

General collections of adult spiders were made in cotton, sugarcane, paddy, pigeon pea, maize, soybean, papaya, guava, sapota, pomegranate and mango fields. The specimens were preserved in 70% ethyl alcohol in screw cap vials.

4. Entomopathogens

The cadavers of *Spodoptera litura* and *Helicoverpa armigera* infected by entomopathogens were collected in dry sterile vials and the pathogens were isolated in the laboratory.

The natural enemies recorded were coccinellids *Coccinella septempunctata* Linn., *Menochilus sexmaculata* (F.)*, Hippodamia variegata* (Goeze), *Scymnus* sp., chrysopids *Chrysoperla zastrowi sillemi* (Esben-Petersen) in cotton, *Dipha aphidivora* Meyrick, *Micromus igorotus* Bank., syrphids on SWA in sugarcane, *Campoletis chlorideae* Uchida on *H. armigera* and *Cotesia* sp. on *Exelastis atomosa* larvae, *M. sexmaculata,* indeterminate Pentatomidae (Hemiptera) in pigeon pea, *Nomuraea rileyi* and *Sl*NPV infected larvae*,* predatory bugs on *S. litura* larvae in soybean, *Coccinella transversalis* F., *M. sexmaculata, Brumoides suturalis* (F.) in maize, *Scymnus coccivora* Ayyar*, Triomata coccidivora* and *B. suturalis* in mealy bug colonies on custard apple, *Acerophagus papayae* N. and S. and *Pseudleptomastix mexicana* N. and S. and *Mallada boninensis* Okam. on papaya mealy bug, spiralling white fly on papaya and *Mallada* sp. and anthocorids on mango hoppers. The parasitism of *Encarsia guadeloupae* was recorded in spiralling white fly on cotton, guava, papaya, pomegranate, mulberry, rose and teak.

The parasitism of *Trichogramma* was attempted to record in crops like cotton, sugarcane, paddy, maize, soybean and pomegranate in Pune through display of sentinel egg-cards of *Corcyra* but it was not observed. The chrysopid *Chrysoperla zastrowi sillemi* Esb. was recorded in cotton, maize, pigeon pea and *M. boninensis* on papaya, pomegranate and mango. *Cryptolaemus* grubs were collected from the pre-released plots of custard apple, papaya, mulberry and guava. The specimens of spiders collected from 6 field crops and 5 orchard crops were sent for identification. The entomopathogens particularly the cadavers of *S. litura* and *H. armigera* infected with *Nomuraea rileyi, Metarhizium anisopliae, Sl*NPV, were collected from soybean, potato, pigeon pea and lucerne. Also,

safflower aphids and, HaNPV mango hoppers were collected from the earlier treated plots and isolated under laboratory conditions (**Table 9**).

Table 9. Natural enemies recorded from western Maharashtra

Sr. No.	Name of Natural Enemies	Crop	Remarks /Natural enemies identified
1	*Trichogramma*	Cotton, sugarcane, paddy, maize, pomegranate	Sentinel cards of *Corcyra* eggs for *Trichogramma* were displayed in the fields from August 2012 to February, 2013 at various crop stages and prevalence of caterpillar pests, but parasitoids were not recovered.
2	Chrysopid *Chrysoperla zastrowi sillemi* Esben-Petersen *Mallada boninensis* Okam.	Cotton, pigeon pea, maize Guava, papaya, pomegranate, rose, cotton, mulberry	The eggs, grubs and adult stages were collected, identified locally and also sent for identification to the NBAII, Bangalore. The species recorded from spiraling whitefly colonies were identified locally.
3	*Cryptolaemus montrouzieri* Mulsant	Custard apple, guava, papaya, mulberry	The grubs were collected from the pre-released fields during August-September, 2012.
4	Spiders	Cotton, sugarcane, paddy, pigeon pea, maize, soybean, papaya, guava, sapota, pomegranate, mango	The specimens were collected and sent for identification to the NBAII, Bangalore.
5	Entomopathogens *Nomuraea rileyi* *Metarhizium anisopliae* *Sl*NPV, *Ha*NPV	Soybean, potato pigeon pea, lucerne, Safflower, mango, Potato, cabbage, Tomato, pigeon pea, chickpea	*Nomuraea rileyi* and *Sl*NPV diseased cadavers of *S. litura*, *Ha*NPV infected larvae of *H. armigera* and safflower aphids and mango hoppers infected with *M. anisopliae* were collected and isolated in the laboratory.

TNAU

The natural enemies' *viz*., *Trichogramma, Chrysoperla, Cryptolaemus*, spiders and parasitoids of papaya mealybug collected in Tamil Nadu were sent to NBAII.

YSPUHF

i) *Trichogramma*

Eggs of *Helicoverpa armigera* and *Pieris brassicae* were collected and brought to the laboratory and kept for *Trichogramm*a emergence. No *Trichogramma* emerged from these eggs. Sentinel cards were placed in the tomato, rose and cauliflower fields periodically for trapping/collection of different species of *Trichogramma,* but no *Trichogramma* were collected/trapped.

Geographical & other details	***Chrysoperla***	**Coccinellid beetles**
Scientific name of the insect	*Chrysoperla zastrowi sillemi*	*Coccinella septempunctata, C. luteopicta Hippodamia varigieta, Pryscibrumus uropygialis, Propylea. lutiopustulata*
Common name of the insect	Green lace wing	Ladybirds
Location	Solan(up to 20Km), Rohru(185Km), Nerwa (180Km), kotkhai (125Km), Kullu (220Km)	Kalpa (Kinnaur)
Taluk, district & Agro-climatic zone	Sub temperate	Temperate high hills
Distance from the HQ	20-220Km	320Km
Date of survey	July, October-November	September- October
Host crop/ sole crop/ intercrop/ etc.	Apple, cucumber	Radish (Seed crop)
Stage of the crop	Fruit bearing	Flowering stage
Stage of the insect pest	Nymphs of apple woolly aphid and greenhouse whitefly	Nymphs and adults of aphids
Weather parameters recorded (max, min temp; rainfall, no. of rainy days)	-	-
GIS data	1200-1500m amsl.	2960m amsl
Pesticide usage pattern	-	-

Geographical & other details	Coccinellid beetles	Coccinellid beetles
Scientific name of the insect	*Coccinella septempunctata*, *C. transversalis, Hippodomia variegata*, *Cheilomenes sexmaculata*, *Oenopia kirbyi, O. sauzeti, O. sexareata, Propylea dessecta,* , *Illeis* sp*, Coelophora bisselata, Brumoides suturalis, Rodolia octoguttata, Megalocaria dilatata* , *Platynaspis saundersi* and *Sumnius vestita*	*Coccinella septempunctata*, *C. transversalis, Hippodomia variegata*, *Cheilomenes sexmaculata*, *Oenopia kirbyi, O. sauzeti, O. sexareata, Propylea dessecta,* , *Coelophora bisselata, Platynaspis saundersi, Pharoscymnus flexibilis, P. horni Chilocorus nigrita*, *Adalia tetraspilota, Phrynocaria perrotetti, Scymnus* sp and an unidentified species.
Common name of the insect	Ladybirds	Ladybirds
Location	Solan	Ghumarwin (Bilaspur) and Sundernagar (Mandi)
Taluk, district & Agro-climatic zone	Sub temperate	Sub temperate
Distance from the HQ	Within 20 Km	135Km and 160Km
Date of survey	March-November	March-April and October-November
Host crop/ sole crop/ intercrop/ etc.	Vegetables, ornamentals, fruits and weeds	Vegetables, ornamentals, fruits and weeds
Stage of the crop	Vegetative and flowering stage	Vegetative and flowering stage
Stage of the insect pest	Nymphs and adults of homopterans	Nymphs and adults of homopterans
Weather parameters recorded (max, min temp; rainfall, no. of rainy days)	-	-
GIS data	1100-1500m amsl	500-600m amsl
Pesticide usage pattern	-	-

Geographical & other details	**Coccinellid beetles**	**Coccinellid beetles**
Scientific name of the insect	*Coccinella septempunctata*, Hippodomia *variegata*, *Cheilomenes sexmaculata*, *O. sauzeti, O. sexareata,* and an unidentified.	*Coccinella septempunctata*, *Hippodomia variegata*, *Cheilomenes sexmaculata*, *O. sauzeti, O. sexareata, Propylea lutiopustulata, Chilocorus infernalis, Harmonia eucharis*
Common name of the insect	Ladybirds	Ladybirds
Location	Kullu and Manali	Rohru and Nerwa
Taluk, district & Agro- climatic zone	Sub temperate and temperate	Sub temperate and temperate
Distance from the HQ	220Km and 270Km	220Km and 270Km
Date of survey	November	November
Host crop/ sole crop/ intercrop/ etc.	Vegetables, ornamentals, fruits and weeds	Vegetables, ornamentals, fruits and weeds
Stage of the crop	Vegetative and flowering stage	Vegetative and flowering stage
Stage of the insect pest	Nymphs and adults of homopterans	Nymphs and adults of homopterans
Weather parameters recorded (max, min temp; rainfall, no. of rainy days)	-	-
GIS data	1200-2500m amsl	1300-1800m amsl
Pesticide usage pattern	-	-

Geographical & other details	**Spiders**	**Predatory mites**
Scientific name of the insect	Unidentified	*Amblyseius (Propioseius)* sp., *Typhlodromus*(*Amblydromella*) *himalayensis*, *Typhlodromus* sp., *Euseius prasadi*, *Euseius finlandicus, Neoseiulus paspalivorus*
Common name of the insect	Unidentified	Predatory mites
Location	Solan	Solan, Sunder Nagar, Rohru and Nakaura
Taluk, district & Agro-climatic zone	Sub temperate	Sub tropical to Sub temperate
Distance from the HQ	Within 20 Km	120-180Km
Date of survey	July	March - November
Host crop/ sole crop/ intercrop/ etc.	Rose and cucumber	Brinjal, Rose, Plum, Apple and Apricot
Stage of the crop	Vegetative and flowering stage	Vegetative stage
Stage of the insect pest	Nymphs and adults of homopterans	All stages of spider mite
Weather parameters recorded (max, min temp; rainfall, no. of rainy days)	-	-
GIS data	1200m amsl	500-2250m amsl
Pesticide usage pattern	-	-

Besides the above mentioned natural enemies, *Scolothrips* sp, staphylinid beetle, predatory midge (all associated with *Tetranychus urticae* on rose), *Zygogramma bicolorata,* eriophyid mite along with predatory midge on tomato were also collected. *Orius* spp. and *Anthocoris* sp. were collected from peach orchards infested with thrips and peach leaf curl aphid, *Brachycaudus helichrysi*. Egg parasitoid *Trisolcus* sp was collected from eggs of *Nezara viridula* and the specimens were supplied to NBAII, Bangaluru.

Insect derived EPNs: Soil samples from potato farms with white grubs and apple orchards having root borer grubs were collected. The experiment for trapping EPNs was conducted in the laboratory as per the protocol supplied by NBAII, Bangalore, but no EPNs were collected/ trapped from any location. White grubs and apple root borer grubs were also collected from these locations, but no EPNs were trapped. Soil samples have been sent to NBAII.

Parasitoids of serpentine leaf miner, *Liriomyza trifolii*: - To study the diversity of parasitoids of the serpentine leaf miner, *Liriomyza trifolii* on tomato, infested leaves were collected at fortnightly intervals from April to September, 2012. The leaves were collected from bottom, middle and top strata of the plant at random. These leaves were brought to the laboratory and observations on live mines (larva inside), dead mines (larva died due to unknown reasons), empty mines and parasitized mines were recorded. For calculation of per cent parasitization dead mines were ignored and data of live mines, empty mines and parasitized mines was pooled to get total number of mines. The leaves were kept in plastic jars for the emergence of miner flies and/or parasitoids. Six species of larval and one of larval-pupal parasitoids were collected. Larval parasitoids were identified as *Neochrisocharis formosa, Chrysocharis* sp. *Diglyphus* sp*, Asecodes deluchii, Asecodes erxias* and *Hemiptarsinus varicornis*, whereas, the larval–pupal parasitoid was identified as *Opius* sp. The parasitoids were active from April to September and total parasitization ranged from 4.2 to 33.9 per cent with maximum during the first fortnight of August (**Table10**). Among larval parasitoids, *N. formosa* was the dominant species.

Table 10. Parasitization of serpentine leaf miner*, Liriomyza trifolii* during 2012.

Month	**% Parsitization**
April II	4.2
May I	10.6
May II	20.5
June I	21.8
June II	28.9
July I	26.5
July II	30.6
August I	33.9
August II	31.6
September I	20.2
September II	20.5
Seasonal mean *	22.7

* Based on parasitized larvae and total larvae collected throughout the season

I-First fortnight; II- Second fortnight

Parasitoids of Pea leaf miner, *Chromatomyia horticola*

Bio-diversity of the parasitoids of pea leaf miner, *Chromatomyia horticola* was studied on peas under mid hill conditions (1300 m amsl). Infested leaves were collected at random and brought to the laboratory. Observations on total mines and parasitized mines were recorded. Dead mines where larvae died due to unknown reasons were ignored while counting total mines for calculation of per cent parasitization. Leaves were kept in plastic jars for the emergence of parasitoids and/or miner flies. During the study, two species of larval parasitoids namely, *Diglyphus* sp. and *Quadrastichus* sp. and one larval-pupal parasitoid, *Opius* sp were recorded. These parasitoids were active from January till April. During first fortnight of January, 22.9 per cent parasitization was recorded which increased gradually and was maximum (40.3%) during first fortnight of March (**Table 11**). Parasitoid activity started declining after first fortnight of March and was 38.3 per cent. Among different parasitoids collected, *Diglyphus* sp. was the dominant species.

Table 11: Per cent parasitization of Pea leaf miner, *Chromatomyia horticola* under mid hill conditions during 2013.

Month	Parastization (%)
January I	22.9
January II	26.5
February I	31.0
February II	29.9
March I	40.3
March II	38.3
Seasonal mean *	30.7

*Based on parasitized larvae and total larvae collected throughout the season
I-First fortnight; II- Second fortnight

KAU

1. Natural enemies of banana pseudostem weevil and banana aphid, pollu beetle and root mealybug of pepper

Seven agroecological zones were selected for surveys of natural enemies of banana pseudostem weevil, banana aphid, pollu beetle and root mealybug of pepper. The agroecological zones with agroclimatic details and area covered are given below (**Table 12**).

Table 12. Details of area covered

Sl. No.	Agroecological zone	Agroclimatic zone	Area covered
1	Coastal sandy	Sub humid alluvium	Thalikulam, Mathilakom, Chendrappinni
2	Central mid land	Sub humid laterite	Perumbavur, Kottapady, Plamudi, Nedungapra, Panamkulam
3	Northern mid land	Sub humid red loam	Payyannur, Thaliparamba, Panniyur
4	Malayoram	Sub humid laterite	Muvattupuzha, Thodupuzha Ollukkara, Kannara,Marottichal
5	Palakkad Plains	Semi dry alluvium	Alathur, Wadakkumchery Kizhakkumchery, Kalamkulam
6	High ranges	Semi dry forest loam	Sulthan Battery, Kalpetta Mananthavady, Adimali, Thankamony, Erattayar Valiyathovala, Nedumkandom Ezukkumvial, Pooppara
7	River bank	Sub humid alluvium	North Paravur, Thottippal Arattupuzha

Details of natural enemies of various pests are given below

a) Banana Pseudostem weevil *Odoiporus longicollis* (Oliv.)

Banana pseudostem weevil is a serious pest in Kerala limiting the productivity of bananas. It is a monophagous pest and both larvae and adult cause severe damage to the crop. Survey was carried out in Thrissur, Ernakulam, Palakkad, Idukki, Malappuram, Kozhikode, Wayanad and Kannur districts. Pest incidence was noticed in almost all the locations. Different types of earwigs were collected from all the locations. The earwigs were noticed on the outer layer of pseudostem. Three species of earwigs were collected and brought to the lab and were found feeding on the eggs of the pseudostem weevil. These were sent to Dr. Hedge, Zoological survey of India, Culcutta for identification.

The details of ear wigs collected are given in Table **13,14 & 15**.

Table 13. Collection details of Earwig 1

Location	Kannara	Kalamkulam, Wadakkumchery	Marottichal	North Paravur	Panamkulam	Thottippal	Erattayar
District & Agroclimatic zone	Thrissur Sub humid laterite	Palakkad Semi dry alluvium	Thrissur Sub humid laterite	Ernakulam Sub humid alluvium	Thrissur Sub humid laterite	Thrissur Sub humid alluvium	Idukki Semi dry forest loam
Distance from the HQ (km)	14	38, 50	29	65	32	26	290
Date of survey	17/09/12 01/12/12 22/01/13	27/11/12	30/11/12 15/12/12	30/10/12	13/12/12	16/11/12 13/12/12	14/02/13
Host crop/sole crop/ inercrop	Sole crop	Sole crop	Sole crop	Sole crop	Sole crop	Sole crop	Sole crop
Stage of the crop	Pre harvest, Harvesting	Harvesting	Harvesting	Pre harvest stage	Harvesting	Harvesting	Harvesting
Stage of the insect pest	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults
Weather parameters recorded	Max.temp. – 33.87^{o}C Min.temp-23.60^{o}C RF- 74.65 mm RH- 66.33%	Max.temp. – 31.4^{o}C Min.temp-22.90^{o}C	Max.temp.-31.65^{o}C Min.temp-22.4^{o}C RF – 121.2 mm RH – 65 %	RF -234 mm	Max.temp.-31.9^{o}C Min.temp - 21.9^{o}C RF – 2.4mm RH -62%	Max.temp.-31.65^{o}C Min.temp-22.4^{o}C RF – 121.2 mm RH – 65 %	Max.temp.-26.96^{o}C Min.temp-13.56^{o}C

* Sent for identification to Dr. Hegde, ZSI, Calcutta

Table 14. Collection details of Earwig 2

Location	Ollukkara	Kannara	Kalamkulam, Wadakkumchery	Marottichal	North Paravur	Panamkulam	Thottippal	Erattayar
District & Agroclimatic zone	Thrissur Sub humid laterite	Thrissur Sub humid laterite	Alathur Palakkad Semi dry alluvium	Thrissur Sub humid laterite	Ernakulam Sub humid alluvium	Thrissur Sub humid laterite	Thrissur Sub humid alluvium	Idukki Semi dry forest loam
Distance from the HQ (km)	2	14	38, 50	29	65	32	26	290
Date of survey	10/09/12 22/09/12	17/09/12 01/12/12 22/01/13	27/11/12	30/11/12 15/12/12	30/10/12	13/12/12	16/11/12 13/12/12	14/02/13
Host crop/sole crop/ inercrop	Sole crop	Sole crop	Sole crop	Sole crop	Sole crop	Sole crop	Sole crop	Sole crop
Stage of the crop	Pre harvest	Harvesting	Harvesting	Harvesting	Pre harvest stage	Harvesting	Harvesting	Harvesting
Stage of the insect pest	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults
Weather parameters recorded	Max.temp -30^{o}C Min.temp. - 23.5^{o}C RF -193 mm RH – 85%	Max.temp. – 33.87^{o}C Min.temp- 23.60^{o}C RF- 74.65 mm RH- 66.33 %	Max.temp. – 31.4^{o}C Min.temp- 22.90^{o}C	Max.temp.- 31.65^{o}C Min.temp- 22.4^{o}C RF – 121.2 mm RH – 65 %	RF -234 mm	Max.temp.- 31.9 ^{o}C Min.temp - 21.9 ^{o}C RF – 2.4 mm RH -62%	Max.temp.- 31.65^{o}C Min.temp- 22.4^{o}C RF – 121.2 mm RH – 65 %	Max.temp.- 26.96^{o}C Min.temp- 13.56^{o}C

* Sent for identification to Dr. Hegde, ZSI, Calcutta

Table 15. Collection details of Earwig 3

Location	Marottichal	Panamkulam	Sulthan Bathery	Adimali
District & Agroclimatic zone	Thrissur Sub humid laterite	Thrissur Sub humid laterite	Wayanad Semi dry forest loam	Idukki Semi dry forest loam
Distance from the HQ (km)	29	32	255	230
Date of survey	30/11/12 15/12/12	13/12/12	28/02/13	16/02/13
Host crop/sole crop/ inercrop	Sole crop	Sole crop	Intercrop	Sole crop
Stage of the crop	Harvesting	Harvesting	Harvested leaving pseudostem	Harvested leaving pseudostem
Stage of the insect pest	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults	Eggs, grubs, adults
Weather parameters recorded	Max.temp.31.65^{o}C Min.temp- 22.4^{o}C RF – 121.2 mm RH – 65 %	Max.temp.31.9 ^{o}C Min.temp.21.9 ^{o}C RF – 2.4 mm RH -62%	Max.temp. 30.37^{o}C Min.temp.16.6 ^{o}C RF – 1.4 mm RH -59.3%	Max.temp.-26.96^{o}C Min.temp- 13.56^{o}C

* Sent for identification to Dr. Hegde, ZSI, Calcutta

b) Banana aphid, *Pentalonia nigronervosa* Coq.

Banana aphid occurs on banana plants usually in small to very large colonies. They are found in sheltered situations in the plant such as base of the pseudostem, top region of the pseudostem and leaf axils. Even though the aphid is found on the plants throughout the year, its population fluctuates in different seasons. The population of the aphid is high from early September to late January. The population dwindles rapidly from the end of January and remains low till the middle of June. Heavy rains reduce the population. Surveys were carried out during the season and predatory coccinellids (*Pseudaspidimem trinotatus, Scymmus pyrocheiles, Jouraria soror* and 2 spp. of *Scymmus*) and an unidentified species of Hemerobidae were collected (**Table 16, 17, 18, 19, & 20**).

Table 16. Collection details of *Pseudaspidimerus trinotatus* (Thunberg)

Location	Ollukkara Kannara	Moovattupuzha , Perumbavur	Thalikulam, Mathilakom, Chendrappinni	Vadakkumchery
District & Agroclimatic zone	Thrissur Sub humid laterite	Ernakulam Sub humid laterite	Thrissur Sub humid alluvium	Palakkad Semi dry alluvium
Distance from the HQ (km)	2, 14	110, 90	66, 58	38
Date of survey	12/07/12 16/07/12	16/10/12 30/10/12	19/11/12	27/11/12
Host crop/sole crop/ inercrop	Sole crop	Sole crop	Sole crop	Sole crop
Stage of the crop	3-4 months old, 7-8 monhs old	3-4 months old	7-8 months old	3-4 months old
Stage of the insect pest	Nymphs, adults	Nymphs, adults	Nymphs, adults	Nymphs, adults
Weather parameters recorded	Max.temp.29.1^{o} C Min.temp.22.5^{o}C RF – 588.2 mm RH – 88 %	RF -234 mm	Max.temp.31.4^{o} C Min.temp.22.9^{o}C RF – 240 mm RH – 68 %	Max.temp.31.4^{o} C Min.temp.22.9^{o}C

Table 17. Collection details of *Scymnus pyrocheilus* (Mulsant)

Location	Marottichal	Ambalavayal	Arattupuzha	North Paravur
District & Agroclimatic zone	Thrissur Sub humid laterite	Wayanad Semi dry forest loam	Thrissur Sub humid alluvium	Ernakulam Sub humid alluvium
Distance from the HQ (km)	29	260	32	65
Date of survey	30/11/12 15/12/12	26/02/13	13/12/13	30/10/12
Host crop/sole crop/ inercrop	Sole crop	Sole crop	Sole crop	Sole crop

Stage of the crop	3-4 months old 7-8 months old	3-4 months old	3-4 months old 7-8 months old	3-4 months old 7-8 months old
Stage of the insect pest	Nymphs, adults	Nymphs, adults	Nymphs, adults	Nymphs, adults
Weather parameters recorded	Max.temp.-31.65^{o}C Min.temp- 22.4^{o}C RF – 121.2 mm RH – 65 %	Max.temp. 30.37^{o}C Min.temp.16.6 ^{o}C RF – 1.4 mm RH -59.3%	Max.temp.31.9^{o}C Min.temp- 21.9^{o}C RF – 2.4 mm RH – 62 %	RF -234 mm

Table 18. Collection details of *Jaurovia soror* Weise

Location	Mathilakom, Chendrappinni	Wadakkumchery	Adimali
District & Agroclimatic zone	Kodungallore Thrissur Sub humid alluvium	Alathur Palakkad Semi dry alluvium	Idukki Semi dry forest loam
Distance from the HQ (km)	66 & 58	38	230
Date of survey	19/11/12	27/11/12	16/02/13
Host crop/sole crop/ inercrop	Sole crop	Sole crop	Sole crop
Stage of the crop	7-8 months old	3-4 months old	7-8 months old
Stage of the insect pest	Nymphs, adults	Nymphs, adults	Nymphs, adults
Weather parameters recorded	Max.temp.31.4^{o}C Min.temp- 22.9^{o}C RF – 240 mm RH – 68 %	Max.temp.31.4^{o}C Min.temp.22.9^{o}C	Max.temp.-26.96^{o}C Min.temp-13.56^{o}C

Table 19. Collection details of *Scymnus* spp (2 species)

Location	Mathilakom, Chendrappinni	Vadakkumchery	Adimali	Ambalavayal
District & Agroclimatic zone	Thrissur Sub humid alluvium	Palakkad Semi dry alluvium	Idukki Semi dry forest loam	Wayanad Semi dry forest loam
Distance from the HQ (Km)	66 & 58	38	230	260
Date of survey	19/11/12	27/11/12	16/02/13	26/02/13
Host crop/sole crop/ inercrop	Sole crop	Sole crop	Sole crop	Sole crop
Stage of the crop	7-8 months old	3-4 months old	7-8 months old	3-4 months old
Stage of the insect pest	Nymphs, adults	Nymphs, adults	Nymphs, adults	Nymphs, adults
Weather parameters recorded	Max.temp.31.4^{o}C Min.temp- 22.9^{o}C RF – 240 mm RH – 68 %	Max.temp.31.4^{o}C Min.temp.22.9^{o}C	Max.temp.26.96^{o}C Min.temp-13.56^{o}C	Max.temp. 30.37^{o}C Min.temp.16.6 ^{o}C RF – 1.4 mm RH -59.3%

Table 20. Collection details of Hemerobid

Location	Vellanikkara	Mathilakom	Wadakkanchery	Marottichal
District & Agroclimatic zone	Thrissur Sub humid laterite	Thrissur Sub humid alluvium	Palakkad Semi dry alluvium	Thrissur Sub humid laterite
Distance from the HQ (km)	2	66	38	29
Date of survey	12/07/12	19/11/12	27/11/12	15/12/12
Host crop/sole crop/ inercrop	Sole crop	Sole crop	Sole crop	Sole crop
Stage of the crop	3-4 months old	4-5 months old	3-4 months old	3-4 months old
Stage of the insect pest	Numphs&adults	Nymphs&adults	Nymphs& adults	Nymphs&adults
Weather parameters recorded	Max.temp.29.1^{o}C Min.temp- 22.5^{o}C RF – 588.2 mm RH – 88 %	Max.temp.31.4^{o}C Min.temp- 22.9^{o}C RF – 240 mm RH – 68 %	Max.temp.31.4^{o}C Min.temp.22.9^{o}C	Max.temp.31.9^{o}C Min.temp- 21.9^{o}C RF – 2.4 mm RH – 62 %

c. Pepper pollu beetle *Longitarsus nigripennis* Mots

Injury caused by grubs to pepper berries is very serious. The grub was also found entering into the spike stalk causing the entire region beyond it to dry up. The adults feed on tender leaves making holes. Season of the pest incidence is from July to March. The survey was carried out in different pepper growing areas in Thrissur, Ernakulam, Idukki, Wayanad and Kannore districts during the season. Coccinellids and spiders were collected from the leaves as predators of the beetle. Spiders collected were identified and the details are given in **Table 21, 22 & 23**.

Table 21. Collection details of spiders

Name of natural enemies (Spiders)
1. *Araneus bilunifer* (Araneidae); 2. *Argiope pulchella* (Araneidae)
3. *Bavia kairali* (Salticidae)

Location	Perumbavur	Payyannur, Panniyur	Ambalavayal	Marottichal
District & Agroclimatic zone	Ernakulam Sub humid laterite	Kannur Sub humid red loam	Wayanad Semi dry forest loam	Thrissur Sub humid laterite
Distance from the HQ (km)	90	260	260	29
Date of survey	24/08/12 18/09/12 16/10/12	27/09/12 28/09/12 29/09/12	28/02/13	15/12/12
Host crop/sole crop/ inercrop	Intercrop	Maincrop	Maincrop	Intercrop
Stage of the crop	Berry formation stage	Berry formation stage	Berry formation stage	Berry formation stage
Stage of the insect pest	Grubs and adults	Grubs and adults	Grubs and adults	Grubs and adults
Weather parameters recorded	RF – 446.2 mm 173 mm, 234 mm	Mean temp 31^{o}C	Max.temp. 30.37^{o}C Min.temp.16.6 ^{o}C RF – 1.4 mm RH -59.3%	Max.temp.31.9^{o}C Min.temp. 21.9^{o}C RF – 2.4 mm RH – 62 %

Table 22. Collection details of spiders

Name of natural enemies (Spiders)

1. ***Clubiona drassodes*(Clubionidae)**
2. ***Oxyopes javanus* (Oxyopidae)**

Location	Perumbavur	Panniyur	Erattayar
District & Agroclimatic zone	Ernakulam Sub humid laterite	Kannur Sub humid red lorm	Idukki Semi dry forest loam
Distance from the HQ	90	260	290
Date of survey	24/08/12 18/09/12 16/10/12	27/09/12 28/09/12 29/09/12	14/02/13
Host crop/sole crop/ inercrop	Intercrop	Maincrop	Maincrop
Stage of the crop	Berry formation stage	Berry formation stage	Berry formation stage
Stage of the insect pest	Grubs and adults	Grubs and adults	Grubs and adults
Weather parameters recorded	RF – 446.2 mm 173 mm, 234 mm	Mean temp 31^{o}C	Max.temp.-26.96^{o}C Min.temp- 13.56^{o}C

Table 23. Collection details of spiders

Name of natural enemies (Spiders)

3. ***Charizopes bengalensis* (Araneidae)**
4. ***Oxyopes birmanicus* (Oxyopidae)**
5. ***Oxyopes swetha* (Oxyopidae)**
6. ***Thiania bhamoensis*(Salticidae)**

Location	Perumbavur	Panniyur	Erattayar
District & Agroclimatic zone	Ernakulam Sub humid laterite	Kannur Sub humid red lorm	Idukki Semi dry forest loam
Distance from the HQ (km)	90	260	290
Date of survey	24/08/12 18/09/12 16/10/12	27/09/12 28/09/12 29/09/12	14/02/13
Host crop/sole crop/ inercrop	Intercrop	Maincrop	Main crop
Stage of the crop	Berry formation stage	Berry formation stage	Berry formation stage
Stage of the insect pest	Grubs and adults	Grubs and adults	Grubs and adults
Weather parameters recorded	RF – 446.2 mm 173 mm, 234 mm	Mean temp. 31^{o}C	Max.temp.-26.96^{o}C Min.temp- 13.56^{o}C

d) Pepper root mealybug

The incidence was observed only in Wayanad district in Mullankolly area. The infestation was observed in main field and in nursery plants. Mealybugs were found infesting on the roots and basal region of stem under the soil. Ants were found associated with the mealybugs. The mealybugs were identified as *Formicoccus polysperes* Williams No natural enemies were collected during the period.

Survey was carried out from September 2012 to March 2013 in pepper growing areas of Kerala and details are given in **Table 24**.

Table 24. Survey in different pepper growing areas of Kerala

Districts	Locations
Ernakulam	Kottapady, Plamudi, Nedungapra
Thrissur	Kannara, Vellanikkara, Marottichal, Valloor
Palakkad	Muthalamada, Wadakkumchery, Kizhakkumchery
Idukki	Thankomony, Nedumkandom, Valiyathovala, Erattayar, Ezhukkumvial, Senapathy, Pooppara
Wayanad	Sulthan Battery, Vythiri, Mullankolly, Ambalavayal, Pulpally
Kannur	Panniyoor, Thaliparamba, Payyannur

PAU

1. Natural enemy complex of rice yellow stem borer and leaf folder; cotton aphids and mirld bug; onion thrips

Populations of rice yellow stem borer & leaf folder and their natural enemies were monitored in rice growing belt of Patiala, Amritsar, Jalandhar, Hoshiarpur, Faridkot and Abohar districts of Punjab during the 2012 cropping season. The population of leaf folder was quite high and farmers resorted to application of various insecticides viz. Chlorpyriphos 20 EC, Triazophos 40 EC, Imidacloprid 200 SL, Lambda cyhalothrin 5EC, Spinosad 48 SC etc. The population of natural enemies was low.

Biocontrol agents in cotton ecosystem were monitored in different districts namely Bathinda, Ferozepur, Muktsar and Mansa. The major insect pests during the cropping season were jassids and whitefly. The population of thrips, mealybugs and tobacco caterpillar was low to moderate. Cotton aphid and mirid bug did not appear at all. The population of biocontrol agents was low to moderate.

The population of natural enemies in relation to onion thrips was regularly monitored in the vegetable growing belt of Punjab during the *rabi* season 2012-13. The plants showing symptoms of thrips attack were regularly bought to the laboratory for monitoring natural enemy emergence.The vegetable farmers, in general, resorted to heavy insecticide spraying of insecticides like Dimethoate 30 EC, Imidacloprid 200 SL, Profenofos 50 EC, Carbosulfan 25 EC, Lambda cyhalothrin 5 EC, Methomyl 40 SP, Spinosad 2.5 SC, Fipronil 5 SC etc which might be the reason for non-observance of any natural enemies.

In cole crops, populations of diamondback moth, cabbage butterfly, cabbage head borer and aphids were monitored along with their natural enemies in vegetable growing

areas of Amritsar, Patiala, Kapurthala and Jalandhar districts. Cabbage butterfly, *Pieris brassicae* is fast emerging as a major pest in cole crops. It has been observed to be parasitized by the larval parasitoid, *Cotesia glomerata* (**Table 25**). The per cent parasitization varied from 35.0 to 40.0 per cent at different locations.

Table 25. Natural enemy complex in different crops

Diversity of biocontrol agents			
S. No.	**Crop**	**Biocontrol agent**	**Pests attacked**
Predators			
1.	Paddy	Spiders	Leaf and plant hoppers, leaf folder and adult stem borers.
		Damsel and dragon flies	Stem borers, hoppers and other flying insects.
		Ladybird beetles	Plant hoppers
		Crickets	Eggs of leaf folder and nymphs of plant hoppers and leaf hoppers.
		Parasites	
		Trichogramma sp. *Telenomus* sp. *Tetrastychus* sp	Eggs of stem borers and leaf folders
		Stenobracon sp.	Larvae of stem borers and leaf folders
2.	Cotton	**Predators**	
		Chrysoperla zastrowi sillemi	Nymphs of cotton jassid and whitefly
		Coccinella spp	Cotton whitefly
		Parasites	
		Encarsia sp	Cotton whitefly
Predators			
3.	Cole Crops	*Coccinella septumpuncata* complex	Nymphs and adults of *Lipaphis erysimi* and *Myzus persicae*
		Chrysoperla zastrowi sillemi	Cabbage aphids
		Parasites	
		Cotesia glomerata	Larvae of cabbage butterfly, *Pieris brassicae*
		Diaeretiella rapae	Nymphs and adults of *Lipaphis erysimi* and *Myzus persicae*

2. Isolation of *Bacillus thuringiensis* from soil samples

The soil samples were collected from different areas of sugarcane and vegetable crops. Soil samples were collected from five different spots of in each area and brought to laboratory for further processing. One gram of soil was suspended in 10 ml of sterilized distilled water and heated for few minutes. Then 1 ml of each sample was added to10 ml of Luria Bertani broth buffered by 0.25M sodium acetate (pH 6.8) which was incubated at 30^0C and heated to 80^0C again for short time. Resulting suspension was serially diluted up to 10^{-6}. Dilutions of 10^{-5} and 10^{-6} were serially diluted on T3 agar plates and kept for incubation at 28^0C to 30^0C for three to five days. The plates were observed for cream colored colonies which gave fried egg appearance. The colonies were further stained with

Amidoblack and observed under microscope for parasporal crystal. Out of the twelve soil samples processed Bt was isolated from two soil samples.

SKUAST

1. Natural enemy complex of pests of apple (Stem borer, San Jose scale, mite and other pests), apricot (borer from Ladakh and other pests), plum, pear, peach, cherry, walnut and almonds

As a result of survey of apple, in the districts of Srinagar and Kargil, twenty different natural enemies including some hyper parasitoids (**Table 26**), viz. *Ablerus* sp., *Aphelinus mali*, *Aphytis proclia*, *Azotus* sp., *Encarsia perniciosi*, *Chilocorus infernalis*, *Chrysoperla zastrowi*, *Chrysoperla sp.*, *Coccinella septempunctata*, *Marietta* sp., *Scymnus* sp., *Trichomalopsis* sp*.,* were discovered. Unidentified species of aphelinid, anthocorid bug, braconid, chalcid, eulophid ichneumonid, trichogrammatid, associated with San Jose scale, *Quadraspidiotus perniciosus,* Wooly aphid, *Eriosoma lanigerum*, apple leaf miner, *Lyonetia* sp., and codling moth, *Cydia pomonella* were found. Out of above mentioned natural enemies, *Homalotylus longipedicellus*, *Trichomalopsis* sp. and unidentified species, each of the aphelinid, chalcid, eulophid from Woolly apple aphid and eulophid from apple leaf miners were discovered for the first time from Kashmir.

Since the above mentioned experiment was offered by NBAII during July' 2012, which was too late for collection of natural enemies from other fruit pests the survey was therefore focused on apple. Detailed observations however on the other pests will be conducted during 2013.

Table 26. Natural enemies associated with pests on apple in Jammu and Kashmir, during 2012

S. No.	Host plant	Host Insects	Location	Natural enemies
1.	Apple	San Jose scale, *Quadraspidiotus perniciosus*	Srinagar	*Encarsia perniciosi*
2.	-do-	-do-	-do-	*Aphytis proclia*
3.	-do-	-do-	-do-	*Ablerus* sp.
4.	-do-	-do-	-do-	*Marietta* sp.
5.	-do-	-do-	-do-	*Azotus* sp.
6.	-do-	-do-	-do-	Trichogrammatid
7.	-do-	-do-	-do-	Unidentified aphelinind
8.	-do-	-do-	-do-	Unidentified chalcid
9.	-do-	-do-	-do-	*Chilocorus infernalis*
10.	-do-	-do-	-do-	*Coccinella septempunctata*
11.	-do-	-do-	-do-	*Scymnus* sp.
12.	-do-	Wooly aphid, *Eriosoma lanigerum*	Shalimar, Uni. campus	*Chrysoperla zastrowi*
13.	-do-	-do-	Kargil	*Chrysoperla* sp.
14.	-do-	-do-	Srinagar	*Aphelinus mali*
15.	-do-	-do-	-do-	*Trichomalopsis sp.*

17.	-do-	-do-	-do-	*Homalotylus longipedicellus*
18.	-do-	-do-	-do-	Unidentified eulophid
19.	-do-	Apple Leaf miner, *Lyonetia* sp.	-do-	Unidentified eulophid
20.	-do-	Codling moth, *Cydia pomonella*	-do-	Ichneumonid
21.	-do-	-do-	-do-	Braconid
22.	-do-	? Codling moth	-do-	Anthocorid bug
23.	Apricot	*Eurytoma* sp.	-do-	--
24.	-do-	Dipteran fly	-do-	--

CAU

1. Collection of spider fauna from rice ecosystem.

Ten species of spiders were collected from the rice ecosystems of rice and they are preserved in 95% ethyl alcohol. The same will be submitted to the Bureau for identification.

JNKVV- No Report

MPUAT-No Report

OUAT

Two species of chrysopids collected locally and spiders from rice ecosystem of coastal Odisha have been sent to NBAII for identification.

CPCRI

1. Natural enemies of coconut black headed caterpillar, eriophid mite, red palm weevil.

Table 27. Name of Insect/ microbial agent: Coconut black headed caterpillar

Geographical & other details		
Scientific name of the insect	*Opisina arenosella* Wlk.	
Common name of the insect	Black headed caterpillar of coconut	
Location	Location 1. Puthiyavila	Location 2. Kallara
Taluk, district & Agro-climatic zone	Thiruvananthapuram Agro climatic zone: Western Coastal	Kottayam Agro climatic zone: Western Coastal
Distance from the HQ	100 Kms	70 Kms
Date of survey	Monthly survey during July 2012 to March 2013	Monthly survey during July 2012 to March 2013
Host crop/ sole crop/ intercrop/ etc.	Host crop : Coconut Sole crop	Host crop : Coconut Intercrop : Paddy
Stage of the crop	Young to adult palms (10-35 years)	Young to adult palms (10-35 years)
Stage of the insect pest	All stages	All stages

Parasitoids recorded	*Apanteles taragamae, Bracon brevicornis, Brachymeria nosatoi, Goniozus nephantidis*	*Apanteles taragamae, Bracon brevicornis, Brachymeria nosatoi, Brachymeria spp., Goniozus nephantidis*
Predators	Spiders (*Rhene indicus, Cheiracanthium spp, Sparassus sp.* and 5 unidentified sp.); Carabid (*Parena nigrolineata)* and Anthocoreid (*Cardiastethus* sp.)	Spiders (*Rhene indicus, Cheiracanthium spp, Sparassus sp.* , **Oxyopes sp.,** and 4 unidentified sp.); Carabid (*Parena nigrolineata)* and Anthocoreid (*Cardiastethus* sp.)
Microbial agents	*Nil*	*Nil*
Weather parameters recorded (max, min temp; rainfall, no. of rainy days)		
GIS data	8° 29'N, 76 °57'E	9.3°N,76°66°'E
Pesticide usage pattern	No pesticide usage	No pesticide usage

Table 28. Name of Insect/ microbial agent: Coconut eriophyid mite

Geographical & other details					
Scientific name of the insect			*Aceria guerreronis* Keifer		
Common name of the insect			Coconut eriophyid mite		
Location	Location 1. Trivandrum, Edava, Oachira, Karunagapally, Kayamkulam, Vechoor, Ernakulam, Kasaragod	Location 2: Colachel, Cumbum	Location 3. Minicoy, Kavarathi	Location 4: Morigaon, Kamrup and Goalpara districts of Assam, Ri-Bhoi and East Garo Hills of Meghalaya	Location 5: Havelock Island, CARI farm, Siphighat farm and Kurmadera coconut farm (Andamans)
Taluk, district & Agro-climatic zone	State: Kerala; Districts: Trivandrum, Alappuzha, Kottayam, Kasaragod **Agroclimatic zone:** (Western Coastal)	State: Tamil Nadu **Agroclimatic zone:** ((East Coast plains and Hill region)	Lakshadweep **Agroclimatic zone:** (Island region)	States: Assam and Megahalaya (NEH region) **Agroclimatic zone: (**Eastern Himalayan region)	UT: : Andamans **Agroclimatic zone:**(Island region)
Distance from the HQ	. 100-400 kms	180-200kms	400Kms	3500kms	
Date of survey	Quarterly during April 2012 to March 2013	May 2012 and August 2012	June2012, November 2012, March 2013	March 2013	March 2012

Host crop/ sole crop/ intercrop/ etc.	Host crop: Coconut. Sole crop/ intercropped with vegetables, banana, tuber crops	Host crop: Coconut homestead at Colachel and Monocrop at Cumbum	Host crop: Coconut : Monocrop	Host crop: Coconut: Intercropped with arecanut, banana	Coconut based cropping system
Stage of the crop	Juvenile, Young to adult palms (3-50 years)	Juvenile, Young to adult palms (3-50 years)	Juvenile, Young to adult palms (3-50 years)	Juvenile, Young to adult palms (3-50 years)	Juvenile, Young to adult palms (3-50 years)
Stage of the insect pest	Eggs, nymphs and adults	Eggs, nymphs and adults	Eggs, nymphs and adults	Eggs, nymphs and adults	Eggs, nymphs and adults
Parasitoids recorded	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*
Predators recorded	*Neoseiulus baraki chelacaropsis moorei, Bdella s*p., *Typhlodromus sp* ., Thrips and syrphid (unidentified)	*Neoseiulus baraki chelacaropsis moorei*, thrips (unidentified)	*Neoseiulus baraki*, thrips (unidentified)	*Neoseiulus baraki chelacaropsis moorei,* thrips (unidentified)	Mite incidence very low in Andamans
Microbial agents	*H.thompsonii*	*Fusarium, Actinomycetes*	*Fusarium, Actinomycetes*	*Actinomycetes*	*Nil*
Weather parameters recorded (max, min temp; rainfall, no. of rainy days)	Temp. 22-35°C		20-34°C	28-35°C	
GIS data	8.507°N, 76.972°E	Colachal 8.18°N,77.2°6E Cumbum 9.73°N,77.3°E	8.278°N, 73.046°E	26 °14N, 91°77E	11.615°N, 92.726°E
Pesticide usage pattern	No pesticide usage	No pesticide usage	No pesticide usage	No pesticide usage	No pesticide usage

Table 29. Name of Insect/ microbial agent: Red palm weevil

Geographical & other details					
Scientific name of the insect		*Rhynchophorus ferrugineus*			
Common name of the insect		Red palm weevil			
Location	Location 1. Trivandrum, Edava, Oachira, Karunagappally, Kayamkulam, Vechoor, Ernakulam, Kasaragod	Location 2: Colachel, Cumbum	Location 3. Minicoy	Location 4: Morigaon, Kamrup and Goalpara districts of Assam, Ri-Bhoi and East Garo Hills of Meghalaya	Location 5: Havelock Island, CARI farm, Siphighat farm and Kurmadera coconut farm (Andamans)
Taluk, district & Agro-climatic zone	State: Kerala; Districts: Trivandrum, Alappuzha, Kottayam, Kasaragod **Agroclimatic zone:** (Western Coastal)	State: Tamil Nadu **Agroclimatic zone:** ((East Coast plains and Hill region)	Lakshadweep **Agroclimatic zone:** (Island region)	States: Assam and Megahalaya **Agroclimatic zone: (**Eastern Himalayan region)	UT: : Andamans **Agroclimatic zone:**(Island region)
Distance from the HQ	. 100-400 kms	180-200kms		3500kms	
Date of survey	Quarterly during April 2012 to March 2013	May 2012 and August 2012	June2012, November 2012, March 2013	March 2013	March 2012
Host crop/ sole crop/ intercrop/ etc.	Host crop: Coconut. Sole crop/ intercropped with vegetables, banana, tuber crops	Host crop: Coconut	Host crop: Coconut : Monocrop	Host crop: Coconut: Intercropped with arecanut, banana	
Stage of the crop	Juvenile, Young to adult palms (3-50 years)	Juvenile, Young to adult palms (3-50 years)	Juvenile, Young to adult palms (3-50 years)	Juvenile, Young to adult palms (3-50 years)	Juvenile, Young to adult palms (3-50 years)
Stage of the insect pest	Eggs, grubs, pupae and adults	Eggs, grubs, pupae and adults	Pest not recorded	Eggs, grubs, pupae and adults	Pest not recorded
Parasitoids recorded	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*

Predators recorded	*Cheilisoches mori* Fab.	Nil	Nil	Nil	Nil
Microbial agents	Nil	Nil	Nil	Nil	Nil
Weather parameters recorded (max, min temp; rainfall, no. of rainy days)	Temp. 22-35°C		20-34°C	28-35°C	::
GIS data	8.507°N, 76.972°E	Colachal 8.18°N,77.2°6E Cumbum 9.73°N,77.3°E	8.278°N, 73.046°E	26°14N, 91°77E	11.615°N, 92.726°E
Pesticide usage pattern	Spot application of pesticides for curative treatment of the pest	Spot application of pesticides for curative treatment of the pest	Pest not reported	Spot application of pesticides for curative treatment of the pest	Pest not reported

Details of Survey for collection of pest and natural enemies

Pest surveillance in Kerala

Random surveys were undertaken in various districts of Kerala *viz.,* Trivandrum, Kollam, Kottayam, Alappuzha, Ernakulam and Kasaragod to record incidence of pest and natural enemies. Leaf damage by black beetle attack ranged from 22-34%. Red palm weevil (5-7%) was the major pest problem in southern districts causing death of the palm. Eriophyid mite incidence ranged from 8-20% in various locations. Outbreak of black headed caterpillar was reported from Kottayam and Trivandrum. In addition special surveillance at quarterly interval was conducted near airport and sea port areas to locate incidence of invasive pests on coconut. The invasive pest *Brontispa longissima* was not reported from any of the areas surveyed during the year.

The entomopathogens *viz*., *Oryctes rhinoceros* nudi virus and *Metarhizium anisopliae* were field collected from Alappuzha and Kollam districts. Natural enemies of Coconut black headed caterpillar include *Apanteles taragamae, Goniozus nephantidis, Bracon brevicornis, Brachymeria* spp for both the infested locations. No natural enemy could be field collected from red palm weevil. Predatory mites *viz., Neoseiulus baraki, N. paspalivorus, Typhlodromus sp., Chelacaropsis moorei* and *Bdella s*p were collected from all locations with predominance of *N. baraki* in 60-80% nuts. Spiders (generalist predators) were collected from coconut ecosystem and sent for identification.

Pest surveillance in Andaman Islands

Survey was conducted in Havelock Island, CARI farm, Siphighat farm and Kurmadera coconut farm for recording the incidence of various pests infesting coconut. Among the key pests infesting coconut, rhinoceros beetle (*Oryctes rhinoceros*) was recorded in 1-2% of palms with negligible damage on leaves. This also confirms the

successful introduction of *Oryctes rhinoceros* nudivirus during early 1990 that has reduced the vigour of the surviving beetles in the Island. This technological intervention has provided the highest reduction of black beetle damage at this point of time. Eriophyid mite incidence was very low (only recorded in one Andaman Yellow Dwarf palm). Rodent damage on nuts was found to be <10% in the surveyed gardens. No incidence of red palm weevil was recorded in the survey. Damage by leaf eating caterpillar, white grub as well as the invasive pest, *Brontispa longissima* was not intercepted during the survey. In the coconut nursery at CARI farm, lace bugs (*Stephanitis typica*), spiralling whitefly, (*Aleurodicus dispersus*), coconut scale (*Aspidiotus destructor*), bagworms and slug caterpillar (*Thosea* sp.?) were recorded at low level of infestation. Damage by lace bugs leading to typical white speckles on the rabbit ear leaf of coconut seedlings as well as the adult lace bugs @ 1-3 adults/ leaf was observed. As such these pests are bio-suppressed under natural condition

Presence of the natural enemies' *viz*., lady beetles (*Chilocorus nigritus*) and *Cybocephalus* sp. and spiders were also recorded.

In the Siphighat farm, colonies of palm aphid (*Cerataphis brasiliensis*) were observed on the undersurface of coconut as well as arecanut seedlings. In addition coconut moth, *Batrachedra arenosella* Walker (Lepidoptera : Cosmopterygidae) was found inside the unopened and opened coconut inflorescence especially on the anther and pollens. Niu Lekha variety was found to be more susceptible compared to other varieties. Damage by coconut moth was also observed at Wandoor area on dwarf coconut accession (Andaman Green dwarf). Occurrence of the caterpillar was observed on the harvested nuts at Kurmadera farm thereby warranting strict quarantine measures when nuts are transported to mainland. During a general observation on the ornamental palm, *Washingtonia* sp. stellate scale, *Vinsonia stellifera* was recorded from one of the palms in Port Blair.

Pest surveillance in Minicoy (Lakshadweep)

Surveys conducted in Lakshadweep Islands did not reveal the presence of the invasive pest, *Brontispa longissima.* Minor occurrence of inflorescence moth, *Batrachedra arenosella* was reported from coconut varieties Laccadive ordinary and LCOD. Rat (*Rattus rattus*) is the major mammalian pest of coconut in the island.The damage caused by rats on the nuts was found to be 33-44% in Minicoy. Gangabondam was highly preferred by *R. rattus* followed by Laccadive Orange Dwarf, Laccadive Green Dwarf and Laccadive Yellow Dwarf.

Black beetle: Survey indicated that the damage caused by black beetle in the island less than 5% (4.3% in Laccadive Green Dwarf, 2.6% in Laccadive Ordinary Tall and 3.7% in Laccadive Yellow Dwarf). Periodical and timely augmentation of *Oryctes rhinoceros* nudivirus in Lakshadweep Island was found effective in the bio-suppression of black beetle.

Coconut eriophyid mite: All varieties including the coloured genotypes were infested by the mite pest (18-22%) in harvested nuts belonging 0-25% damage category.

Scale insects of coconut and their natural enemies: Four different types of scale insects *viz*., coconut scale, *Aspidiotus destructor* Signoret (Diaspididae: Hemiptera), pink wax scale, *Ceroplastes rubens* Maskell (Coccidae: Hemiptera), mussel scale, *Lepidosaphes* sp. (Diaspididae: Hemiptera) and a soft scale, *Lecanium* sp. (Coccidae: Hemiptera) were

recorded feeding on coconut leaflets / nuts. A mealy bug belonging to the genus *Planococcus* sp. (Pseudococcidae: Hemiptera) was also found feeding on the under surface of the coconut leaflets. Two different species of lady beetles *Chilocorus subindicus* Booth (Coccinellidae: Coleoptera) and *Scymnomorphus* sp. (Coccinellidae: Coleoptera) were found predatory on coconut scale insects. In addition to that there was one more effective predator on scale insects *viz*., *Cybocephalus* sp. (Cybocephalidae/ Nitidulidae: Coleoptera)

Papaya mealy bug (*Paracoccus marginatus*): Good establishment of the parasitoid of papaya mealy bug, *Acerophagous papayae* as well as the predatory caterpillar, *Spalgius epius* was observed in the CPCRI farm in most of the mealybug infested papaya plants. The population of Acerophagous *papaya* was so high that the parasitoids were collected and released in other areas. Papaya flowers were badly damaged by spotted cuckoo and were plucked away by the avian pest after recovery from the mealy bug attack.

Pest surveillance in Cumbum and Colachel (Tamil Nadu)

Coconut scale insect, *Aspidiotus destructor*, star scale, *Vinsonia stellifera*, soft scale, *Lecanium* sp., wax scale. *Ceroplastes* sp. and the mealybug, *Pseudococcus cryptus* were recorded at moderate levels of infestation. In addition the whitefly, *Aleurocanthus arecae* and spiralling whitefly, *Aleurodiscus dispersus* were also observed at low levels. These sucking insect pests were naturally suppressed by the lady beetles belonging to *Chilocorus nigritus* as well as cybocephalid beetles in the coconut system. Occurrence of plant hopper, *Proutista moesta* was recorded in certain pockets with coconut root (wilt) disease. Rat damage was found to be quite severe in the garden with sporadic incidence of leaf damage by black beetle.

At Colachel, mealy bugs, *Pseudococcus cryptus,* coconut scale insects, *Aspidiotus destructor* and wax scales, *Ceroplastes* sp. were recorded at low levels. These sucking pests were naturally suppressed by biotic agents. *Proutista moesta* and *Stephanitis typica* could be located at random in the coconut gardens. Infestation by red palm weevil was also recorded infew gardens (<0.5%).

Pest surveillance in NEH region (Assam and Meghalaya)

Surveys were conducted in Morigaon, Kamrup and Goalpara districts of Assam, Ri-Bhoi and East Garo Hills of Meghalaya with emphasis on invasive pests. The invasive pest *Brontispa longissima* was not reported from any of the areas surveyed. Pest problems identified are minor incidence (<1%) of red palm weevil and low to medium (20-30%) incidence of eriophyid mite.Minor incidence of mealy bugs, white fly *Aleurocanthus arecae* and scale insect *Aspidiotus destructor* were also recorded from juvenile and young palms which were naturally bio-suppresed by lady bird beetles especially *Chilochorus* spp. Mealy bug (*Paracoccus marginatus*) infestation was recorded as very severe in papaya in all the areas surveyed in Assam and Meghalaya

CTRI

1. Spiders and parasitoids in tobacco intercropping systems

Survey and collections of spiders were made only on tobacco as intercropping systems were not available in tobacco. Parasitization of aphids was nil.

IIHR-No Report

UAS-Raichur

Roving survey was made in Raichur district and few natural enemies were collected and the identity of the specimens needs to be ascertained. Hymenopteran and dipteran parasitiods were collected which will be sent for identification shortly.

2. Mapping of EPN diversity (AAU-A, PAU)

AAU-A

Mapping of EPN diversity in Gujrat

Soil samples were collected from different geographic locations as listed in **Table 30**. In the first set, 126 samples were checked and 21 EPN suspected samples were found and sent to NBAII. While in second set of 720 samples only 41 were found positive as EPN (**Table 31**).

Set- 1

Table 30: Soil Samples Collected for Isolation of EPN

Sr. No.	Date of Collection	Place	Crop	GPS	Infestation Y/N
1	"	"	-	N- 21^0 27.366 E- 072^0 59.280	**Yes**
2	"	"	-	N- 21^0 26.219 E- 072^0 58.331	**Yes**
3	"	"	-	N- 21^0 26.166 E- 072^0 58.261	**Yes**
4	"	"	-	N- 21^0 19.113 E- $072^0$57.838	**Yes**
5	"	"	-	N- 21^0 19.117 E- 072^0 57.838	**Yes**
6	"	"	-	N- 21^0 11.995 E- 072^0 57.966	**Yes**
7	"	"	-	N- 21^0 00.121 E- 072^0 58.307	**Yes**
8	"	Valsad (ollgam)	-	N- 20^0 42.961 E- 072^0 58.108	**Yes**
9	"	Valsad (Dungri)	Rose	N- 20^0 41.193 E- 072^0 57.409	**Yes**
10	"	"	-	N- 20^0 41.125 E- 072^0 57.428	**Yes**
11	9/8/12	"	Sugarcane	N- 20^0 54.323 E- 072^0 53.615	**Yes**
12	"	"	Sugarcane	N- 20^0 55.379 E- 072^0 57.515	**Yes**
ANAND					
13	"	"	-	N- 22^0 32.892 E- 073^0 02.848	**Yes**
14	"	"	-	N- 22^0 35.555	**Yes**

				E- 073^0 01.499	
15	“	“	-	N- 22^0 35.262 E- 073^0 02.841	**Yes**
16	“	“	-	N- 22^0 34.522 E- 073^0 03.199	**Yes**
17	“	“	-	N- 22^0 34.644 E- 073^0 03.111	**Yes**
18	“	“	-	N- 22^0 29.093 E- 073^0 04.480	**Yes**
19	“	“	-	N- 22^0 34.694 E- 072^0 59.758	**Yes**
20	“	“	-	N- 22^0 38.032 E- 073^0 01.231	**Yes**

Set- 2

Table 31: Soil Samples Collected for Isolation of EPN

Sr. No.	Date of Collection	Place	Crop	GPS	Infestation Y/N
1	“	“	-	N- 22^0 39.799 E- 072^0 59.509	**Yes**
2	“	“	-	N- 22^0 41.698 E- 073^0 00.836	**Yes**
3	“	“	-	N- 22^0 41.662 E- 073^0 00.119	**Yes**
4	“	“	-	N- 22^0 41.225 E- 073^0 00.037	**Yes**
5	“	Pansora	-	N- 22^0 42.579 E- 73^0 01.937	**Yes**
6	“	“	-	N- 22^0 442.466 E- 073^0 01.927	**Yes**
7	“	“	-	N- 22^0 42.345 E- 073^0 01.918	**Yes**
8	“	“	Paddy	N- 22^0 42.229 E- 073^0 01.909	**Yes**
9	“	“	-	N- 22^0 41.619 E- 073^0 01.727	**Yes**
10	“	“	-	N- 22^0 43.141 E- 073^0 02.005	**Yes**
11	“	“	-	N- 22^0 43.332 E- 073^0 01.990	**Yes**
12	“	“	-	N- 22^0 42.639 E- 073^0 02.715	**Yes**
13	9/10/12	Thamna	-	N- 22^0 42.208 E- 073^0 06.409	**Yes**
14	“	“	-	N- 22^0 42.860 E- 073^0 05.370	**Yes**
15	“	Bhatpura	-	N- 22^0 41.396 E- 073^0 09.581	**Yes**
16	“	Sundarpura	-	N- 22^0 39.518 E- 073^0 10.084	**Yes**
17	“	Sareli	-	N- 22^0 40.277	**Yes**

				E- 073^0 08.306	
18	“	“	-	N- 22^0 40.641 E- 073^0 08.064	**Yes**
19	“	“	-	N- 22^0 40.292 E- 073^0 06.993	**Yes**
20	“	“	-	N- 22^0 40.414 E- 073^0 06.984	**Yes**
21	“	Mogar	-	N- 22^0 31.915 E- 073^0 00.437	**Yes**
22	“	“	-	N- 22^0 24.964 E- 073^0 02.112	**Yes**
23	“	“	-	N- 22^0 24.670 E- 073^0 02.071	**Yes**
24	“	“	-	N- 22^0 26.506 E- 073^0 02.001	**Yes**
25	“	“	-	N- 22^0 32.500 E- 072^0 59.542	**Yes**
26	“	“	-	N- 22^0 27.105 E- 072^0 56.263	**Yes**
27	“	“	-	N- 22^0 31.722 E- 072^0 51.217	**Yes**
28	“	Asarma	-	N- 22^0 21.583 E- 073^0 01.003	**Yes**
29	“	“	-	N- 22^0 19.186 E- 073^0 02.676	**Yes**
30	“	“	-	N- 22^0 29.785 E- 072^0 47.507	**Yes**
31	“	Kasbara	-	N- 22^0 29.501 E- 072^0 27.284	**Yes**
32	“	“	-	N- 22^0 29.969 E- 072^0 28.557	**Yes**
33	“	Indraanuj	-	N- 22^0 29.651 E- 072^0 32.331	**Yes**
34	“	“	-	N- 22^0 30.045 E- 072^0 34.339	**Yes**
35	“	“	-	N- 22^0 29.981 E- 072^0 36.796	**Yes**
36	“	“	-	N- 22^0 20.057 E- 072^0 39.716	**Yes**
37	“	“	-	N- 22^0 20.053 E- 072^0 39.878	**Yes**
38	“	“	-	N- 22^0 19.955 E- 072^0 48.498	**Yes**
39	“	Kathol	-	N- 22^0 19.616 E- 072^0 51.787	**Yes**
40	“	“	-	N- 22^0 19.710 E- 072^0 52.426	**Yes**

PAU

Mapping of EPN diversity in Punjab

200 soil samples were collected from twelve different locations of Punjab during wet season at root zone and placed in plastic containers with lid and processed for isolation of EPN. For isolation of EPN five healthy 5th instar *Galleria* larvae were placed at the bottom of containers before filling the samples. These larvae were daily examined for their mortality for 7 days. The suspected EPN infected cadavers which did not putrify and did not rot were separated from soil. Out of different samples tested, the samples collected from Amritsar and Sangrur caused mortality of *Galleria* larvae and these were found infected with EPN. Then these were labeled and sent to NBAII, Bangalore for further identification as per protocol mentioned in technical programme. The detailed information is presented in **Table 32**.

Table 32: Mapping of EPN diversity in Punjab

Location	District	Common name of pest	Scientific name of insect	Distance from HQ	Month of survey	Host crop	Stage of crop	Stage of pest	GIS data	Pesticides used
Rattangarh	Amritsar	Jassid and Mealy bug	*Amrasca biguttula biguttula* and *M. hirsutus*	142 Km	July 2012	Okra	Fruiting	adult	31.63^0 N and 74.87^0 E	No information
Porshian (Rajputhana)	Amritsar	Jassid	*Amrasca biguttula biguttula*	138 Km	July 2012	Okra	Fruiting	adult	31.63^0 N and 74.87^0 E	No information
Shabridran (Malerkotla)	Sangrur	Brinjal shoot and fruit borer	*Leucinodes orbonalis*	58 Km	July 2012	Okra	Fruiting	larvae	30.54^0 N and 75.96^0 E	Coragen Acetaprimid Confidor
Machaki kalan	Faridkot	No pest	-	125 Km	July 2012	Cucumber	Fruiting	-	30.11^0N and 74.75^0 E	No information
Pucka village	Faridkot	No pest	-	122 Km	July 2012	Long gourd	Fruit & flowering	-	30.11^0 N and 74.75^0 E	No spray
Kaler village	Bathinda	No pest	-	159 Km	August 2012	Okra	Fruiting	-	30.11^0 N and 75.00^0E	No information
Paddi Khalsa	Jalandhar	Stalk borer	*Chilo auricilius*	62 Km	September 2012	Sugarcane	Five month old	larvae	30.9^0 N and 75.9^0E	No spray
Mahal Khurd	Barnala	Okra fruit borer	*Earias vitella*	76 Km	August 2012	Okra	Fruiting	-	30.38 ^{0}N and 75.52^0 E	Heavy spray*
Karewala	Bathinda	Stalk borer	*Chilo auricilius*	141 Km	August 2012	Sugarcane	Four month old	-	30.11^0N and 75.00^0E	No spray
Karewala	Bathinda	No pest	-	141 Km	August 2012	Long gourd	Fruiting & flowering	-	30.11^0 N and 75.00^0 E	No spray
Sandhara	Hoshiarpur	No pest	-	77 Km	September 2012	Long gourd	Flowering	-	31.32^0 N and 75.59^0E	No information
Sahareli	Patiala	Maize borer and aphid	*Chilo partellus* and *Raphalosiphum maidis*	98 Km	September 2012	Maize	Cob formation	-	30.20^0 N and 76.25^0 E	No spray

*Farmers were not sure about the names of pesticides which they used. They were spraying the crop after every week with a number of pesticides purchased from local markets

3. Surveillance for alien invasive pests *Brontispa longissima, Aleyrodicus digessi, Phenacoccus manihoti, Paracoccus marginatus*, *Phenacoccus madeirensis* and others (AAU-A, AAU-J, ANGRAU, KAU, MPKV, PAU, SKUAST, TNAU, YSPUHF, CAU, JNKVV, MPUAT, OUAT, CPCRI, CTRI, IIHR, UAS-Raichur)

AAU-A

a. *Brontispa longissima*
b. *Aleurodicus dugesii*
c. *Phenacoccus manihoti*
d. *Paracococcus marginatus*
e. *Phenacoccus madeirensis*
f. Alien invasive pests of fruits and vegetables in the market yards.
g. Others

Periodic surveys were carried out but none of the invasive pests listed above were recorded.

AAU-J

Periodic surveys were carried out for alien invasive pests in vulnerable areas of Jorhat, Kamrup, Golaghat and Dibrugarh districts of Assam. Papaya mealybug (*Paracoccus marginatus*) on papaya fruits and leaves was first detected in Kamrup district on 7.8.2012 in a homestead garden nearby Guwahati. Subsequently the invasive pest was also observed in Jorhat and Dibrugarh district during September, 2012. No incidence of papaya mealy bug was observed in Golaghat district till March, 2013.No mealy bugs were recorded in vegetables. However, the mealy bugs detected on guava and citrus leaves were sent to NBAII, Bangalore for identification in Sept.'2012.

ANGRAU-No report

KAU

Mealybugs from different crops like pepper, cocoa, phyllanthus, citrus and pineapple were collected and identified (Table 33).

Table 33. Collection of mealybugs

No.	Mealybugs	Host plant
1	*Ferrisia virgata* (Cockerell) and *Icerya seychellarum* (Westwood)	Pepper
2	*Rastrococcus iceryoides* (Green) *Nipaecoccus viridis* (Newstead)	Phyllanthus
3	*Formicoccus polysperes* Williams	Pepper (root)
4	*Pseudococcus* sp nr. *aurantiacus* Williams	Citrus
5	*Dysmicoccus brevipes* (Cockerell)	Pineapple

No incidence of alien invasive pests - *Brontispa longissima, Aleyrodicus digessi, Phenacoccus manihoti* and *Phenacoccus madeirensis. Paracoccus marginatus* incidence was observed in Thrissur, Ernakulam and Palakkad districts. But the intensity was very low. The parasitoid *Acerophagus papayae* was also present in all the locations.

MPKV

The field crops, horticultural crops and ornamental plantations were surveyed in western Maharashtra covering five agro-ecological zones. The fields and orchards in Pune

region were frequently visited for the record of pests species *viz.,* coconut leaf beetle *Brontispa longissima,* spiraling white fly *Aleurodicus dugessi,* mealy bugs *Phenacoccus manihoti, Paracoccus marginatus, Phenacoccus madeirensis* and other alien invasive pests. The stages of *Paracoccus marginatus* W. and G. and *Phenacoccus solenopsis* Tinsley were collected for record of natural enemies. The pest infested fruits and vegetables were collected from city market yards and investigated in the laboratory for alien invasive pests and natural enemies. Amongst the target pests, papaya mealy bug *Paracoccus marginatus* was observed in papaya orchards on main host papaya and five weed plants in the vicinity of papaya orchards in five districts (Pune, Ahmednagar, Jalgaon, Dhule and Nandurbar) of western Maharashtra along with the encyrtid parasitoid *Acerophagus papayae* and *Pseudleptomastix mexicana* in Pune region. The mealy bug species *Phenacoccus solenopsis* Tinsley was recorded on tomato in Kasarsai village of Pune for the first time on 18th January 2013. The pest specimens were sent to NBAII, Bangalore and IARI, New Delhi for identification. The species identification was received on 19/2/2013 from Dr. Sushila Joshi and Dr. V. V. Ramamurthy, Network Project on Insect Biosystematics, Division of Entomology, IARI, New Delhi. The parasitism of *Aenasius bambawalei* Hayat was recorded at 2-5 per cent in densely populated mealy bug colonies on tomato. Besides, the spiralling white fly was recorded on papaya, cotton, guava, pomegranate, mulberry and rose with 60 to 75 per cent parasitism of *Encarsia guadeloupae* in these crops.

PAU

Regular surveys of alien invasive pests were conducted from June, 2012 to March, 2013 in different districts of Punjab at fortnightly intervals. The different cropping systems of vegetables, field and horticultural crops were surveyed throughout the year. At none of the locations the above mentioned pests were observed. The common mealybug species *Planococcus citri* and *Phenacoccus solenopsis* were recorded form citrus and cotton respectively.

SKUAST

Different fruits (cherry, ctraw berry, pear, banana, papaya and mangoes) and vegetables (brinjal, okra, peas, pointed gourd, *Trichosanthes dioica*, tomatoes*)* from outside states for commercial purpose in the markets of Srinagar (Natti pora, Lal Chowk, Khanyar, Mira kadal, Raina wari, Hazrat bal and Lal bazaar) were examined for the occurrence of invasive pests. No pests however like *Aleyrodicus digessi*, *Phenacoccus manihoti*, *Paracoccus marginatus, Phaenacoccus madeirensis* were found associated with the fruits or vegetables. Nevertheless, brinjal, okra and peas were found to have some borer infestation.

TNAU

Survey was conducted in different districts of Tamil Nadu for the occurrence of the following insect pests.

a. *Brontispa longissima*
b. *Aleurodicus dugesii*
c. *Phenacoccus manihoti*
d. *Paracococcus marginatus*
e. *Phenacoccus madeirensis*
f. Others

During the study period the following species of mealybug were recorded**.**

1. Papaya mealybug *Paracococcus marginatus*
2. Jack Beardsley mealy bug *Pseudococcus jackbeardsleyi*

In June 2012 during a survey for the papaya maely bug *Paracoccus marginatus* and its parasitoid *Acerophagus papayae* in Sathiyamangalam**,** Tamil Nadu, a short tailed mealy bug was found together with *P.marginatus* colonizing papaya in two plantations. This mealybug was identified as the Jack Beardsley mealybug, *Pseudococcus jackbeardsleyi* Gimpel and Miller **(**Hemiptera: Pseudococcidae) by an integrated taxonomic approach. This work appears to be the first report of *Pseudococcus jackbeardsleyi* in India and of papaya as a host of this pest.

The following alien invasive insect pests were not recorded during the year 2012-13.
Brontispa longissima
Aleurodicus dugesii
Phenacoccus manihoti
Phenacoccus madeirensis

YSPUHF

Different vegetable and fruit ecosystems at Solan, Sundernagar, Ghumarwin, Mandi, Kull, Manali, Kotkhai, Rohru, Nerwa, Rajgarh, Rekongpeo and Kalpa were surveyed for the collection of pests like*, Aleyrodicus digessi, Phenacoccus manihoti, Paracoccus marginatus*, *Phenacoccus madeirensis* but none of the aforesaid pests were encountered in any of the ecosystem.

CAU-Pasighat-No Report

JNKVV- No Report

MPUAT- No Report

OUAT- No Report

CPCRI

The alien invasive pest *Brontispa longissima* was not reported on coconut from any of the areas surveyed in Kerala, Tamil Nadu, Lakshadweep, Andamans, Assam and Meghalaya.The papaya mealy bug *Paracoccus marginatus* is a major pest problem in Assam and Meghalaya. Pest incidence in Lakshadweep could be effectively bio-suppressed by the release of the parasitoid *Acerophagous papaya.*

CT R I

Tobacco crop was free of alien invasive pests.

IIHR

An invasive align mealy bug *Pseudococcus jackbeardsleyi* Gimpel and Miller was recorded from papaya garden in Coimbatore. The mealy bug was found only on papaya in two orchards. Its spread is being monitored. No serious damage was casued by this mealy bug. *Cryptolaemus montrouzieri* was found preying on this mealybug. Its biology and biosystematics have been studied.

UAS-Raichur

During roving survey in North Karnataka no invasive pests were reported except few papaya orchards where the incidence of papaya mealy bug was noticed in Lingasgur Taluka and efforts were made to collect the potential parasitiod, *Acerophagous papayae* from NBAII, Bangalore and the same were released in farmer's field.

Biological control of plant diseases using antagonistic organisms

2.2. Plant Disease and Nematode antagonists

1. Screening of selected abiotic stress tolerant (i.e. drought and salinity) isolates of *Trichoderma harzianum* for their potential to produce hydrolytic enzymes under *in vitro* conditions (GBPUAT)

The experiment is under progress.

2. Development of oil-based formulations of selected isolates of *Trichoderma harzianum* and study of their shelf life (GBPUAT)

In the present investigation, a comparative study of shelf-life of 10 isolates of *Trichoderma harzianum* in different formulations was carried out to find out suitable formulation.

Oil-based formulations used: Paraffin petroleum oil, Groundnut oil
Wettable powder-based formulation used: Talcum powder

Antagonists used

Abiotic stress tolerant *Trichoderma harzianum* isolates viz. Th-13, Th-14, Th-19, Th-33, Th-50, Th-56, Th-69, Th-75, Th-82 and Th-89.

Methodology

For oil-based formulations spore powder of *Trichoderma harzianum* was suspended in the oil (1g /100 ml oil) while for wettable powder based formulations spore powder was mixed in 100g talc powder (1g/100g talc). Three replicates were maintained for each treatment. The bottles containing the oil-based formulations were screw capped while wettable powder was packed in air tight polyethylene bags and kept in BOD incubator at 28°C. The viability of the *Trichoderma* isolates in each formulation was recorded at one month interval starting from March, 2012 (zero month) to March, 2013 by dilution plate method. Viability of each isolate in each formulation was tested by making serial dilutions of 10^{-6}-10^{-8}. One ml of suspension from the desired dilution was poured into sterilized Petri plates followed by pouring of 15 ml of *Trichoderma* selective medium (TSM). The suspension was uniformly mixed in TSM by inclined and swirling motion. The plates were incubated at 26±2^{0}C for 5 days. CFU count (per plates) was recorded 5 days after incubation and CFU/ml or g was calculated.

Results

The data presented in **table 34 (a, b & c)** revealed that among various formulations *viz*. groundnut oil, paraffin petroleum oil and talcum powder of selected *Trichoderma* isolates, maximum CFU was observed in groundnut oil (41-48x10^8 CFU/ml) followed by talc (41-47x10^8 CFU/ml), while minimum was in paraffin petroleum oil (41-46x10^8 CFU/ml) just after preparation (0 month). These formulations were further tested for their shelf-life up to 1 year during storage at 28^{0}C in BOD incubator. A gradual decline in the CFU of *Trichoderma* isolates were observed in all the formulations up to 5 months and thereafter, sudden decline was observed. Maximum CFU was observed in groundnut oil

(20.1-25.7x10^8 CFU/ml) even with a loss of 46.55 to 49.55 per cent viable propagules. Among various *Trichoderma* isolates, maximum CFU was observed in Th-14 (25.7x10^8 CFU/ml) followed by Th-50 (22.8x10^8 CFU/ml), while minimum in Th-69 (20.1x10^8 CFU/ml) after five months of storage. At 12th month all the isolates retained CFUs in the range of 13-66x10^6 with a loss of about 98-99 per cent viable propagules. Maximum CFUs was retained by Th-14 (66x10^6 CFU/ml) followed by Th-50 (57x10^6 CFU/ml), while minimum was observed in Th-69 (13x10^6 CFU/ml).

Minimum CFU of *Trichoderma* isolates were observed in paraffin petroleum oil (in the range of 19-24x10^8 CFU/ml) with a loss of 41.7 to 52.7 per cent viable propagules after five months of storage. Among various isolates, maximum CFU was observed in Th-14 (24.6x10^8 CFU/ml) followed by Th-75 (22.4x10^8 CFU/ml), while minimum in Th-69 (20.1x10^8 CFU/ml). At 12th month all the *Trichoderma* isolates retained their CFU of 46.9-12.3x10^6 even with a loss of 98.8 to 99.7 per cent viable propagules. However, maximum CFU was observed in Th-14 (46.9x10^6 CFU/ml) followed by Th-13 (46.3x10^6 CFU/ml), while minimum in Th-69 (12.3x10^6 CFU/ml) in groundnut oil based formulation.

3. Field evaluation of groundnut oil, talc and paraffin petroleum oil based formulation of *T. harzianum* (Th-14) for the management of foliar and soil borne disease of tomato (Hybrid - Dev). (GBPUAT)

Treatments

1. Groundnut oil based formulation of *T. harzianum* (Th-14)
2. Paraffin oil based formulation of *T. harzianum* (Th-14)
3. Talc based formulation of *T. harzianum* (Th-14)
4. Control

Crop	-	Tomato
Variety	-	Hybrid - Dev
Plot size	-	2 x 2m^2
Seedling nursery	-	22/2/201
Date of transplanting	-	24/03/2013
Treatments	-	4
Replications	-	3
Row to row spacing	-	50 cm
Design	-	RBD

Application

Nursery was laid during third week of February 2013 by treating the seeds with different formulations of *Trichoderma* (Th-14). Transplanting was done after seedling root dip treatment (10g/L) during third week of March 2013. The experiment was laid in a randomized block design in three replications with a plot size of 2 x 2 m^2 under natural conditions and is under progress.

4. Field evaluation of invert-emulsion formulation of *T. harzianum* for the management of foliar and soil borne diseases of chick pea crop variety (PG-186) (GBPUAT)

Treatments

1. Invert emulsion formulation of *T. harzianum* (IEF1)
2. Invert emulsion formulation of *T. harzianum* (IEF2)

3. Talc formulation of *T. harzianum*
4. Carbendazim seed treatment
5. Mancozeb (0.2%) foliar spray
6. Control

Crop	-	Chick pea
Variety	-	PG-186
Plot size	-	5 x 5m^2
Date of sowing	-	23/12/2012
Treatment	-	6
Replication	-	3
Row to row spacing	-	31 cm
Design	-	RBD

Application

1. Soil application: Invert emulsion formulation of *T. harzianum* (IEF1) and (IEF2) each of 500ml and talc (1kg) were mixed separately in 100kg completely decomposed dry FYM and applied in the field @ 100kg/acre.

2. Seed treatment: with IEF1 and IEF2 each @ 5 ml/kg seed, talc formulation @ 5g/kg seed and carbendazim @2g/kg seed.

3. Foliar spray: IEF1 and IEF2 each @ 10 ml/lit., talc formulation @10g/lit. and mancozeb @ 2g/lit. at 60DAS.

A field experiment was conducted at Pantnagar during 2012-13 to evaluate efficacy of invert emulsion formulation of *T. harzianum* (IEF1 and IEF2) and talc formulation as soil application, seed treatment and foliar spray for the management of soil borne and foliar diseases of chick pea. The crop was sown on Dec. 23, 2012 after the harvest of paddy crop.

The data on plant stand (45 and 90 DAS) (**Table 35**) revealed significant increase in plant stand in all the treatments except mancozeb. However, maximum increase in plant stand over control was observed in carbendazim (69.75 & 110.36%) followed by invert emulsion IEF2 (56.80 & 118.13%) and talc (51.61 &106.66%) at 45 and 90 days, respectively. The reduction in plant stand was due to root rot incidence. Least mortality between 45 to 90 DAS was recorded in IEF2 (6.80%) followed by talc (8.66%) as compared to control (32.99%). However, no foliar disease was observed at 90 DAS.

Significantly maximum population of *Trichoderma* in rhizosphere and rhizoplane (75 DAS) was observed in invert emulsion IEF2 ($20.66x10^3$ & $16.33x10^2$ CFU/g) followed by IEF1 ($18.66x10^3$ & $13.00x10^2$ CFU/g) and talc ($15.00x10^3$ & $10.66x10^2$ CFU/g) and were at par with each other as compared to check ($4.00x10^3$ & $3.33x10^2$ CFU/g). The experiment is under progress.

Table 34 (a): Shelf life of *Trichoderma* isolates in Groundnut oil based formulation during storage at 28°C

Trichoderma isolate	Spores concentration (x 10^6CFU/ ml)												
	Month												
	0	1	2	3	4	5	6	7	8	9	10	11	12
Th-13	4250.66	3996.00	3789.66	3610.66	2298.50	2238.73	1966.33	1459.33	1133.33	453.66	179.06	85.33	55.80
Th-14	4815.66	4357.08	4090.08	3898.30	2479.66	2579.33	1997.00	1789.09	1485.39	789.56	218.00	109.00	66.80
Th-19	4145.37	4121.37	3878.69	3710.90	2263.03	2149.66	1900.00	1739.00	1251.66	519.66	179.00	89.00	54.04
Th-33	4345.66	3848.33	3687.00	3399.60	2264.67	2209.00	1799.66	1443.35	1147.05	409.31	189.65	89.99	47.08
Th-50	4800.60	4149.01	3939.31	3768.00	2860.61	2280.33	2139.13	1977.09	1515.00	649.96	256.00	99.38	57.04
Th-56	4370.76	4046.00	3776.66	3599.09	2355.33	2147.00	1918.63	1701.66	1340.00	523.33	229.86	79.99	43.55
Th-69	4378.33	3467.66	3336.33	3148.03	2489.43	2010.01	1722.66	1427.00	1152.66	512.66	129.33	39.90	13.89
Th-75	4457.66	3844.33	3495.09	3369.69	2485.33	2249.33	2039.80	1761.66	1313.00	648.40	189.76	79.70	45.39
Th-82	4456.00	3812.60	3647.08	3631.66	2429.39	2110.08	2010.00	1769.70	1416.08	387.37	129.36	67.70	27.90
Th-89	4276.67	3923.66	3784.33	3516.00	2449.76	2145.00	2046.40	1723.80	1441.73	456.65	221.63	80.33	39.00
					Months (A)		**Formulations (B)**		**AxB**				
CD (0.05)					**149.63**		**142.67**		**459.19**				

Table 34 (b): Shelf life of *Trichoderma* isolates in talc-based formulation during storage at 28°C

Trichoderma isolate	Spores concentration (x 10^6CFU/ g)												
	Month												
	0	1	2	3	4	5	6	7	8	9	10	11	12
Th-13	4330.66	3893.00	3778.66	3511.66	2440.66	2137.33	1900.00	1763.00	1385.33	769.66	149.00	73.33	45.00
Th-14	4790.60	4307.00	4040.33	3873.33	2288.00	2274.33	1963.33	1452.33	1133.33	443.66	210.00	97.33	56.00
Th-19	4159.37	4111.33	3866.66	3700.00	2253.33	2147.66	1896.00	1729.00	1241.66	510.66	170.00	82.00	51.04
Th-33	4270.66	3848.33	3637.00	3395.66	2254.66	2200.00	1795.66	1433.33	1137.00	403.33	185.66	87.00	44.08
Th-50	4432.66	4144.00	3933.33	3758.66	2862.66	2574.33	2133.33	1973.00	1500.00	644.66	248.00	99.00	56.4
Th-56	4346.76	4039.00	3766.66	3597.00	2349.33	2137.00	1903.66	1698.66	1300.00	513.33	227.66	77.66	33.56
Th-69	4345.33	3456.66	3326.33	3137.33	2479.33	2000.00	1712.66	1418.00	1140.66	507.66	124.33	34.00	10.89
Th-75	4400.66	3837.33	3489.00	3362.66	2481.33	2234.33	2031.00	1756.66	1303.66	641.00	183.66	71.00	41.34
Th-82	4400.00	3809.66	3637.33	3330.66	2424.33	2100.00	2000.00	1762.00	1407.00	378.33	124.33	57.00	21.99
Th-89	4243.67	3915.66	3774.33	3507.33	2445.66	2131.00	2033.00	1711.00	1433.33	450.66	210.66	74.33	31.00
					Months (A)		**Formulations (B)**			**AxB**			
CD (0.05)					**144.23**		**131.67**				**456.11**		

Table 34 (c): Shelf life of *Trichoderma* isolates in paraffin petroleum oil-based formulation during storage at 28°C

Trichoderma isolate	Spores concentration (x 10^6CFU/ ml)												
	Month												
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Th-13	4220.66	3796.40	3638.60	3401.46	2344.66	2031.33	1809.00	1568.00	1282.23	679.46	129.12	68.33	46.30
Th-14	4697.60	4207.00	3040.33	3000.33	2185.40	2464.03	2123.00	1879.00	1405.70	547.05	150.00	87.33	46.94
Th-19	4232.64	4040.70	3839.33	3654.76	2769.87	2044.33	1843.23	1312.03	1035.43	353.76	118.00	67.40	37.00
Th-33	4140.66	3749.33	3578.09	3259.66	2150.96	2104.60	1684.66	1333.03	1007.00	333.53	118.66	61.00	35.78
Th-50	4099.30	4001.43	3736.76	3602.60	2159.34	2048.36	1798.78	1529.70	1141.06	410.76	160.40	62.07	41.04
Th-56	4304.00	3749.00	3500.33	3234.64	2321.30	2014.00	1956.00	1667.00	1347.60	417.03	177.46	52.56	23.96
Th-69	4244.06	4009.90	3656.76	3497.00	2247.99	2004.60	1703.06	1598.66	1250.00	279.39	104.03	37.00	12.39
Th-75	4340.66	3747.33	3387.00	3282.66	2341.33	2224.33	2034.70	1657.06	1213.06	571.80	163.00	51.00	35.34
Th-82	4275.33	3355.66	3225.63	3037.33	2359.63	1979..00	1632.64	1318.00	1080.63	400.98	116.13	53.40	19.99
Th-89	4123.63	3825.65	3654.33	3403.33	2346.26	2041.10	1937.00	1644.00	1334.03	342.66	106.96	64.93	26.70
				Months (A)		**Formulations (B)**		**AxB**					
CD (0.05)				**127.23**		**123.67**		**366.11**					

Table 35: Field evaluation of invert-emulsion and talc formulation of *Trichoderma harzianum* for the management of soil borne and foliar diseases of chick- pea

Treatment	Plant stand (per sq m)	Increase over check	Plant stand (per sq m)	Increase over check	Mortality after initial plant stand	Shoot length	Increase over check	Root length	Increase over check	Rhizosphere population (x 10^3 CFU g^{-1})	Rhizoplane population (x10^2 CFU g^{-1})	Yield /plot (Kg)	Yield (q/ha)
	45 d	**%**	**90 d**	**%**	**%**		**%**		**%**	**75 d**			
IEF1	63.00	40.00	55.33	84.43	12.17	To be recorded at the time of harvest		To be recorded at the time of harvest		15.00	10.66	To be recorded after harvest	To be recorded after harvest
IEF2	70.22	56.80	65.44	118.13	6.80					20.66	16.33		
Talc	67.88	51.61	62.00	106.66	8.66					18.66	13.00		
Carbendazim	76.00	69.75	63.11	110.36	16.96					2.00	1.66		
Mancozeb	58.55	12.91	40.22	34.06	31.30					4.33	3.66		
Control	44.77	--	30.00	--	32.99					4.00	3.33		
CD (0.05)	**14.62**	**--**	**7.58**							**1.87**	**4.25**		
CV(%)	**12.68**	**--**	**6.66**							**12.56**	**28.51**		

5. Field evaluation of promising *Trichoderma* isolates under field conditions (GBPUAT)

I. Rice (Kalanamak-3131)

Mode of application of bioagents: Seed treatment, colonized compost and foliar spray (talc based formulation of *Trichoderma*)

A field experiment was conducted at organic farming block of Breeder Seed Production Center of G.B.P.U.A&T., Pantnagar to evaluate the potential 19 isolates of *Trichoderma* on rice (cv Kalanamak-3131). Nursery was laid during first week of June 2012 by seed biopriming with different *Trichoderma* isolates and the transplanting was done during last week of July 2012. The different *Trichoderma* isolates were applied as seed treatment (10g/kg), seedling root dip treatment (10g/lt.), soil application (1 kg/100 kg vermicompost) and as two foliar sprays (10 g/lit). The experiment was laid in a randomized block design in three replications with a plot size of 5 x 2 m^2.

Data presented in **Table 36** indicates low level of brown spot disease severity in isolates Th-75 (20.3%) , Th-19 (21.4%), Th-11(24.3%), Th-3 (25.2%), T-13 & Th-45 (25.4%), which were at par with each other as compared to check (53.3%). Low level of sheath blight index was recorded in isolates Th-4 (9.1%), Th-13 (9.3%), Th-11&Th-19 (9.7%) and Th-3 & Th-55 (9.8%) as compared to check (31.8%). No sheath rot disease incidence was observed. Among all the isolates Th-4, Th-13, Th-11, Th-19, Th-3 and Th-55 were found good in managing brown spot and sheath blight diseases.

The study on the effect of 19 isolates of *T. harzianum* on rice (cv Kalanamak 3131) under field conditions (**Table 37**) showed significantly higher plant and panicle length as compared to control. However, maximum increase in plant length was observed in Th-14 (10.02%) followed by Th-11 (8.45%) and Th-39 (8.21%) over control. Maximum increase in panicle length was observed in Th-14 (31.13%) followed by Th-13(27.72%), Th-17(25.92%), Th-69 (23.91%) and Th-19(23.03%) while, significantly maximum increase in tiller/hill was observed in Th-14 (68.21%) followed by Th-17 (45.42%) and Th-11, Th-56, Th-19 (40.92%). Significantly higher yield was recorded in Th-14 (32.00q/ha) followed by Th-17 (31.30q/ha) as compared to control (21.00 q/ha). Maximum increased in yield was observed in Th-14 (52.38%) followed by Th-17(49.04%) and Th-19 (42.85%).

Among all the promising isolates evaluated under field conditions Th-14 was found best in increasing plant vigour and yield of rice (cv Kalanamak-3131) followed by Th-17, and Th-19.

Table 36: Efficacy of promising *Trichoderma* isolates in managing rice diseases (cv Kalanamak-3131)

***Trichoderma* isolate**	**Per cent disease severity (DS)/ incidence(DI) in Rice (3131)**	
	Brown spot (% DS)	**Sheath blight (% DI)**
Th-1	26.16 (30.74)	11.03 (19.24)
Th-3	25.20 (30.10)	9.83 (18.24)
Th-5	30.96 (33.58)	12.60 (20.71)
Th-11	24.33 (29.55)	9.70 (17.31)
Th-13	25.43 (30.28)	9.33 (17.77)
Th-14	26.90 (31.23)	9.16 (17.61)
Th-17	30.16 (33.30)	13.00 (21.12)
Th-19	21.43 (27.57)	9.70 (17.83)
Th-39	37.40 (37.67)	11.50 (19.81)
Th-45	25.40 (30.26)	12.50 (20.58)
Th-50	34.03 (35.68)	10.83 (19.01)
Th-55	30.13 (33.29)	9.83 (18.20)
Th-56	36.23 (37.00)	11.83 (20.05)
Th-57	32.93 (35.00)	12.83 (20.97)
Th-62	28.70 (32.39)	11.00 (18.88)
Th-69	30.33 (33.41)	12.83 (20.97)
Th-75	20.30 (26.77)	10.83 (19.18)
Th-82	29.93 (33.16)	12.33 (20.43)
Th-89	31.90 (34.38)	11.66 (19.89)
Control	53.36 (46.93)	31.83 (34.31)
CD (0.05)	**5.47 (3.35)**	**5.12 (4.87)**
CV(%)	**11.00 (6.13)**	**25.37 (14.65)**

Values in parenthesis are angular transformed values

Table 37: Efficacy of promising *Trichoderma* isolates on plant vigour and yield of rice cv Kalanamak-3131

	Plant vigour						Yield		
***Trichoderma* isolate**	**Plant height (cm)**	**Increase over check (%)**	**Panicle length (cm)**	**Increase over check (%)**	**Tiller/hill (no.)**	**Increase Over check (%)**	**Yield/10 m^2 plot (kg)**	**Yield/ha (in q)**	**Increase over check (%)**
Th-1	153.64	8.19	29.92	20.06	9.66	31.78	2.70	27.0	28.57
Th-3	152.06	7.08	28.97	16.25	8.33	13.64	2.60	26.3	25.23
Th-5	151.25	6.51	30.45	22.19	8.00	9.14	2.83	28.3	34.76
Th-11	154.51	8.45	29.67	19.06	10.36	40.92	2.83	28.0	33.33
Th-13	152.26	7.22	31.83	27.72	9.33	27.28	2.93	29.3	39.52
Th-14	156.24	10.02	32.68	31.13	12.33	68.21	3.20	32.0	52.38
Th-17	151.03	6.35	31.38	25.92	10.66	45.42	3.10	31.3	49.04
Th-19	153.56	8.14	30.66	23.03	9.00	40.92	3.03	30.0	42.85
Th-39	153.66	8.21	29.81	19.62	9.33	27.28	2.93	29.3	39.52
Th-45	152.34	7.28	30.18	21.10	9.00	22.78	2.60	26.0	23.80
Th-50	149.20	4.93	30.36	21.82	9.66	31.78	2.73	27.3	30.00
Th-55	150.47	5.96	29.54	18.53	10.00	36.42	2.63	26.3	26.66
Th-56	151.20	6.47	28.54	14.52	10.33	40.92	2.83	28.3	33.33
Th-57	150.74	6.15	30.18	21.18	10.00	36.42	2.73	27.3	28.57
Th-62	153.06	7.78	30.31	21.62	9.00	22.78	2.36	23.6	16.66
Th-69	150.54	6.01	30.88	23.91	9.33	27.28	2.50	25.0	19.04
Th-75	149.57	5.33	29.74	19.34	9.66	31.78	2.66	26.6	30.00
Th-82	150.55	6.02	30.93	24.11	9.33	27.28	2.56	25.6	23.80
Th-89	149.15	5.03	30.27	24.11	10.33	22.78	2.53	25.3	19.04
Control	142.00	0.00	24.92	0.00	7.33	0.00	2.10	21.0	00.00
CD(0.05)	**7.52**		**2.817**		**2.27**		**0.523**		

II. Lentil (PL-5)

A field experiment was conducted in organic farming block of Seed Production Center of GBPUA&T, Pantnagar during Rabi 2012-13 to evaluate the efficacy of 19 potential isolates of *Trichoderma* on Lentil (PL-07) for plant yigour, disease incidence and yield. Sowing was done on Dec. 24, 2012. Bioagents were applied as soil treatment (1 kg/100 kg vermicompost), seed treatment (10g/kg seed) and as foliar sprays (10 g/ lit. water). The experiment was laid in a randomized block design in three replications with a plot size of 4x5 m^2.

The data on plant stand (45 and 90 DAS) (**Table 38**) revealed increase in plant stand at 45 and 90 DAS in all the treatments. Significantly maximum increase in plant stand was observed in Th-14 (54.08 & 78.52%) followed by Th-17(48.76 & 71.71%) , Th-3 (47.76 & 69.30%), Th-39 (47.17 & 66.54%), Th-56 (43.22 & 56.27%), Th-55 (42.38 & 54.38%), Th-62(39.81 & 49.72%) and Th-50 (36.31 & 43.00%) over control. Minimum root rot incidence was observed in Th-14 (5.21%) followed by Th-17 (5.57%), Th-3 (6.27%) and Th-39 (7.43%) as compared to control (18.19%).

Significantly maximum population of *Trichoderma* in rhizosphere (75 DAS) was observed in Th-14 ($21x10^3$) followed by Th-17 ($14.33x10^3$) as compared to control ($2.33x10^3$). The experiment is under progress.

3. Chickpea (PG-186)

A field experiment was conducted in organic farming block of Seed Production Center of GBPUA&T, Pantnagar during Rabi season 2012-13 to evaluate the efficacy of 19 potential isolates of *Trichoderma* on Chickpea (PG-186) for plant vigour, disease incidence and yield. Sowing was done on Dec. 24, 2012. Bioagents were applied as soil treatment (1 kg/100 kg vermicompost), seed treatment (10g/kg seed) and as foliar sprays (10 g/ L water). The experiment was laid in a randomized block design in three replications with a plot size of 5x5 m^2.

The data on plant stand (45 and 90 DAS) (**Table 39**) revealed increase in plant stand over check. Significantly maximum increase in plant stand was observed in Th-14 (46.30 & 78.52%) followed by Th-17(42.32 & 71.71%) and Th-3 (37.31 & 69.30%) respectively, over control. Minimum root rot incidence was observed in Th-14 (7.36%) followed by Th-17 (9.70%) and Th-3 (11.06%) as compared to control (33.83%).

Significantly maximum population of *Trichoderma* in rhizosphere (75 DAS) was observed in Th-14 ($21.00x10^3$) followed by Th-17 ($19.00x10^3$) and Th-3($10.66x10^3$) as compared to check ($3.00x10^3$). The experiment is under progress.

Table 38: Effect of selected *Trichoderma* isolates on disease, plant vigour and yield of lentil crop variety PL-5

Treatment	Plant stand (per sq m)	Increase over check	Plant stand (per sq m)	Increase over check	Mortality after initial plant stand	Shoot length	Increase over check	Root length	Increase over check	Rhizosphere population	Yield	
	45 d	**%**	**90 d**	**%**	90 d	**90 d**	**%**	**90 d**	**%**	**(X 10^3 CFU g^{-1})**	**Kg/plot ($20m^2$)**	**q /ha**
Th-1	154.11	7.85	133.11	13.88	13.62	To be recorded at the time of harvest		To be recorded at the time of harvest		4.66	To be recorded after harvest	To be recorded after harvest
Th-3	211.12	47.76	197.88	69.30	6.27					9.66		
Th-5	166.11	16.25	150.33	28.61	9.49					4.66		
Th-11	150.66	5.44	138.66	18.63	7.96					6.33		
Th-13	180.12	26.06	165.00	41.17	8.39					6.33		
Th-14	220.15	54.08	208.66	78.52	5.21					21.00		
Th-17	212.55	48.76	200.77	71.71	5.57					14.33		
Th-19	198.63	39.01	175.00	49.72	11.89					5.33		
Th-39	210.29	47.17	194.66	66.54	7.43					5.33		
Th-45	160.17	12.10	139.55	19.39	12.87					3.66		
Th-50	194.77	36.31	169.55	45.06	12.94					6.00		
Th-55	203.44	42.38	180.44	54.38	11.30					4.33		
Th-56	204.64	43.22	182.66	56.27	10.74					4.00		
Th-57	164.44	15.08	145.22	24.24	11.68					8.00		
Th-62	199.77	39.81	175.00	49.72	12.39					3.66		
Th-69	159.18	11.40	138.11	18.16	13.23					6.33		
Th-75	191.32	33.90	175.11	49.82	8.47					7.00		
Th-82	187.15	30.98	169.11	44.68	9.63					6.66		
Th-89	156.27	9.37	141.55	21.10	9.41					3.57		
Control	142.88	00.00	116.88	0.00	18.19					2.33		
CD (0.05)	**50.70**	**--**	**18.02**							**9.66**		

Table 39: Efficacy of selected promising *Trichoderma* isolates on plant vigour, disease and yield of chick pea crop variety (PG-186)

Treatment	Plant stand (per sq m)	Increase over check	Plant stand (per sq m)	Increase over check	Mortality after initial plant stand	Shoot length	Increase over check	Root length	Increase over check	Rhizosphere population	Yield	
	45 d	**%**	**90 d**	**%**	90 d	**90 d**	**%**	**90 d**	**%**	**(x 10^3 CFU g^{-1})**	Kg/plot ($25m^2$)	q/ha
Th-1	68.52	31.21	57.66	66.88	15.84	To be recorded at the time of harvest		To be recorded at the time of harvest		7.00	To be recorded after harvest	To be recorded after harvest
Th-3	71.96	37.31	64.00	85.23	11.06					10.66		
Th-5	60.86	16.54	48.55	40.52	20.22					4.33		
Th-11	56.32	7.85	41.66	20.57	28.56					3.33		
Th-13	62.88	20.41	50.88	47.26	19.08					5.66		
Th-14	76.40	46.30	70.77	104.83	7.36					21.00		
Th-17	74.32	42.32	67.11	94.24	9.70					19.00		
Th-19	59.59	14.11	44.66	29.26	25.05					3.33		
Th-39	60.85	16.52	47.88	38.58	21.31					2.00		
Th-45	52.95	1.39	38.00	9.98	28.23					3.66		
Th-50	59.38	13.71	42.88	24.10	27.78					4.00		
Th-55	60.48	15.81	46.77	35.36	22.77					4.00		
Th-56	65.88	26.15	53.88	55.94	18.21					2.66		
Th-57	63.66	21.90	50.88	47.26	20.07					7.00		
Th-62	66.10	26.57	54.77	58.52	17.14					4.33		
Th-69	69.29	32.68	59.88	73.31	13.53					7.00		
Th-75	59.77	14.45	41.00	18.66	31.40					5.66		
Th-82	70.59	35.17	62.44	80.72	11.54					7.66		
Th-89	67.77	29.77	56.22	62.72	17.04					2.66		
Control	52.22	00.00	34.55		33.83					3.00		
CD(0.05)	**9.99**	**--**	**4.03**							**4.11**		

6. Large scale field demonstration of biocontrol technologies (GBPUAT)

Rice

During Kharif season 2012, large scale field demonstration of biocontrol technologies was conducted at different villages of district Nainital on the field of 51 farmers covering and area of 83.5 hectares with the plot size ranging from 0.5-5.0 hectares. The bioagents were applied as soil application with FYM/vermicompost (5-10 tons/ha) colonized with Pantnagar bioagents-3 (mixture of *T. harzianum* Th-14 and *P. fluorescens* PBAP-173), followed by seed treatment (10 g/kg seed), seedling dip treatment (10g/lit. water) and need-based foliar sprays of PBAT-3 (10g/lit. water). During the crop season there was no major outbreak of any insect pest and diseases. However, occurrence of brown spot (*Drechslera oryzae*), sheath blight (*Rhizoctonia solani*) and stem borer was observed. An average yield of 51q/ha was obtained by adopting biocontrol technologies.

Tomato

Field demonstrations were laid at the fields of 20 farmers at Golapar-Chorgalia, Haldwani District Nanital covering an area of 50 acre. The bioagents were applied as soil application with FYM/vermicompost (5-10 tons/ha) colonized with Pantnagar bioagents-3 (mixture of *T. harzianum* Th-14 and *P. fluorescens* PBAP-173), followed by seed treatment (10 g/kg seed), seedling dip treatment (10g/lit. water) and need-based foliar sprays of PBAT-3 (10g/lit. water). No effect of biocontrol agents on crop health was observed due to heavy loss of the crop (70-80%) which was due to heavy frost injury.

Pea

During Rabi 2012-13 large scale field demonstrations of biocontrol technologies was conducted on pea variety Arkil, at six farmer's fields at Rudrapur, Kashipur, Jaspur and Bajpur covering an area of 25 acres. The bioagents were applied as soil application with FYM/vermicompost (5-10 tons/ha) colonized with Pantnagar bioagents-3 (mixture of *T. harzianum* Th-14 and *P. fluorescens* PBAP-173), followed by seed biopriming (10 g/kg seed) and soil drenching with PBAT-3 (10g/lit. water). During the last year (2011-12) farmers suffered from 70% crop losses due to wilt problem. During this year (2012-13) the farmers used biocontrol agents for the management of wilt problems. Due to the successive application of biocontrol the farmers got desired yield of green pea (30-35 q/acre) as compared to yield obtained during last year (15-20q/acre).

7. Monitoring for emergence of newer pests and diseases of various crops in districts Udham Singh and Nainital of Uttarakhand (GBPUAT).

No newer and major outbreak of insects-pests and diseases have been observed in the Udham Singh Nagar and Nainital Districts of Uttarakhand. However, the list of insect pests and diseases observed at farmers field is presented in **Table 40**.

Table 40: Occurrence of insect pest and diseases in various crops (Udham Singh and Nainital)

Crop	Diseases		Insects pest	
	Major	**Minor**	**Major**	**Minor**
Rice	Nil	Brown spot (*Drechslera oryzae*) Sheath blight (*Rhizoctonia solani*) Bacterial leaf blight (*Xanthomonas oryzae pv. oryzae*), Blast (*Pyricularia oryzae*)	Nil	Stem borer (*Scirpophaga incertulas*)
Wheat	Yellow rust (*Puccinia striiformis*)	Brown rust (*Puccinia recondita)* Leaf blight (*Alternaria triticina*) Powdery mildew (*Erysiphe graminis f. sp. tritici*)	Nil	Aphid (*Macrosiphum miscanthi*), Termites (*Odontotermis obesus*)
Pea	Rust (*Uromyces viciae fabae*)	Downy mildew (*Peronospora viciae*) Wilt complex, Powdery mildew (*Erysiphe pisi*)	Pod borer (*H. armigera*)	Pea Aphid (*Aphis craccivora*)
Chickpea	Wilt (*Fusarium oxysporium f. sp. ciceri*)	Grey mold (*Botrytis cinerea*)	Pod borer (*H. armigera*)	Nil
Lentil	Rust (*Uromyces viciae fabae*)	Wilt (*Fusarium oxysporium f. sp. Lentis*)/ Root rot (*Rhizoctonia solani*)	Nil	Nil
Cabbage	Nil	leaf spot (*Alternaria brassicae*), Bacterial rot (*Xanthomonas campestris pv. campestris*)	Aphid (*Brevicoryne brassicae*)	Diamond backmoth (*Plutella xylostella),*cabbage butterfly (*Pieris brassicae*) White grub (*Holotrichia consanguinea*), painted bug (*Bagrada hilaris)*
Capsicum	Root rot (*Phytophthora capsici*), Bacterial wilt (*Ralstonia solanacearum*)	Damping off (*Pythium* sp.), Leaf curl (*Leaf curl virus)*	Nil	Cut worm (*Agrotis segetum*) Thrips (*Scirtothrips dorsalis*)
Chilli	Fusarium Wilt (*Fusarium oxysporum f. sp. capsici*)	Leaf curl (*Chilli leaf curl virus)*	Thrips (*Thrips tabaci*)	Aphid (*Myzus persicae*)
Tomato	Late blight (*Phytophthora infestans*), Bacterial wilt (*Ralstonia solanacearum*)	Damping off , Early blight (*Alternaria solani*), Mosaic, Leaf curl	Fruit borer (*Helicoverpa armigera*)	Nil
Brinjal	Nil	Wilt (*Ralstonia solanacearum),* Phomopsis blight (*Phomopsis vexans*), Sclerotinia rot (*Sclerotinia sclerotiorum*)	Fruit & shoot borer borer (*Leucinodes orbonalis*)	Hadda beetle (*Epilachna*)
French bean	Anthracnose (*Colletotrichum lindemuthianum*)	Sclerotinia rot (*Sclerotinia sclerotiorum*), Yellow mosaic	Bihar Hairy caterpillar (*Diachysia obliqua*)	Aphid (*Aphis cracivora)*
Rapeseed Mustard	Alternaria blight (*A. brassicae*), White rust (*Albugo candida*)	Downy mildew (*Perenospora parasitica*), Sclerotinia rot (*Sclerotinia sclerotiorum*)	Aphid (*Lipaphis erysimi*)	Sawfly (*Athalia lugens proxima*)

8. Evaluation of fungal and bacterial antagonists against collar rot of groundnut caused by *Aspergillus* spp. and *Scrlotium rolfsii* (AAU-A)

No Report

9. Isolation, identification and characterization of indigenous strains of *Pseudomonas fluorescens and Bacillus* strains effective against *Fusarium* wilt in pigeon pea (AAU-A)

Location : Biocontrol Research Laboratory, Anand
Year of commencement : 2011
Season and year : *Kharif,* 2012
Crop : Pigeonpea

Methodology: Antifungal activity were checked by 2 methods first as percentage inhibition of spore germination and the isolate having more than 25 % check in germination were counted as affective isolate and second by the dual culture plate assay where the culture having inhibition diameter more than 15 mm were take as affective one.

Isolation of *Bacillus*: 10g soil sample was added to 100 ml sterile water, heated at 80° C for 5 minutes and kept on shaker for 15 minutes at 1000 rpm. The samples were serially diluted and plated on Nutrient agar plates by spread plate technique. Raised dry/ rough colonies were selected, suspended in 1 ml sterile distilled water. Gram staining was carried and the isolates were stored on Nutrient agar slants for further studies.

Results: A total of 90 *Pseudomonas* isolates that were isolated on PDA plate, and further screened for their antagonistic potential against *F. udum* by *in vitro* dual-culture assay. Of the 90 *Pseudomonas* isolates, 47 of them were found to have the antagonistic potential against *F. udum* (**Table 41**). Among 28 villages, maximum load of *Pseudomonas* was found at Undel while Vidyanagar, Davol, Bochasan and Golana showed zero count. Among 114 isolates of *Bacilli*, only 30 were found antagonistic to *F. udum.* Sarsa and Vadtal soil samples were found more affluent in antagonistic *Bacilli* sp. (**Table 42**) of the all *Pseudomonas* isolates obtained from the 28 villages of Anand district, 52 % of them were found to have the antagonistic potential against *F. udum.*

Table 41. Total count of culturable bacteria and antagonistic *Pseudomonas*

No.	Habitat	Bacterial count on (CFU/g Average of five)	*Pseudomonas* (confirmed on Morphological basis)	Antagonistic to *F.udum*
1	Anand	$3X10^3$	4	2
2	Vidyanagar	$5X10^4$	1	0
3	Vadaseel	$7X10^3$	2	2
4	Umreth	$6X10^5$	5	3
5	Boriyavi	$1X10^4$	6	3
6	Sarsa	$4X10^3$	3	2
7	Vadtaal	$5X10^4$	3	2
8	Sunav	$6X10^3$	1	0
9	Sojitra	$6X10^4$	1	0

10	Petlad	$7X10^6$	1	0
11	Borsad	$3X10^3$	3	0
12	Dahemi	$4X10^3$	4	1
13	Davol	$6X10^5$	1	0
14	Kanbha	$6X10^5$	2	2
15	Bochasan	$5X10^5$	2	0
16	Bhadran	$4X10^5$	3	3
17	Ras	$2X10^5$	3	2
18	Kathana	$7X10^4$	4	2
19	Gundel	$2X10^3$	4	3
20	Golana	$3X10^3$	2	0
21	Undel	$6X10^4$	11	3
22	Dhuwaean	$6X10^2$	2	1
23	Khambat	$6X10^2$	3	2
24	Wadgam	$3X10^4$	4	1
25	Tarapur	$5X10^6$	4	2
26	Lunej	$2X10^3$	5	4
27	Nar	$6X10^4$	5	3
28	Bhalej	$2X10^6$	1	0
Total			**90**	**47**

Table 42: *Bacilli* found effective against wilt fungus

No.	**Habitate**	***Bacilli colonies* on Nutrient Agar (Type of isolate)**	**Antagonistic *Bacilli* against *Fuzarium udum* (types of isolate)**
1	Anand	6	0
2	Vidyanagar	8	0
3	Vadaseel	7	2
4	Umreth	6	0
5	Boriyavi	0	0
6	Sarsa	12	4
7	Vadtaal	3	3
8	Sunav	4	0
9	Sojitra	8	2
10	Petlad	9	1
11	Borsad	5	1
12	Dahemi	3	0
13	Davol	5	0
14	Kanbha	4	2
15	Bochasan	0	0
16	Bhadran	6	3
17	Ras	3	1
18	Kathana	2	1
19	Gundel	0	0
20	Golana	0	0
21	Undel	0	0
22	Dhuwaean	2	1
23	Khambat	3	2
24	Wadgam	4	2

25	Tarapur	6	1
26	Lunej	8	2
27	Nar	0	0
28	Bhalej	0	2
Total		**114**	**30**

10. Evaluation of fungal and bacterial antagonists for the management of foot rot of citrus (kinnow) caused by *Phytophthora* spp. (PAU)

The experiment was conducted at farmer's field in district Hoshiarpur. The seven treatments were Talc formulation of *Trichoderma harzianum, T. asperellum, T. virens,* two Invert formulations of *T. harzianum* i.e ThIE1 and Th IE2, chemical control (Ridomil gold) and unsprayed control. The Kinnow orchard showing symptoms of foot rot was selected and treated with different fungal formulations. At that time the difference between the numbers of foot rot infected plants was non-significant (Table 49). The treatments were given as soil application (@100Kg of completely dried FYM enriched with 1 Kg Talc formulation. The observation on number of foot rot infected plants and yield parameter were recorded.

The results of this experiment showed that rhizosphere population of antagonists increased in all *Trichoderma* treated plots and it was 16.0, 13.9, 12.0, 15.9 and 12.0 x 10^3 cfu/g soil in *Trichoderma harzanium*, *Trichoderma asperellum*, *Trichoderma virens, T. harzianum* IE-1 and *T. harzianum* IE-2 treated plots respectively, in December. However, no population was recorded in carbendazim and control plots.When the numbers of fruits were recorded from four trees per treatment, the mean number of fruits per plant was maximum (580.50) in *T. harzianum* (Talc) treatment which was at par with chemical treatment (498.00). Minimum number (277.00) of fruits was recorded in unsprayed control (**Table 43**).

All the treatments were significantly better than unsprayed control. The yield per plant was maximum (102.82 kg) in *T. harzianum* (Talc) treatment which was at par with chemical treatment (87.60kg) and *T. harzianum* (IE-1) (81.39kg). However, minimum yield (44.45kg) was recorded in untreated plot, which was significantly lower than other treatments.

Table 43: Evaluation of fungal antagonists for the management of foot rot if citrus (kinnow)

Treatments	No of foot rot infected plants	Number of fruits /plant	Weight of 10 fruits/plant (Kg)	Yield/plant (Kg)
***T. harzianum* (Talc)**	19	580.50[a]	1.76	102.82 [a]
***T. asperellum* (Talc)**	18	429.00 [abcd]	1.75	74.70 [abcd]
***T. virens* (Talc)**	19	457.50 [abc]	1.63	65.50 [bcd]
T. harzianum IE-1	19	471.00 [ab]	1.68	81.39 [ab]
T harzianum IE-2	19	331.25 [bcd]	1.65	53.55 [cd]
Chemical treatment	20	498 [a]	1.76	87.60 [ab]
Control (untreated)	18	277.00 [d]	1.55	44.45 [d]
CV	5.38	26.33	11.05	29.69

11. Evaluation of fungal and bacterial antagonists for the management of fusarial wilt of cucurbits (PAU)

The experiment is being conducted at Entomological Research Farm, PAU Ludhiana in Punjab Sunehri variety of muskmelon. There are six treatments with four replications. The muskmelon seeds were treated with respective fungal and bacterial formulations and sown in polybags. These were then transplanted in the field and the experiment is in progress.

Biological control of plant parasitic nematodes using antagonistic organisms

12. Demonstration on biological control of root-knot nematode, *Meloidogyne incognita* race II in pomegranate (MPKV)

A field experiment was conducted in farmer's orchard (Mr. Sharad Rambhau Walunj, At. Pimpalgaon Konzira, Tal. Sangamner, Dist. Ahmednagar) on three year old orchard of pomegranate var. Bhagawa planted at 4 x 3 m spacing over 2 acres. The bioagents, *Paecilomyces lilacinus* @ 20 kg/ha (10^7 spores/g), *Pochonia chlamydosporium* @ 20 kg/ha (10^7 spores/g) talc formulations alone (T1 and T2) and mixed with organic manure FYM @ 2.5 t/ha (T3 and T4) and chemical pesticide carbofuran 3G @ 1.0 kg a.i./ha (T5) were applied in soil on 28/02/2012 at *Bahar* treatment. Light irrigation was given after treatment application. Untreated control (T6) was maintained for comparison. The trial was laid out in RBD with four replications. Weeds were cleared at the base of pomegranate trees and then 100 g formulation mixed with soil (T1 and T2) and with FYM (T3 and T4) was applied at the root zone per tree. The observations were recorded on RKN population in 200 cc soil and number of root galls per 5 g roots at initial, intermediate and final i.e. termination of season and yield per ha.

The pre-treatment root-knot nematode population in soil ranged from 540 to 573 nematodes (J_2) per 200 cc soil and 23 to 25 nematodes (J_2) per 5 g roots. Data in **Tables 44 and 45** revealed that all the treatments were significantly superior to untreated control in reducing the RKN population in soil as well as in roots and increased the fruit yield. The treatment with soil application of *P. lilacinus* @ 20 kg/ha + organic manure found most effective in reducing the RKN population (31.7%) and root galls/5 g roots (25.4%), and increased 15.6% fruit yield of pomegranate with 1: 17.3 ICBR. It was, however, followed by *P. chlamydosporium* @ 20 kg/ha + organic manure and carbofuran 3G @ 1.0 kg a.i./ha. The treatment *P. chlamydosporium* @ 20 kg/ha + organic manure gave maximum yield (19.2 t/ha) with 1: 18.5 ICBR.

Table 44. Effect of bioagents on RKN population in soil in pomegranate

Treatment	RKN population/ 200 cc soil			Decline in RKN population (%)	
	Initial	Intermediate	Final	Intermediate	Final
T1: *Paecilomyces lilacinus* @ 20 kg/ha	540.0[a]	380.0[b]	420.0[b]	29.6[c]	22.2[b]
T2: *Pochonia chlamydosporium* @ 20 kg/ha	560.0[a]	386.7[b]	413.3[b]	31.0[c]	25.9[b]
T3: *P. lilacinus* @ 20 kg/ha + organic manure	573.3[a]	366.7[b]	393.3[a]	36.1[b]	31.7[a]
T4: *P. chlamydosporium* @ 20 kg/ha + organic manure	560.0[a]	373.3[b]	386.7[a]	33.0[b]	30.6[a]
T5: Carbofuran 3G @ 1.0 kg a.i./ha	540.0[a]	260.0[a]	373.3[a]	51.9[a]	30.8[a]
T6: Untreated control	560.0[a]	600.0[c]	680.0[c]	0.0[d]	0.0[c]
CD (p = 0.05)	NS	39.3	34.8	2.7	3.5

Table 45. Effect of bioagents on root galls due to RKN and yield of pomegranate

Treatment	No. of root galls/ 5 g roots			Decline in root galls (%)		Yield* (t/ha)	ICBR
	Initial	Inter-mediate	Final	Inter-mediate	Final		
T1: *P. lilacinus* @ 20 kg/ha	24.7[a]	20.7[c]	22.0[b]	16.2[d]	10.8[b]	18.4[b] (11.3)	1: 15.6
T2: *P. chlamydosporium* @ 20 kg/ha	24.3[a]	20.3[c]	21.7[b]	16.4[d]	10.9[b]	18.3[b] (11.1)	1: 15.2
T3: *P. lilacinus* @ 20 kg/ha + organic manure	25.0[a]	18.0[b]	18.7[a]	28.0[b]	25.4[a]	19.1[a] (15.6)	1: 17.3
T4: *P. chlamydosporium* @ 20 kg/ha + organic manure	23.3[a]	18.0[b]	18.3[a]	22.9[c]	21.4[a]	19.2[a] (16.3)	1: 18.5
T5: Carbofuran 3G @ 1.0 kg a.i./ha	24.0[a]	13.7[a]	18.3[a]	43.0[a]	23.7[a]	18.4[a] (11.8)	1: 28.0
T6: Untreated control	24.7[a]	29.0[d]	34.0[c]	0.0[e]	0.0[c]	16.5[c]	-
CD (p = 0.05)	NS	1.5	1.6	2.5	3.1	0.7	

* Figures in parentheses are per cent increase in yield over control

Market rates: i. Bioagents- Rs. 250/- per kg; ii. Carbofuran 3G – Rs. 75/- per kg
iii. Organic manure – Rs.500/- per t; iii. Pomegranate fruits– Rs. 50,000/- per t
iv. Labour charges- Rs. 1000/- per ha

13. Demonstration of Biocontrol practices for management of root-knot nematode in Pomegranate (1 ha) (ongoing experiments to be continued) (AAU-A)

Results

Large scale demonstration was carried out at field of Shri. Afzal Agaria, a farmer of village Sherpura near Palanpur on 6th November, 2012 to control whitegrub and root knot nematodes. Forty five pomegranate growers of the Banaskantha region, including the village of Sherpura, Umiyanagar and Navisna remained present. Dr. Bhummanavar and Dr. Nagesh explained the farmers the incidence and factors affecting the activity and mode of action of *Pochonia chlamydosporia* as well as different EPN formulation and demonstrated the methods of application and dose of *Pochonia chlamydosporia* formulation as well as EPN (both powder and sponge formulations). Dr. Mehta briefed the farmers about the importance of the biological control agents for the control of other pests in the area while Dr. B. A. Patel explained the use of nematicidal fungi in crops other than pomegranate where nematode infestation was observed. Mr. Ramji Mangukia of M/s Agriland Biotech Pvt. Ltd, the producer of *Pochonia chlamydosporia* (under Technical collaboration with NBAII) remained present at the meeting and assured the farmers about the quality of the product.

2.3. Sugarcane

1. Monitoring the sugarcane woolly aphid (SWA) incidence and impact assessment of natural enemies on its bio suppression (MPKV, TNAU, UAS-Raichur)

MPKV

The sugarcane woolly aphid incidence and occurrence of natural enemies (*Dipha aphidivora, Micromus igorotus, Encarsia flavoscutellum,* syrphid, spider) were recorded during June 2012 to March, 2013 at five agro-ecological zones of western Maharashtra covering Pune, Satara, Sangli, Kolhapur, Solapur, Ahmednagar, Nashik, Nandurbar, Dhule and Jalgaon districts. The SWA incidence, pest intensity rating (1-6 scale) and natural enemies population were recorded at five spots and five clumps per spot from each plot during crop growth period. The pest incidence was recorded in riverside and canal areas in 10 tehsils from Pune region during July to December, 2012. However, there was soon occurrence of natural enemies in infested fields. The SWA incidence was also noticed in Satara, Sangli and Kolhapur areas in Krishna and Panchaganga riverside fields; its intensity was low in Ahmednagar and Jalgaon districts and very low in the remaining parts of western Maharashtra. The average pest incidence and intensity were 0.44 per cent and 1.39, respectively. The natural enemies recorded in the SWA infested fields were mainly predators like *Dipha aphidivora* (0.5-2.3 larvae/leaf), *Micromus igorotus* (1.2-5.1 grubs/leaf), syrphid, *Eupoderes confractor* (0.03-1.1 larvae/leaf) and spider (0.02-0.5 per leaf) during August to November, 2012 on 7 to 10 month-old canes (**Table 46**). The parasitoid, *Encarsia flavoscutellum* was observed in Pune and Satara districts. These natural enemies were found to be distributed and established well in sugarcane fields and regulated the SWA incidence in western Maharashtra.

Table 46. Incidence of sugarcane woolly aphids and natural enemies in Maharashtra

Districts surveyed	SWA incidence (%)	Pest intensity rating (1-6)	Natural enemies/leaf	
			D. aphidivora	***M. igorotus***
Pune	0.75	1.6	1.2	4.5
Satara	0.69	1.5	1.3	3.5
Sangli	0.68	1.7	2.1	4.3
Kolhapur	0.82	1.9	2.3	5.1
Ahmednagar	0.23	1.1	0.5	1.2
Solapur	0.21	1.1	0.6	1.2
Jalgaon	0.28	1.4	1.3	2.0
Dhule	0.23	1.1	0.8	1.2
Nandurbar	0.30	1.3	0.5	1.3
Nashik	0.29	1.2	1.4	2.6
Average	0.44	1.39	1.20 (0.5-2.3)	2.69 (1.2-5.1)

TNAU

The sugarcane wooly aphid incidence and occurrence of natural enemies (*Dipha aphidivora, Micromus igorotus, Encarsia flavoscutellum,* syrphid and spider) were recorded from different agro-ecological zones of Tamil Nadu and correlated with abiotic factors. The Sugarcane woolly aphid incidence and occurrence of natural enemies were recorded from July 2012 to February 2013 from seven major sugarcane growing districts covering different agro ecological zones of Tamil Nadu *viz.*, Coimbatore, Erode, Salem, Cuddalore, Karur, Vellore and Tirunelveli at monthly basis. The pest incidence and the natural enemies were not noticed during July-September 2012. The SWA was noticed in patches and the occurrence of *Encarsia flavoscutellum*, *Dipha aphidivora* and *Micromus igorotus* was observed (**Tables 47 & 48**) along with the population of SWA thereafter. A maximum of 68.2 *Encarsia*/ leaf was observed in Coimbatore during December 2012. SWA incidence was noticed in all the locations from September-October 2012 to January 2013. *Dipha* and *Micromus* populations were also observed during October 2012 to January 2013.

Table 47. Mean incidence of Sugarcane Woolly Aphid in different zones of Tamil Nadu

Districts surveyed	October 2012		November 2012		December 2012		January 2013		February 2013	
	% incidenc	*Grade*	*% incidenc*	*Grade*	*% incidenc*	*Grade*	*% incidenc*	*Grade*	*% incidenc*	*Grade*
Erode	3.8	1.0	4.2	1.0	12.6	2.0	1.2	1.0	0.0	0.0
Cuddalore	2.4	1.0	3.0	1.0	1.2	1.0	0.4	0.0	0.0	0.0
Coimbatore	7.2	1.0	16.8	1.0	17.6	2.0	2.0	1.0	0.2	0.0
Salem	3.2	1.0	8.4	1.0	13.6	2.0	0.8	0.0	0.0	0.0
Karur	0.6	0.0	3.6	1.0	2.4	1.0	0.4	0.0	0.0	0.0
Vellore	0.4	0.0	2.2	1.0	1.0	1.0	0.0	0.0	0.0	0.0
Tirunelveli	0.4	0.0	1.6	1.0	0.0	0.0	0.0	0.0	0.0	0.0

UAS-Raichur

In Raichur district the area under sugarcane is very meagre and whereas the cultivation of sugarcane is picking up in Deodurga taluk. No incidence of woolly aphid was noticed in Bidar district.

Table 48. Mean incidence of Sugarcane Woolly Aphid and its natural enemies in different zones of Tamil Nadu

Districts surveyed	October 2012				November 2012				December 2012				January 2013				February 2013			
	SWA/ 6.25 sq.cm	*SWA/ 6.25 sq.cm*	*Dipha/ leaf*	*SWA/ 6.25 sq.cm*	*SWA/ 6.25 sq.cm*	*Dipha/ leaf*	*Encarsia/ leaf*	*Micromus/ leaf*	*Dipha/ leaf*	*Encarsia/ leaf*	*Micromus/ leaf*	*Encarsia/ leaf*	*Micromus/ leaf*	*Dipha/ leaf*	*Encarsia/ leaf*	*Micromus/ leaf*	*SWA/ 6.25 sq.cm*	*Dipha/ leaf*	*Encarsia/ leaf*	*Micromus/ leaf*
Erode	16.4	28.8	0.0	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.2	0.0	0.0	1.4	14.4	0.0	6.4	1.0
Cuddalore	12.2	20.4	0.4	4.2	0.0	0.0	0.0	0.0	0.0	2.0	0.0	1.4	1.4	0.0	0.0	0.6	8.6	0.0	4.8	0.0
Coimbatore	8.2	43.0	0.0	6.4	2.4	0.0	0.2	0.0	0.0	4.4	0.2	29.6	0.0	0.0	2.0	0.0	31.4	0.2	68.2	2.4
Salem	22.4	26.6	1.2	5.4	0.0	0.0	0.0	0.0	0.4	1.6	0.0	13.6	2.0	0.4	4.8	0.0	13.8	0.2	7.6	1.6
Karur	10.8	18.4	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.2	5.4	1.2	0.0	1.2	0.0	8.2	0.0	2.6	0.0
Vellore	16.8	22.6	0.0	3.6	0.0	0.0	0.0	0.0	0.0	1.8	0.0	5.2	2.4	0.2	0.0	0.6	10.8	0.0	1.8	0.6
Tirunelveli	4.8	6.4	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.2	0.0	0.0	0.0	2.2	0.0	0.0	0.0

Table 49. Field evaluation of *Trichogramma chilonis* produced using Eri-silk worm eggs as factitious host

Experimental plot	Damage by INB 15 days after								Intensity of damage	Yield (t/ac)
	I	II	III	IV	V	VI	VII	VIII		
	Release									
Release of *Trichogramma* reared on Eri Silk worm eggs @ 20,000/acre	24.1	23.6	21.7[a]	16.7[a]	14.9[a]	13.6[a]	10.4[a]	9.3[a]	5.4[a]	42.9[a]
Release of *Trichogramma* reared on *Corcyra* worm eggs @ 20,000/ acre	24.7	24.2	22.0[a]	17.2[a]	16.1[a]	15.0[a]	14.9[b]	15.0[b]	7.2[a]	39.3[b]
Control	24.3	24.4	25.8[b]	24.9[b]	26.1[b]	27.4[b]	24.8[c]	25.6[c]	21.8[b]	36.0[c]
't' value	NS	NS	3.4	3.6	4.6	5.1	4.4	4.6	3.9	3.0

2. Field evaluation of *T. chilonis* produced using Eri-silk worm eggs as factitious host against early shoot borer of Sugarcane (ANGRAU, TNAU, NBAII)

ANGRAU

Eri silk worm eggs can be used as a factitious host for mass production of the available strains of trichogrammatids under laboratory condition. The efficiency of *T. chilonis* produced using Eri silk worm eggs was compared with the parasitoids produced using *Corcyra* eggs in the field evaluation against sugarcane internode borer with release of *Trichogramma* reared on Eri Silk worm eggs or on Corcyra eggs @ 20,000/acre. The release was made at weekly intervals for 8 weeks after 4th month of planting. Preliminary laboratory studies showed that difference in parasitisation between *Trichogramma* reared on Eri silk worm eggs and that reared on *Corcyra* eggs was only five percent.

TNAU

There was a significant reduction in the incidence and intensity of damage due to internode borer infestation by the release of *Trichogramma chilonis* reared on Eri Silk worm eggs @ 20,000 / acre and release of *Trichogramma chilonis* reared on *Corcyra* moth eggs @ 20,000/ acre than the unreleased fields (Table 49). The level of damage due to INB was low in the both the parasitoid released plots whereas it was significantly high in the unreleased field. Similarly the intensity of damage in the parasitoid released fields was significantly lower as compared to the unreleased plots. After eighth release, in the release of *Trichogramma chilonis* reared on Eri Silk worm eggs @ 20,000/acre recorded significant reduction of INB (5.4%) as compared to release of *Trichogramma chilonis* reared on *Corcyra* eggs @ 20,000/ acre (7.2%). The untreated control recorded higher INB incidence (21.8%).

NBAII

Trichogramma chilonis reared on Eri silk worm eggs was field evaluated against sugarcane against internode borer *Chilo infuscatellus* at ZARS, VC Farm, Mandya. Percent pest incidence and percent pest intensity was recorded and infestation index was calculated indicated in the **table 50**.

Period: December, 2011 to August, 2012 (**First trail**)

Plot size: 1 acre per treatment

Age of the crop: Four and half months old

Variety: CO 62175

No. of releases of the parasitoids: 8 releases & 20000 adults per release per acre at weekly intervals

Table 50. Percent pest incidence, Percent pest intensity and infestation index in different treatments

Treatments	Pest incidence (%)	Pest intensity (%)	Infestation Index
Control plot	92.0	10.6	9.6
T. chilonis reared on Esw eggs released plot (Tc - ESW)	76.0	6.1	5.1
T. chilonis reared on *Corcyra* eggs released plot (Tc – Cc)	68.0	7.7	6.1

Statistically not-significant

Data indicates that the pest incidence, pest intensity and infestation index were comparatively higher in the control plot in comparison to that of Tc – ESW and Tc – Cc released plots. Data was subjected to statistical analysis and the differences were oserved to be statistically not significant (**Table 50**).

Second trial

A second trial was conducted to compare the efficiency of *T. chilonis* produced using Eri silkworm eggs with that produced using *Corcyra* eggs through a field evaluation trial in the ratoon crop of sugarcane against early shoot borer and inter node borer

Symptoms observed: Dead hearts of early shoot borer.

About 10 and 15 clumps were observed in Tc - Esw and Tc – Cc released plots respectively on 30/5/12. Damage rating to 61.11% and 31.65% respectively was recorded and imposed treatment on the same day i.e. first release on 30/5/12

Treatments imposed:
T1: Release of *T. chilonis* reared on Eri silkworm eggs @40,000 adults / acre
T2: Release of *T. chilonis* reared on *Corcyra* eggs @40,000 adults / acre
T3: Untreated control

Area of the experimental plots:
One acre plot of farmers fields were selected for each treatment and were further divided into five subplots.
Treatment plots were away from each other by 1Km.

Crop details: Sugarcane 45 days old crop of mixed two varieties CO 86032 and CO 62175 in three treatments
Madla village - Tc – Cc (Plot 1) treatments, Plots of Tc – Esw (Plot 2) and Control Plot (Plot 3).

Duration and number of releases: 30th May, 2012 to 31st August, 2012; 14 releases at weekly intervals.

Observations:

1. Top shoot borer and *Chilo* egg masses of were collected and also trap cards (with sentinel eggs) were placed to assess the percent parasitism. Trap card enclosed with nylon mesh and 12 batches were kept and percent parasitism was recorded.
2. Percent clumps infested and percent plants infested per clump at 5 random spots in each subplot i.e. at 20 spots in one acre were recorded during 14 releases and once post release.
3. Destructive sampling was done at the time of harvesting and data of percent pest incidence, percent pest intensity and infestation index were calculated.
4. Data of destructive sampling and percent parasitism by *T. chilonis* was subjected to angular transformation, data subjected to Anova single factor and CD values were calculated.
5. Yield was also recorded.

The trial was done in a farmer's field on a 45 days old ratoon crop of sugarcane. The farmer had noticed severe damage by early shoot borer with the symptoms of dead hearts in this field. Hence, since the trial was taken up in already infested fields, *T. chilonis* releases were initiated at higher dosages of 40,000 per acre and totally fourteen releases were made to cover the infestation by internode borer too. Initial observations in the control revealed very negligible infestation by the pest. Most of the field collected egg masses were parasitized by *Telenomus* sp.

The data was subjected to statistical analysis, which revealed that pest incidence, intensity and infestation index were significantly lower in the treatment plots in comparison to those in the control plot. Similarly infestation index was significantly less in the parasitoid released plots than in control. The activity of the parasitoid checked through the sentinel cards was significantly higher in the released plots than in control. Even though initially the pest infestation was very negligible in the control but in the later stages there was a build up in the pest population and the final yield was recorded as 34.7 tonnes / acre. In the Tc – ESW and Tc – Cc released plots, where there was a high initial infestation by early shoot borer, the pest intensity was considerably reduced through parasitoid releases and the final yield was 39.9 and 26.6 tonnes / acre, Tc-ESW and TC-Cc, treatments respectively (**Table 51**).

Table 51. Percent pest incidence, Percent pest intensity, Infestation index and Percent parasitism by *T. chilonis* and yield in different treatments

Treatments	Pest incidence (%)	Pest intensity (%)	Infestation Index	Parasitism (%)	Yield (Tonnes / acre)
Control plot	76 (63.82)[b]	7.5 (16.03)[b]	6.1 (14.13)[b]	0.67 (5.71)[b]	34.7
T. chilonis reared on Esw eggs released plot	32 (32.00)[a]	2.1 (8.50)[a]	1.1 (6.75)[a]	12.63 (19.02)[a]	39.9
T. chilonis reared on *Corcyra* eggs released plot	20 (22.6)[a]	1.1 (6.71)[a]	0.5 (5.47)[a]	9.34 (17.70)[a]	26.6
CD at 5%	16.81	3.47	3.34	3.75	-

2.4. Cotton

1. Monitoring diversity and out breaks for invasive mealy bugs on cotton (ANGRAU, MPKV, PAU, TNAU).

ANGRAU

Surveys conducted in kharif season in Mahaboobnagar and Nalgonda districts revealed that cotton was mainly affected by *Planococcus solenopsis* followed by *Maconellicoccus hirsutus*.

MPKV

The cotton seeds var. Ankur, Bollgard II were sown on 24th July 2012 at 90 x 75 cm spacing in 40 x 40 m plot on the research farm of Botany Section, College of Agriculture, Pune. All the recommended crop management practices except pesticide application were followed to maintain healthy crop growth. The incidence of cotton mealy bug, *Phenacoccus solenopsis* Tinsley and occurrence of natural enemies were monitored at fortnightly interval from the day of germination till harvest of the crop. However, it was not observed throughout the year. Besides, survey was also carried out by visiting farmers' fields in cotton growing areas of western Maharashtra. The pest incidence was noticed meagre in the months of August, September and October 2012 in Jalgaon and Dhule region in early crop stage. The parasitism of *A. bambawalei* was found common on cotton, parthenium, hibiscus and marigold. Besides, other natural enemies recorded were parasitic *Anagyrus* sp. and predatory coccinellids, *Coccinella, Menochilus* and *Scymnus*, chrysopids, *Spalgis epius,* brumoids and spiders.

PAU

Regular survey of cotton crop was conducted during July to October, 2012. The different locations of entire cotton belt viz. Ferozepur, Faridkot, Bathinda and Mansa were regularly visited at fortnightly interval to record incidence of mealybug, *Phenacoccus solenopsis* and its natural enemies. The mealy bug population remained very low to medium during the entire season though the parasitism by *Aenasius bambawalei* Hayat varied from 70.0 to 90 % at different locations. The maximum parasitism was recorded in first fortnight of July followed by first fortnight of August and it decreased later on (**Table 52**). The mean parasitism was 81.9 per cent. The main predators recordrd were *Brumus suturalis, Cheilomenes sexmaculata, Scymnus coccivora* and *Chrysoperla zastrowi sillemi* and their population varied from 0.1 to 1.6 predators per plant. The mean predator population during the entire season was 0.9 predators per plant

Table 52: Monitoring biodiversity and outbreaks for invasive mealy bugs on cotton

Period of observations		**Mealy bug Infestation (*Phenacoccus solenopsis*)**	**Parasitism by *Aenasius bambawalei***	**Predators/Plant**
July	**I**	Low	76.6	1.3
	II	Low	84.8	1.5
August	**I**	Medium	80.4	1.2
	II	Low	90.4	1.6
September	**I**	Low	88.6	0.6
	II	Low	70.6	0.3
October	**I**	V. Low	82.5	0.1
Mean			**81.9**	**0.9**

Scale used: V. Low = <5 percent plant infestation; Low = 5-10 percent plant infestation
Medium = 10-30 percent plant infestation; High = 30-50 percent plant infestation
V High = >50 percent plant infestation

TNAU

Fortnightly surveys were conducted in cotton fields for mealy bug incidence in Coimbatore, Tiruppur and Erode districts. The infested plant parts were brought back to the laboratory and held under caged conditions for emergence of natural enemies. Four species of mealy bugs viz., *Phenacoccus solenapsis*, *Maconellicoccus hirsutus, Ferrissia virgata* and *Paracoccus marginatus* were recorded on cotton. Survey indicated that *P. solenopsis* was the predominant species recorded. For *P.solenopsis*, the hosts are cotton, sunflower, vegetables (brinjal, tomato, bhendi, cucurbits), pulses calotropis, datura and parthenium. While for *P. marginatus*, papaya, tapioca, *Plumeria alba*, *Jatropha curcas* and *Psidium guajava,* mulberry, almost all vegetables, flower crops, weeds, including forest trees like teak, rain tree and *Prosopis* are recorded as important alternate hosts. So far rose, jasmine and crosandra are found to be free from the infestation of this pest. The incidence of *P. marginatus* varied from 0.00 to 45 per cent on many crops. The seasonal incidence of *Phenacoccus solenopsis* population was maximum (28 insects/ 5 cm) during June 2012 and decreased slowly during September and there was no incidence up to February 2013. Survey was made in different blocks of Coimbatore, Erode, Tirupur and Dindugul districts of Tamil Nadu to record the alternate hosts of papaya mealybug, *P. marginatus.* A total of 119 species belonging to 47 families were found to be infested by *P. marginatus* including pulses, oilseeds, fibre crops, narcotics, green manures, vegetables, fruit trees, flower plants, tuber crops, ornamentals, plantation crops, medicinal plants, biofuel crops, tree species and weeds. The alternate hosts and natural enemies from different mealy bug species of cotton are listed below (**Table 53**)

Table 53. Alternate hosts and natural enemies of cotton mealy bugs

Sl. No.	Species of Mealy bug	Alternate Host Plants	Natural enemies recorded
1	*Phenacoccus solenapsis*	cotton, sunflower, brinjal, tomato, bhendi, cucurbits, pulses calotropis, datura and parthenium,	*Aenasius bambawalei* Hayat (Encyrtidae: Hymenoptera),*Cryptolaemus montrouzieri* (Mulsant) (Coleoptera: Coccinellidae) *Coccinella septumpunctata* (Coleoptera: Coccinellidae),*Chrysoperla zastrowi sillemi* Esben- Peterson (Neuroptera: Chrysopidae), *Spalgis epius* (Lycaenidae: Lepidoptera)
2	*Maconellicoccus hirsutus*	Cotton, bhendi, grapevine, guava, hibiscus, citrus, mulberry	*Anagyrus dactylopii* (Encyrtidae: Hymenoptera), *Scymnus coccivora* (Coleoptera: Coccinellidae) *Cryptolaemus montrouzieri* (Coleoptera: Coccinellidae), *Chrysoperla* sp (Neuroptera: Chrysopidae) *Spalgis epius* (Lycaenidae: Lepidoptera)
3	*Ferrisia virgata*	Cotton, tapioca, custard apple, guava, brinjal, hibiscus	*Cryptolaemus montrouzieri* Mulsant (Coleoptera: Coccinellidae), *Cheilomenus sexmaculatus* (Fabricius) (Coleoptera: Coccinellidae), *Coccinella transversalis*(Fabricius) (Coleoptera: Coccinellidae), *Scymnus coccivora* Ayyar (Coleoptera: Coccinellidae), *Mallada* sp

			(Neuroptera: Chrysopidae)
4	*Paracoccus marginatus*	Papaya, tapioca, *Plumeria alba*, *Jatropha curcas* and *Psidium guajava,* mulberry, almost all vegetables, flower crops, parthenium, teak, rain tree and *Prosopis.*	*Acerophagus papayae* Noyes & Schauff (Hymenoptera: Encyrtidae), *Spalgis epius* Westwood (Lepidoptera: Lycaenidae) *Cryptolaemus montrouzieri* Mulsant (Coleoptera: Coccinellidae), *Scymnus coccivora* Ayyar (Coleoptera: Coccinellidae), *Chrysoperla zastrowi sillemi* Esben- Peterson (Neuroptera: Chrysopidae), *Brumoides suturalis* Fabricius (Coleoptera: Coccinellidae), *Cheilomenus sexmaculatus* (Fabricius) (Coleoptera: Coccinellidae), *Hormonia octomaculata* (Coleoptera: Coccinellidae), *Coccinella transversalis* (Fabricius) (Coleoptera: Coccinellidae)

2. Monitoring the diversity and outbreaks of sap sucking pests, mirids and their natural enemies in *Bt* cotton (MPKV, UAS-Raichur)
MPKV

The *Bt* cotton var. Ankur, Bollgard II was raised separately on the research farm of College of Agriculture, Pune. Seeds were sown on 24th July 2012 on ridges and furrows at 90 x 75 cm spacing in 40 x 40 m size plots. All the recommended agronomic practices were followed except pesticide application. The sucking pests and natural enemies were recorded from randomly selected but tagged 25 plants from the plot at fortnightly interval. The pest population was recorded from three leaves (top, middle and lower portion) per plant. Similarly, mirids and natural enemies were also recorded on the plant.

The incidence of aphids was recorded from 1st week of August 2012 (33rd MW), whereas jassids, thrips and white flies were observed during 3rd week of August 2012 (35th MW). Mites were noticed from 4th week of September 2012 (40th MW). Initially, the pests' population was low but it was increased gradually from 40th MW. The peak incidence of jassids and thrips was recorded during 1st week of November 2012 (46th MW) and white flies in subsequent fortnight (48th MW). The aphid population was noticed maximum during 2nd week of January 2013 (2nd MW). The mealy bug incidence and mirids were not observed throughout the crop growth period. The natural enemies coccinellids *Menochilus sexmaculata* Fab., *Coccinella septempunctata* Linn. and spiders were recorded from 1st week of September 2012 and their population recorded maximum during 3rd week of November 2012 (48th MW). The chrysopid *Chrysoperla zastrowi sillemi* Esb. observed from the last week of September (40th MW). All these predators were recorded till harvest of the crop. Besides, the farmers' plots were also surveyed from September to November 2012 but the incidence of all these sucking pests was comparatively low in *Bt* cotton plots due to stress conditions during this year (**Table 54**).

Table 54. Incidence of sucking pests and their natural enemies in *Bt* cotton

Date of record	Av. population / 3 leaves / plant								
	Aphids	Jassids	Thrips	White flies	Mealy bug	Mites	Chrysopid	Coccinellids	Spiders
7.8.12	0.28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21.8.12	1.24	2.72	0.40	0.16	0.0	0.0	0.0	0.0	0.0
7.9.12	0.60	2.52	3.90	0.24	0.0	0.0	0.0	0.24	0.08
24.9.12	0.68	0.92	0.40	0.08	0.0	0.20	0.04	0.24	0.24
8.10.12	1.76	2.80	1.49	0.16	0.0	0.28	0.12	0.40	0.24
23.10.12	3.48	7.60	4.12	0.48	0.0	0.52	0.40	0.28	0.20
7.11.12	3.52	10.04	6.20	1.76	0.0	0.60	0.56	0.36	0.16
23.11.12	4.24	3.00	3.80	4.08	0.0	0.88	0.40	0.60	0.72
8.12.12	2.90	2.50	2.00	0.24	0.0	0.64	0.40	0.48	0.56
23.12.12	4.64	1.20	0.96	0.44	0.0	0.64	0.36	0.24	0.32
9.01.12	8.28	1.92	2.68	0.08	0.0	1.24	0.0	0.16	0.64
25.01.12	4.84	1.16	2.76	0.32	0.0	2.16	0.08	0.56	0.60

UAS-Raichur

Among various sucking insect pests, leafhoppers was maximum during September to October month whereas moderate during August month. Thrips population reached peak during August and was low during December month. In general whiteflies population was low during the season. Maximum mirid bug population was recorded in December month. Similarly the activity of mealy bug was noticed on first week of December and continued till January and the peak activity of parasitoid was noticed on January Second week (**Table 55**).

Table 55. Incidence of sucking pests and predators at Main Agricultural Research Station, Raichur during 2012-2013.

Standard weeks	Sucking pests									
	Thrips/3 leaves	Leafhoppers/ 3 leaves	Aphids / 3 leaves	Whiteflies / 3 leaves	Miridbugs /10 squares	Mealy bug infested plants (%)	No. of mealybugs/2.5 cm shoot	Red cotton bug/plant	Predators/ plant	
									Spiders	Coccinellids
August										
33	6.24	10.07	0.04	0.00	0	0	0	0	0.11	0.00
34	16.57	20.21	0.07	0.00	0	0	0	0	0.18	0.00
35	18.67	27.48	0.00	0.00	0	0	0	0	0.22	0.14
September										
36	9.47	28.47	0.00	0.00	0	0	0	0	0.38	0.05
37	9.02	30.80	0.18	0.00	0	0	0	0	0.24	0.00
38	8.41	27.00	0.37	0.34	0	0	0	0	0.20	0.20
39	6.14	26.37	0.00	0.18	0	0	0	0	0.14	0.14
October										
40	4.24	23.21	0.24	0.00	0	0	0	0	0.48	0.16
41	2.69	21.57	0.06	0.40	0	0	0	0	0.32	0.18

42	1.62	22.97	0.00	0.27	0	0	0	0	0.18	0.10
43	2.50	18.27	0.00	0.82	0	0	0	0.14	0.23	0.00
44	2.68	17.21	1.68	0.89	0	0	0	0.22	0.52	0.06
November										
45	1.17	14.22	1.97	0.52	0.21	0	0	0.41	0.22	0.18
46	0.97	8.74	2.07	0.00	0.68	0	0	0.46	0.54	0.00
47	1.04	7.10	2.14	0.82	2.86	0	0	1.32	0.52	0.24
48	1.59	6.18	1.88	1.07	2.27	0	0	1.07	0.72	0.34
December										
49	0.88	5.28	1.22	1.10	1.92	2.00	0.89	1.21	0.47	0.29
50	0.94	5.00	1.26	1.28	2.05	8.00	3.47	0.98	0.88	0.41
51	0.54	3.08	1.57	1.51	2.19	16.00	4.22	1.16	0.98	0.38
52	0.77	1.57	1.25	0.88	2.33	16.00	6.49	1.28	0.48	0.54
January										
1	1.78	1.12	1.08	0.76	1.57	16.00	8.91	2.12	0.52	0.26
2	2.02	1.92	1.00	0.60	1.59	24.00	12.71	1.74	0.22	0.38
3	2.17	2.04	0.72	0.48	1.04	24.00	16.62	1.60	0.31	0.19
4	1.87	2.33	0.67	0.32	1.47	24.00	18.24	2.12	0.27	0.24

* Average of 25 plants

2.5. Tobacco

1. Survey and record of bio control agents (insects, pathogens) on *Orobanche* spp. (CTRI)

Orobanche was free of any insect pests and diseases

2. Natural enemies of aphids infesting different types of tobacco cultivated in different regions of the country (CTRI)

A survey was conducted at Vadisaleru, Katheru,Kunavaram, Raghudevapuram Kalavacherla and Jeelugumilli villages of East/ West Godavari districts between Dec to Feb 2012-13 on tobacco. The nymphs and adults of *M. persicae* were observed for natural enemies on 50-70 days old crop. The following natural enemies were associated with aphids *Myzus nicotianae* infesting FCV, Lanka, natu and burley tobaccos: *Chielomenes sexmaculata, Coccinella repanda* (Coleoptera: Coccinellidae): *Nesidiocoris tennuis* (Hemiptera: Miridae).

2.6. Rice

1. Seasonal abundance of predatory spiders in rice ecosystem (AAU-A, AAU-J, ANGRAU, KAU, TNAU)

AAU-A

Collection was made during morning hours during *Kharif* season. Population dynamics of the predatory spiders was worked out using quadrate method. Five fields of paddy were randomly selected from the intense paddy growing area. Spiders were collected from five quadrates (1×1m each) from each field at weekly interval. Conspicuous spiders through size colour and webs on the top of the plant were collected first. Later, each plant was searched from top to bottom on leaves, tillers and panicles for spiders. Ground area near each plant within the quadrate was searched. Collected specimens were preserved in 70% ethanol with proper labelling of locality, date and area of the field. Five pitfall traps on each border (20/field) were installed in each field. Data collected were subjected to diversity analyses. A total of 36 species were collected. Highest species richness was observed for *Neoscona theisi* (133) and *Leucauge sp.* (133) followed by *Cyrtophora cicatrosa* (72), *Argiope sp.* (72), *Tetragnatha javana* (72) and *Argiope anasuja* (65), *Leucauge decorate* (65) as evident from **Table 56**.

Table 56. Species richness of spiders in paddy

Spider species	Richness	Spider species	Richness
Cyrtophora cicatrosa	72	*Leucauge decorate*	65
Neoscona theisi	133	*Leucange celebesiana*	72
Cyrtophora sp.	11	*Zygeilla malanostoma*	1
Argiope anasuja	65	*Tetragnatha virescens*	5
Argiope sp.	72	*Tetragnatha mandibulata*	23
Gibbaranea bituberculata	1	*Pardosa pseudoannulata*	2
Neoscona excelsus	5	*Pardosa sp.*	3
Neoscona sp.	23	*Pardosa birmanica*	1
Neoscona mukerjei	1	*Pardosa altitudis*	1
Larinia sp.	6	*Marpissa sp.*	1
Araneus sp.	1	*Phidippus pateli*	2
Argiope aemula	1	*Oxyopes sp.*	9
Gea corbetti	1	*Oxyopes swetae*	10
Larinia tyloridia	2	*Oxyopes ratnae*	6
Argiope pradhani	2	*Peucetia sp.*	6
Tetragnatha javana	72	*Clubiona sp.*	1
Leucauge sp.	133	*Olios sp.*	1
Tetragnatha sp.	11	*Olios wroughtoni*	2

Species diversity (H') was computed using Shannon-weiner index as 2.43**.** Species evenness or equitability (E) calculated using Kreb's formula was 0.678. Total spider density was calculated. The data was converted to $\sqrt{x+1}$ transformation and subjected to ANOVA using CRD and finally DNMRT.

A total 478 predatory spiders specimens were collected and identified from different paddy growing sites of middle Gujarat region. They were classified under seven families *viz*., Araneidae, Oxyopidae, Tetragnathidae, Theridiidae, Lycosidae, Thomisidae and Salticidae and 36 species. Among the different species of predatory spiders, Araneidae found to be predominant species followed by tetragnathidae and salticidae (**Table 57& 58**).

Table 57: Collection of spiders in paddy field

Field	No. of spider/plots	Field	No. of spider/plots
1	2.22 (4.44)	20	1.31 (1.22)
2	2.20 (4.36)	21	1.59 (2.04)
3	2.18(4.27)	22	1.25(1.06)
4	2.34 (4.99)	23	1.82(2.82)
5	2.49 (5.72)	24	1.73(2.49)
6	2.02 (3.59)	25	1.82(2.82)
7	2.52 (5.86)	26	1.66(2.25)
8	1.82 (2.82)	27	1.79(2.72)
9	2.19 (4.29)	28	1.68(2.33)
10	2.36 (5.07)	29	1.67(2.27)
11	2.19 (4.29)	30	1.69(2.37)
12	1.79 (2.72)	31	1.51(1.79)
13	1.90 (3.12)	32	1.45(1.59)
14	1.99 (3.47)	33	1.49(1.73)
15	2.03 (3.62)	34	1.54(1.87)
16	1.88 (3.02)	35	1.78(2.65)
17	1.87(2.98)	36	1.59(2.04)
18	1.49 (1.73)	37	1.51(1.79)
19	1.17 (0.86)		
SEM	**0.18**		
$CD_{0.05}$	**0.51**		

* Figures are $\sqrt{x+1}$ transformation transformed values whereas those in parentheses are retransformed values

Table 58: Families (No.) present in paddy ecosystem

S. No.	Family	Numbers
1	*Araneidae*	401
2	*Tetragnathidae*	32
3	*Lycosidae*	7
4	*Salticidae*	3
5	*Oxyopidae*	31
6	*Clubionidae*	1
7	*Sparassidae*	3
Total		**478**

AAU-J

The experiment was carried out in five different rice fields located in rice growing areas of Jorhat district during *kharif* season, 2012-13. To determine the diversity and fluctuation of predatory spiders, the samples were collected randomly from 10 quadrats (1x1m) from each field at weekly interval. Altogether 7 Nos. of predatory spiders' *viz*. *Oxyopes javanus, Tetragnattha sp., Lycosa psedoannulata, Argiope catanulata, Uluborous* spp. *Tomisus* spp*. Neoscona* spp .were observed in rice ecosystem. The population of predatory spiders was maximum during September to mid of October (2012). Among the different spiders *Oxyopes* spp. was recorded maximum followed by *Argiope spp*, *Tetragnatha spp* and *Lycosa spp. Oxyopes* spp. was the most dominant species during the cropping season (**Table 59**). Data collected from different rice field was analysed to know the Species richness, species diversity and species evenness for each predatory species.

Table 59: Population of spider (species wise) collected during kharif 2012(mid August to Nov. 2012)

Location	Predatory Spiders count							
	Oxyopes sspp.	***Tetragnatha spp.***	***Lycosa spp.***	***Argiope spp.***	***Ulubor-ous spp.***	***Tomisus spp.***	***Neoscona Spp.***	**Total**
Rajabahar	9.0	8.0	6.0	7.0	2.0	2.0	1.0	35.0
Pirakota	11.0	9.0	6.0	9.0	-	1.0	2.0	38.0
AAU farm	15.0	5.0	5.0	9.0	3.0	3.0	3.0	43.0
Titabor	12.0	5.0	6.0	10.0	1.0	-	-	34.0
Allengmara	10.0	7.0	6.0	6.0	-	-	1	30.0

Results

The richness of species of spider in the five different rice fields was not identical. The richness of spider population in five different rice fields was as follows

Field No. 1 (Rajabahar) 35 nos of species (Total collected species)
Field No. 2 (Pirakota) 38 Nos. of species
Field No. 3 (AAU farm) 43 nos. of species
Field No. 4 (Titabor) 34 nos. of species
Field No. 5 (Allengmora) 30 nos. of species

The species diversity (**Table 60**) using Shannon Weiner index method, indicated that more diversity of predatory spiders was observed in AAU farm (**$H^{/}$=1.74**) followed by Pirakota rice ecosystem (**$H^{/}$=1.57**). the diversity was found to be almost equal in case of Allengmara (**$H^{/}$=1.45**), Rajabahar (**$H^{/}$=1.40**) and Titabor rice field (**$H^{/}$=1.41**) respectively, during *kharif* Sali rice, 2012. In case of species evenness (E), the higher value of E (**0.4627**) in AAU rice field and Pirakota rice field (**0.4325**) showed less variation and low evenness in distribution of spiders. Community was quite even in distribution in case of Allengmara, Rajabahar and Titabor rice field with **0.4264, 0.3943** and **0.4005** evenness index (E), respectively (Table 64).

Table 60. Diversity indices of spiders in different locations of Rice Ecosystems

Location	Species richness	Species diversity	Species evenness
Rajabahar	35.0	1.40	0.3943
Pirakota	38.0	1.57	0.4325
AAU farm	43.0	1.74	0.4627
Titabor	34.0	1.41	0.4005
Allengmara	30.0	1.45	0.4264

ANGRAU

Collection was made during morning hours in kharif and rabi seasons of 2012-13 to access the population dynamics of the predatory spiders. Five fields of paddy were selected from the intense paddy growing area. All the spiders were collected from 10 quadrates (1×1m) from each field at weekly interval. Conspicuous spiders through size colour and webs on the top of the plant were collected first. Later, each plant was searched from top to bottom on leaves, tillers and panicles for spiders. Ground area near each plant within the quadrate was searched. Collected specimens were preserved in 70% ethanol with proper labelling of locality, date and area of the field. Five pitfall traps on each border (20/field) were installed in each field. Collections were made on alternate days. Adult males and females were identified up to spesies level with the help of available literature.

Nine genera of spiders were collected during the *kharif* seasons from five locations in Rajendranagar.Species (Genera) Richness was found to be 9. A total of nine genera were recorded. Species Diversity (Shannon Weiner Index) (H) was found to be 1.91.*Oxyopes* sp. was found to be the most abundant genus with a relative abundance of 0.27 followed by *Tetragnatha* sp. with a relative abundance of 0.25.*Neoscona* sp. was the least abundant with a relative abundance of 0.02.Species Evenness was 0.87.Spider Density ranged between 1.36 – 6.00/sq.m. with an average was 3.68/sq.m. In *rabi*, Species Diversity (Shannon Weiner Index)(H) was found to be 1.29. A total of 5 genera were recorded. *Tetragnatha* was found to be most abundant genus with a relative abundance of 0.41 followed by *Oxyopes* with an abundance of 0.3. *Thomisus* and *Atypena* were found to be least abundant with a relative abundance of 0.03. Spider density ranged from 12.28 – 17.76 spiders/sq.m.with an average of 15.02/sq.m (**Table 61 - 66**).

Table 61. Seasonal abundance of predatory spiders in rice ecosystem –Kharif, 2012

Date	Location	Tetragnatha	Clubiona	Pardosa	Oxyopes	Neoscona	Argiope	Thomisus	Atypena	Unknown	Total
7.9.12	Student farm	12	7	3	8	1	1	3	1	5	41
	College farm	15	5	3	11	1	0	0	0	2	37
	Farmers' field, Budvel	4	2	2	8	0	1	1	1	2	21
	ARI Rice field - 1	5	3	2	2	0	1	3	4	0	20
	ARI Rice field – 2	4	4	1	6	1	0	2	3	0	21
	Total	40	21	11	35	3	3	9	9	9	140
15.9.12	Student farm	5	2	2	6	1	2	2	2	1	23
	College farm	4	4	0	1	0	0	6	3		18
	Farmers' field, Budvel	15	11	1	9	2	0	0	0	0	38

	ARI Rice field - 1	9	10	4	6	0	0	2	2	0	33
	ARI Rice field - 2	13	10	0	8	0	0	2	1	1	35
	Total	46	37	7	30	3	2	12	8	2	147
26.9.12	Student farm	1	2	5	6	2	1	3	1	0	21
	College farm	9	1	0	10	0	0	1	0	0	21
	Farmers' field, Budvel	8	2	1	3	1	0	0	0	3	18
	ARI Rice field - 1	6	1	5	5	0	0	2	0	0	19
	ARI Rice field - 2	8	8	3	0	0	0	1	3	0	23
	Total	32	14	14	24	3	1	7	4	3	102
6.10.12	Student farm	11	2	2	2	0	5	0	4	1	27
	College farm	1	2	0	15	2	0	0	3	0	23
	Farmers' field, Budvel	1	0	3	10	2	0	12	4	1	33
	ARI Rice field - 1	2	7	2	9	2	2	2	2	1	29
	ARI Rice field - 2	6	0	1	11	0	0	3	2	0	23
	Total	21	11	8	47	6	7	17	15	3	135
16.10.12	Student farm	5	4	1	9	1	3	2	2	0	27
	College farm	1	12	7	12	2	3	0	0	5	42
	Farmers' field, Budvel	4	0	0	14	0	0	2	3	0	23
	ARI Rice field - 1	7	1	0	5	0	0	0	2	11	26
	ARI Rice field - 2	9	0	0	10	0	0	3	10	0	32
	Total	26	17	8	50	3	6	7	17	16	150
26.10.12	Student farm	5	2	1	8	2	2	2	1	2	25
	College farm	4	4	2	7	0	1	3	2	0	23
	Farmers' field, Budvel	2	2	1	6	0	1	2	3	0	17
	ARI Rice field - 1	3	0	0	9	0	1	0	1	0	14
	ARI Rice field - 2	4	0	0	3	2	0	1	2	0	12
	Total	18	8	4	33	4	5	8	9	2	91
6.11.12	Student farm	2	2	1	2	1	1	1	2	1	13
	College farm	4	1	0	4	1	1	2	1	0	14
	Farmers' field, Budvel	3	2	0	6	0	0	4	2	0	17
	ARI Rice field - 1	5	1	0	2	0	0	3	3	0	14
	ARI Rice field - 2	6	1	0	5	0	0	3	3	0	18
	Total	20	7	1	19	2	2	13	11	1	76
16.11.12	Student farm	5	3	1	4	0	2	3	2	2	22
	College farm	6	2	0	5	0	0	6	3	3	25
	Farmers' field, Budvel	3	5	0	7	0	0	7	5	0	27
	ARI Rice field - 1	7	3	0	2	0	0	2	0	0	14
	ARI Rice field - 2	9	7	0	4	0	0	9	0	0	29
	Total	30	20	1	22	0	2	27	10	5	117

Table 62. Diversity of spiders in Rajendranagar area during Kharif 2012

Spider genus	Abundance	Relative abundance	Natural logarithm (Ln)	(Ln)*Rel. abun
Tetragnatha	286	0.25	-1.39	-0.35
Clubiona	153	0.13	-2.02	-0.27
Pardosa	56	0.05	-3.02	-0.15
Oxyopes	305	0.27	-1.33	-0.35
Neoscona	27	0.02	-3.75	-0.09
Argiope	31	0.03	-3.61	-0.10
Thomisus	133	0.12	-2.16	-0.25
Atypena	104	0.09	-2.40	-0.22
Unknown	53	0.05	-3.08	-0.14
Total	**1148**			**H' = 1.91**

Table 63 : Seasonal abundance of predatory spiders in rice ecosystem - Rabi 2012

Date	Location	Tetragnatha	Clubiona	Pardosa	Oxyopes	Neoscona	Argiope	Thomisus	Atypena	Unknown	Total
26/11/2012	Student farm	7	4	1	3	1	1	3	2	0	22
	College farm	6	3	0	7	0	0	2	1	0	19
	Farmers' field, Budvel	9	4	0	9	0	0	1	2	4	29
	ARI Rice field -1	11	2	0	9	0	0	2	3	0	27
	ARI Rice field -2	5	0	0	3	0	0	3	0	0	11
	Total	38	13	1	31	1	1	11	8	4	108
6/12/2012	Student farm	2	1	1	4	1	0	2	3	2	16
	College farm	2	1	0	2	0	0	3	2	0	10
	Farmers' field, Budvel	3	2	0	2	0	0	1	3	0	11
	ARI Rice field -1	2	1	0	2	0	0	2	0	0	7
	ARI Rice field -2	1	0	0	2	0	0	1	0	0	4
	Total	10	5	1	12	1	0	9	8	2	48
26/12/2012	Student farm	1	0	0	0	1	2	3	1	6	48
	College farm	1	0	0	0	0	0	5	1	0	14
	Farmers' field, Budvel	1	0	0	0	0	0	2	2	0	7
	ARI Rice field -1	1	0	0	0	0	0	3	1	0	5
	ARI Rice field -2	1	0	0	2	0	0	0	0	0	5
	Total	5	0	0	2	1	2	13	5	6	34

Table 64. Diversity of spiders in Rajendranagar area during rabi 2012

Spider genus	Abundance	Relative abundance	Natural logarithm (Ln)	(Ln)*Rel. abun
Tetragnatha	970	0.41	-0.90	-0.37
Pardosa	549	0.23	-1.47	-0.34
Oxyopes	706	0.30	-1.22	-0.36
Thomisus	77	0.03	-3.43	-0.11
Atypena	80	0.03	-3.39	-0.11
Total	**2382**			**H' =Σ(Ln)*(Rel. abundance) = 1.29**

Species Diversity of Spiders in rabi season in Rajendranagar = 1.29
Species Richness = 5
Species Evenness = 0.75
Spider density = 12.48-17.76 spiders/sq.m.

Table 65. Seasonal abundance of predatory spiders in rice ecosystem – *Rabi* 2013

Date of collection	Location	*Tetragnatha*	*Pardosa*	*Oxyopes*	*Thomisus*	Atypena	Total
7/2/2013	Student farm	32	33	17	2	3	87
	College farm	32	23	16	4	5	80
	Farmers' field, Budvel	41	21	17	5	6	90
	ARI Rice field -1	23	30	14	2	3	72
	ARI Rice field – 2	18	19	17	10	0	64
	total	146	126	81	23	17	393
17/2/2013	Student farm	23	21	13	3	2	62
	College farm	34	23	26	1	4	88
	Farmers' field, Budvel	35	18	19	0	2	74
	ARI Rice field -1	26	23	22	0	1	72
	ARI Rice field -2	34	16	25		3	78
	Total	129	80	92	1	10	312
27/2/2013	Student farm	35	23	12	1	1	72
	College farm	38	24	23	2	3	90
	Farmers' field, Budvel	39	29	17	1	1	87
	ARI Rice field -1	45	19	34	2	2	102
	ARI Rice field -2	34	21	23	5	1	84
	Total	191	116	109	11	8	435

Table 66. Seasonal abundance of predatory spiders in rice ecosystem – *Rabi* 2013

10/3/2013	Student farm	24	22	34	4	2	86
	College farm	34	21	32	8	1	96
	Farmers' field, Budvel	22	34	12	7	2	77
	ARI Rice field -1	12	35	29	6	2	84
	ARI Rice field -2	17	22	22	9	3	73
	Total	109	134	129	34	10	416
20/3/2013	Student farm	32	12	23	2	2	71
	College farm	33	14	26	3	3	79
	Farmers' field, Budvel	45	23	27	4	2	101
	ARI Rice field -1	47	12	37	5	3	104
	ARI Rice field -2	39	17	31	1	1	89
	Total	196	78	144	15	11	444
	Student farm	48	14	23	2	4	91
30/3/2013	College farm	37	12	24	1	5	79
	Farmers' field, Budvel	27	11	21	1	6	66
	ARI Rice field -1	39	18	21	2	7	87
	ARI Rice field -2	36	12	20	1	2	71
	Total	187	67	109	7	24	394

KAU

Three paddy fields were selected from intense paddy growing areas *viz*., Koorkkenchery and Mannuthy of Thrissur district. The first two plots were at Koorkkenchery where IPM was practicing for the management of crop pests for the last 10 years. The second plot was at Mannuthy, where the application of insecticides was a usual practice for controlling insect pests. For taking observations on the number of spiders, four pitfall traps were installed in each field. Counts on the number of spiders from each trap were taken seven days after installation and were preserved in70 per cent alcohol. The observations were taken at three stages tillering stage, panicle initiation, flowering stage. Ten species of spiders were identified and represented in the table below. *Pardosa pseudoannulata* was seen in large numbers (**Table 67- 70**).

Table 67. Spiders collected and identified from rice fields

Sl. No.	Species	Family
1	*Pardosa sumatrana*	Lycosidae
2	*Pardosa pseudoannulata*	Lycosidae
3	*Pardosa shyamae*	Lycosidae
4	*Pardosa birmanica*	Lycosidae
5	*Oxyopes javanus*	Oxyopidae
6	*Trochosa punctipes*	Lycosidae
7	*Crocodilosa sp.*	Lycosidae
8	*Tetragnatha mandibulata*	Tetragnathidae
9	*T. maxillosa*	Tetragnathidae
10	*Araneus ellipticus*	Araneidae

Species richness, Diversity index and Evenness index were worked out for different locations in different stages of the crop.

Table 68. Location: Koorkkenchery 1

Crop stage	Species richness	Shannon-Weiner diversity index (H)	Evenness index (J)
Tillering stage	3	0.802	0.730
Panicle initiation	2	0.562	0.811
Flowering stage	3	1.04	0.947

Table 69. Location: Koorkkenchery 2

Crop stage	Species richness	Shannon-Weiner diversity index (H)	Evenness index (J)
Tillering stage	3	0.381	0.347
Panicle initiation	3	0.825	0.751
Flowering stage	4	1.27	0.916

Table 70. Location: Mannuthy

Crop stage	Species richness	Shannon-Weiner diversity index (H)	Evenness index (J)
Tillering stage	4	1.31	0.995
Panicle initiation	2	0.50	0.721
Flowering stage	1	0	0

It is noticed that the incidence of spiders was very low in the flowering stage in Mannuthy area.

TNAU

Collection of spiders was made during morning hours in Kharif and summer seasons.

Population dynamics of the predatory spiders was worked out using quadrate method.

Methodology

1. Five fields of paddy was randomly selected from the intense paddy growing area.
2. All the spiders collected from 10 quadrates (1×1m) from each field at weekly interval. Conspicuous spiders through size colour and webs on the top of the plant were collected first. Later, each plant was searched from top to bottom on leaves, tillers and panicles for spiders. Ground area near each plant within the quadrate was searched. Collected specimens were preserved in 70% ethanol with proper labelling of locality, date and area of the field.
3. Five pitfall traps on each border (20/field) was installed in each field. Collections were made on alternate days.
4. Data collected were subjected to analyses.

Species richness will be calculated using formula

Species richness (S) = number of species collected

Species diversity (H') will be computed using Shannon-weiner index of diversity

$$\text{Species diversity (H')} = - \sum_{i=1}^{k} p_i \ln p_i$$

where, p_i = Proportion of ith species in the total sample

$p_i = f_i/n$

n = Total number of specimen in the sample

f_i = Number of specimen of the ith species

k = total number of species

ln = natural logarithm ($\log_e$)

Species evenness or equitability (E) will be calculated using Kreb's formula

$$E = \frac{H}{H'_{max}}$$

Where, H'_{max} = natural logarithm of the number of species present

$0 < E \leq 1$, the maximum value being possible in a community in which all species are equally abundant

Any logarithmic base i.e. e, 10 and 2 may be used to compute H' and E, evenness value will remain the same.

Total spider density will be calculated. The data shall be subjected to

$\sqrt{x+1}$ transformation and subjected to ANOVA using CRD and finally DNMRT

Comparison between the seasons and comparison with the data available of the year 2012 was worked out.

The spiders *viz*., *Lycosa pseudoannulata, Oxyopes javanus, Tetragnatha sp.* and *Argiope catanulata* were observed in the rice ecosystem. The occurrence of spiders was more during rabi season than on kharif. Among the spiders, *Lycosa pseudoannulata* was found maximum followed by *Oxyopes javanus* and *Tetragnatha sp. Argiope catanulata* was recorded in few numbers.

The analysis of spider diversity through Shanon- Weiner method indicated that more number of diversity of spider species occurred during the milking stage of the crop (56 DAT = 1.1798 (Table 6) during the Kharif 2012 season and during tillering stage (77 DAT) in Rabi 2012-13 season (1.2027). Regarding the species richness, more of species diversity was recorded during the vegetative phase and tillering period in kharif 2012. During Rabi, more of species diversity was recorded during the early vegetative stage and nearing maturity stage. In general the richness of species was more during Rabi as compared to Kharif season (**Table 71**).

Table 71. Diversity indices of spiders in different crop stages of paddy

Crop stages/ Days After Sowing		No. of species recorded		Richness index (Margalef)		Diversity (Shannon-Weiner)		Evenness (Equitability J)	
		Kharif 2012	Rabi 2013	Kharif 2012	Rabi 2013	Kharif 2012	Rabi 2013	Kharif 2012	Rabi 2013
Vegetative	7	1	4	0	1.674	0	1.2425	0	0.8962
	14	1	4	0	1.207	0	1.3086	0	0.9440
	21	2	4	0.5581	1.1078	0.4506	1.0776	0.3250	0.7773
	28	3	4	0.8049	0.9706	0.9596	1.2112	0.6922	0.8737
	35	4	4	1.038	0.8656	1.0588	1.1052	0.7638	0.7973
	42	3	4	0.6676	0.8656	0.8237	1.0103	0.5942	0.7288
Milking	48	4	4	0.8656	0.8079	1.1052	1.0104	0.7973	0.7289
	56	4	4	0.8189	0.7388	1.1798	1.1678	0.8511	0.8424
	63	4	4	0.7976	0.6949	1.0917	1.1854	0.7875	0.8551
	70	4	4	0.9102	0.6789	0.8201	1.1767	0.5915	0.8488
Tillering	77	4	4	1.082	0.7486	0.9508	1.2027	0.6858	0.8676
	84	3	4	0.8341	0.8909	0.7596	1.1406	0.5480	0.8228
	91	1	3	0	1.0278	0	0.9557	0	0.6894

2. Evaluation of IPM for upland rice pest and diseases (CAU)

CAU

The experiment was carried out at three locations of East Siang District of Arunachal Pradesh, viz. Sille, Pasighat and Mebo during *kharif*, 2012. In each location three treatments viz. IPM practice, farmer's practice and untreated control were maintained and each treatment was replicated three times. The local high yielding rice cultivar 'Itanagar' was used for the experiment. The IPM practice includes- seed treatment with *Pseudomonas florescence* (Su-mona, Pest Control India Limited, Mumbai) @ 5gm/ kg of seed; installation of yellow stem borer trap from 40 days after transplanting (DAT) @ 15 traps / ha; spraying of entomopathogenic nematode (EPN) (CAU-1) at 40,50, 60 and 70 DAT and installation of fermented snail trap from 85 DAT @ 20 traps/ ha area. Farmer's Practice includes seed treatment with carbendazim @ 2gm/ kg of seed, spraying of 0.05% profenophos/ monocrotophos at 40, 55, 70 and 85DAT. The stem borers (*Chilo suppressalis*, *Scirpophaga incertulas* and *Sesamia inferens*) infestation was recorded at 45, 55, 65, 75 and 85 DAT as per cent dead heart(DH)/ white ear head (WEH) from randomly selected 10 hills per plot. The gundhi bug (*Leptocorisa oratorius*) was recorded as per cent damage grain from 10 randomly selected panicles/ plot at 95 and 105 DAT.

At Sille, no significant difference was observed between IPM practice and untreated control in stem borer infestation during the vegetative stage of the crop.

However, at later stage of the crop (reproductive stage) the per cent white earhead (WEH) in the IPM field was significantly lower than the untreated control (6.08 per cent WEH). Lowest incidence of stem borer was recorded in the farmer's practice field. At Pasighat, significantly lower infestation of stem borers in the IPM field than the untreated control was recorded from 65 DAT (days after transplanting) onward. Similar with the observation at Pasighat, significantly lower incidence of stem borers in the IPM field than the untreated control was recorded from 65 DAT onward at Mebo. At 85 DAT, the incidence of stem borers in the IPM field (2.37 per cent WEH) was even comparable with the farmer's practice field (1.41 per cent WEH).

No significant difference was observed between the farmer's practice and IPM practice in the infestation of rice gundhi bug in all the three locations except at 105DAT at Sille. However, the mean per cent grain infestation between the farmer's practice and IPM practice were comparable in all the locations. Significantly higher infestation of rice gundhi bug was recorded in the untreated control than the other two treatments. Highest grain yield of 46.55q/ha was recorded in farmer's practice field and it was closely followed by IPM practice (43.65q/ha) at Sille. Similarly, at Mebo also, the grain yield of Farmer's practice (42.51q/ha) was comparable with the IPM (40.66q/ha). However, at Pasighat, Farmers practice (43.84q/ha) gave significantly higher yield than the IPM practice (40.37q/ha) (**Table 72-77**).

Table 72. Stem borer infestation at Sille during the cropping period *kharif*, 2012

Treatment	% dead heart				%white ear head			Grain Yield in q/ha
	45DAT	55DAT	65DAT	Mean	75DAT	85DAT	Mean	
IPM Practice	2.05 (8.04)	3.77 (11.30)	4.27 (11.96)	3.36 (10.43)	3.50 (10.81)	2.69 (9.41)	3.10 (10.11)	43.65
Farmer's practice	2.02 (7.96)	1.47 (6.95)	1.79 (7.60)	1.76 (7.50)	1.69 (7.48)	1.13 (6.01)	1.41 (6.75)	46.55
Control	1.98 (8.02)	3.79 (11.44)	6.35 (14.57)	4.04 (11.34)	6.83 (15.15)	5.32 (13.42)	6.08 (14.29)	40.07
SEd±	1.51	0.61	0.99	1.51	0.51	0.76	0.12	1.71
$CD_{0.05}$	NS	1.71	2.75	4.19	1.41	2.12	0.34	4.74

Figures in the parentheses are angular transformed values.

Table 73. Stem borer infestation at Pasighat during the cropping period *kharif*, 2012.

Treatment	% dead heart				%white ear head			Grain Yield in q/ha
	45DAT	55DAT	65DAT	Mean	75DAT	85DAT	Mean	
IPM	1.80 (7.04)	4.19 (11.82)	3.53 (10.82)	2.93 (9.89)	3.55 (10.87)	2.77 (9.60)	3.16 (10.23)	40.37
Farmer's practice	2.31 (8.70)	1.43 (6.79)	1.60 (7.21)	1.78 (7.57)	1.66 (7.21)	1.13 (6.80)	1.40 (7.01)	43.84
Control	2.22 (8.57)	5.23 (13.20)	5.99 (14.18)	4.48 (11.98)	6.71 (15.00)	6.05 (14.25)	6.38 (14.63)	37.33
SEd±	0.55	0.50	0.69	1.80	0.65	0.58	0.31	1.09
$CD_{0.05}$	NS	1.39	1.90	5.00	1.81	1.61	0.85	3.04

Figures in the parentheses are angular transformed values.

Table 74. Stem borer infestation at Mebo during the cropping period *kharif*, 2012.

Treatment	% dead heart				%white ear head			Grain Yield in q/ha
	45DAT	55DAT	65DAT	Mean	75DAT	85DAT	Mean	
IPM	1.84 (7.83)	3.07 (10.09)	4.20 (11.82)	3.04 (9.91)	4.13 (11.72)	2.37 (8.75)	3.25 (10.23)	40.66
Farmer's practice	2.01 (7.96)	1.08 (5.97)	2.29 (8.69)	1.79 (7.54)	1.72 (7.48)	1.41 (6.78)	1.57 (7.13)	42.51
Control	2.18 (8.52)	3.77 (11.22)	7.02 (15.38)	4.32 (11.71)	6.83 (15.15)	5.94 (14.09)	6.39 (14.62)	36.49
$CD_{0.05}$	NS	2.12	1.66	3.54	0.98	2.73	2.40	3.54

Figures in the parentheses are angular transformed values.

Table 75. Rice gundhi bug infestation at Sille during the cropping period *kharif*, 2012.

Treatment	% infested grain			Yield Grain Yield in q/ha
	95DAT	105DAT	Mean	
IPM	1.00(5.67)	1.12(6.07)	1.06(5.87)	43.65
Farmer's practice	1.02(5.79)	0.96(5.59)	0.99(5.69)	46.55
Control	1.92(7.97)	2.00(8.13)	1.96(8.05)	40.07
$CD_{0.05}$	1.50	0.28	0.59	4.74

Figures in the parentheses are angular transformed values.

Table 76. Rice gundhi bug infestation at Pasighat during the cropping period *kharif*,2012.

Treatment	% infested grain			Yield Grain Yield in q/ha
	95DAT	105DAT	Mean	
IPM	0.83(5.22)	0.99(5.71)	0.91(5.47)	40.37
Farmer's practice	0.64(4.54)	0.92(5.50)	0.78(5.02)	43.84
Control	1.73(7.63)	1.93(7.99)	1.83(7.81)	37.33
$CD_{0.05}$	1.08	0.50	0.62	3.04

Figures in the parentheses are angular transformed values.

Table 77. Rice gundhi bug infestation at Mebo during the cropping period *kharif*, 2012.

Treatment	% infested grain			Grain Yield in q/ha
	95DAT	105DAT	Mean	
IPM	1.09(5.99)	1.07(5.91)	1.08(5.95)	40.66
Farmer's practice	0.99(5.69)	1.00(5.70)	1.00(5.70)	42.51
Control	2.10(8.33)	2.06(8.25)	2.08(8.29)	36.49
$CD_{0.05}$	0.41	0.87	0.10	3.54

Figures in the parentheses are angular transformed values.

3. Field evaluation of *Trichogramma chilonis* (produced using Eri-silk worm eggs as factitous host) against Rice stem borer (CAU).

Trichogramm chilonis in Eri-silk worm egg was received, however, all the *T. chilonis* was emerged and died when it was received due to delay in postal delivery.

2.7. Pulses

1. Evaluation of NBAII liquid formulations (PDBC-BT1 and NBAII-BTG4) and IARI *Bt* against pigeon pea pod borer (*Helicoverpa armigera*) and legume pod borer (*Maruca testulalis*) (AAU-A, ANGRAU, MPKV, PAU, TNAU, JNKVV, UAS-Raichur)

AAU-A

Year of commencement : 2012
Season and year : *Kharif* –2012
Treatments
: 11

1. PDBC-BT1 @ 1% spray
2. PDBC-BT1 @ 2% spray
3. NBAII-BTG4 @ 1% spray
4. NBAII-BTG4 @ 2% spray
5. IARI *Bt* isolates @ 1% spray
6. IARI *Bt* isolates @ 2% spray
7. *Beauveria bassiana* @ 1.5kg/ha
8. *Beauveria bassiana* @ 2.0kg/ha
9. NSKE 5%
10. Chlorpyriphos @ 0.04 % spray
11. Control

Replications **:** 3
Design **:** RBD
Crop and variety **:** Pigeonpea, BDN-2
Spacing **:** 90 x 20 cm
Plot size **:** Gross: 5.4 x 4.0 m
Net : 3.6 x 3.6 m

Spray schedule: Three sprays (pre flowering, post flowering and pod emergence)

Results: Larval population and pod damage recorded before impose of insecticidal treatments showed non-significant difference.

(1) Larval population of *H. armigera*

Larval population of *H. armigera* recorded at 7 and 14 days after treatment (DAT) indicated that minimum number of larvae was registered in plots treated with NBAII-BT G4 @ 1% followed by chemical insecticide, PDBC-BT-1 @ 2%, NBAII-BT G4 @ 2%, IARI *Bt* isolate @ 2%, and IARI *Bt* isolate @ 1%. All the *Bt* based formulations performed equally effective against *H. armigera*. The pooled results for 3 sprays indicated that all the treated plots registered significantly less number of *H. armigera* larvae than the untreated control. All the microbial insecticides found equally effective in suppressing the incidence of the pest, however, relatively lesser population of *H. armigera* larvae was found in PDBC-BT1, IARI *Bt* isolates, and NBAII-BT G4 sprayed at 2% concentration.

(2) Pod damage

All the *Bt* based treatments performed equally effective and found comparable with the treatment of chemical insecticide at 14 DAT. The pod damage (7.92 to 58.92 %) recorded at harvest showed that the treatments of NBAII-BT G4 @ 1%, NBAII-BT G4 @ 2 %, PDBC-BT1 @ 2% and IARI *Bt* isolate @ 1 and 2% found equally effective,

(3) Grain damage and yield

Grain damage (**Table 78**) recorded at harvest revealed that the plots treated with chemical insecticide registered significantly low incidence of *H. armigera* in comparison to microbial insecticides. All the *Bt* based microbial insecticides exhibited grain damage ranging from 7.62 to 10.77% and found at par. *B. bassiana* applied @ 1.5 and 2.0 kg/ha proved inferior in suppressing the pest incidence. Maximum grain yield (1832 kg/ha) yield was registered in plots treated with chemical insecticide followed by NBAII-BT G4 2% (1750 kg/ha) and 1% (1695 kg/ha). Both the doses of NBAII-BT G4 produced significantly higher yields than *Beauveria bassiana* and NSKE @ 5%.

ANGRAU

Treatments : 11

1. PDBC-BT1 @ 1% spray
2. PDBC-BT1 @ 2% spray
3. NBAII-BTG4 @ 1% spray
4. NBAII-BTG4 @ 2% spray
5. IARI *Bt* isolates @ 1% spray
6. IARI *Bt* isolates @ 2% spray
7. *Beauveriabassiana* @ 1.5kg/ha
8. *Beauveriabassiana* @ 2.0kg/ha
9. NSKE 5%
10. Chlorpyriphos @ 0.04 % spray
11. Control

Spray schedule: 3 sprays (pre flowering, post flowering and pod emergence)

Design: RBD, **Replications**: 3, **Crop / variety**: pigeon pea, **Spacing**: 30 x 10 cm (pigeon pea),

Plot size: 5 x 8 m.

Observations: % pod damage, % seed damage**,** Pest severity**,** Yield data

Results

The treatment with NBAII-BTG4 @ 2% spray proved promising with least larval count, lesser damage and better yields as compared to other treatments.

Table 78: Impact of different *Bt* formulations on pod and grain damage due to *H. armigera* in pigeonpea (AAU-A)

Sr. No.	Treatments	Pod damage (%)					Grain damage (%)					Yield (Kg/ha)
		Before Spray	7 DAT	14 DAT	At harvest	Pooled	Before Spray	7 DAT	14 DAT	At harvest	Pooled	
1	PDBC-BT1 @ 1 % spary	18.37* (9.93)	18.01 (9.56)	14.95 (6.66)	17.34 (8.88)	16.76 (8.32)	25.48 (18.51)	20.83 (12.64)	18.01 (9.56)	18.94 (10.54)	19.25 (10.87)	1250
2	PDBC-BT1 @ 2 % spary	18.05 (9.60)	18.37 (9.93)	14.92 (6.63)	16.68 (8.24)	16.65 (8.21)	26.41 (19.78)	19.95 (11.64)	16.75 (8.31)	16.02 (7.62)	17.57 (9.11)	1564
3	NBAII-BTG4 @ 1 % spary	18.71 (10.29)	18.74 (10.32)	16.04 (7.63)	16.34 (7.92)	17.04 (8.59)	24.85 (17.66)	19.59 (11.24)	18.19 (9.74)	18.72 (10.30)	18.83 (10.42)	1695
4	NBAII-BTG4 @ 2 % spary	18.37 (9.93)	19.05 (10.65)	15.31 (6.97)	16.40 (7.97)	16.92 (8.47)	23.87 (16.38)	19.31 (10.93)	15.92 (7.52)	16.95 (8.50)	17.39 (8.93)	1750
5	IARI *Bt* isolates @ 1% spray	19.00 (10.60)	19.27 (10.89)	15.31 (6.97)	17.38 (8.92)	17.32 (8.86)	24.42 (17.09)	19.94 (11.63)	18.25 (9.81)	19.16 (10.77)	19.11 (10.72)	1463
6	IARI *Bt* isolates @ 2% spray	18.09 (9.64)	19.61 (11.26)	14.56 (6.32)	17.07 (8.62)	17.08 (8.63)	25.39 (18.39)	21.40 (13.31)	17.75 (9.29)	18.88 (10.47)	19.34 (10.97)	1375
7	*Beauveria bassiana* @ 1.5 kg/ha	19.00 (10.60)	19.32 (10.95)	17.11 (8.66)	18.32 (9.88)	18.25 (9.81)	25.68 (18.78)	23.79 (16.27)	21.93 (13.95)	21.93 (13.95)	22.55 (14.71)	1068
8	*Beauveria bassiana* @ 2.0 kg/ha	17.76 (9.30)	18.73 (10.31)	17.76 (9.30)	18.71 (10.29)	18.39 (9.95)	26.53 (19.95)	20.51 (12.28)	19.25 (10.87)	20.13 (11.84)	19.96 (11.65)	1137
9	NSKE 5%	19.05 (10.65)	19.92 (11.61)	16.02 (7.62)	18.37 (9.93)	18.10 (9.65)	24.96 (17.81)	19.31 (10.93)	17.29 (8.83)	19.21 (10.83)	18.60 (10.17)	1092
10	Chlorpyriphos @ 0.04% spray	15.67 (7.30)	15.31 (6.97)	14.14 (5.97)	14.92 (6.63)	14.79 (6.52)	24.81 (17.61)	16.37 (7.94)	12.41 (4.62)	14.50 (6.27)	14.42 (6.20)	1832
11	Control	21.37 (13.28)	22.47 (14.61)	22.76 (14.97)	21.68 (13.65)	22.30 (14.40)	24.07 (16.63)	25.07 (17.95)	25.83 (18.98)	26.29 (19.62)	25.73 (18.85)	965
	S.Em.± T	1.22	1.01	1.11	1.10	0.59	2.32	0.90	1.35	1.74	0.73	166
	T x P	-	-	-	-	1.00	-	-	-	-	1.37	-
	C. D. at 5%	NS	2.99	3.28	3.25	1.67	NS	2.65	3.99	5.13	2.05	491.3
	T x P	-	-	-	-	NS	-	-	-	-	NS	
	C. V. %	1.46	9.25	11.85	10.86	10.59	15.96	7.57	12.78	15.71	12.29	20.88

* Arc sin transformed values, Figures in parentheses are retransformed values NS = Non Significant DAT = Days After Treatment

MPKV

A field experiment was conducted on the research farm of Botany Section, College of Agriculture, Pune. The pigeon pea seeds var. ICPL-87 was sown at 30 x 10 cm spacing in 8 x 5 m plots. The trial was laid out in RBD with nine treatments and three replications. The treatments comprised spraying of liquid formulations of *Bt* strains PDBC-BT1 @ 1 and 2%, NBAII-BTG4 @ 1 and 2%, *Beauveria bassiana* @ 1.5 and 2.0 kg/ha, NSKE 5%, chlorpyriphos 0.05% as standard chemical check and untreated control. Three sprays were given.

The results indicated that three sprays of chlorpyriphos 0.05% at fortnightly interval was significantly superior over other treatments in suppressing the larval population of *H. armigera* (av. 0.9 larva/plant) and *M. vitrata* (av. 2.1 larvae/plant) on pigeon pea and recorded minimum pod (11.4%) and seed (8.4%) damage with maximum 15.9 q/ha yield. It was however, at par with the *Bt* strain NBAII-BTG4 @ 2% in respect of pod damage (11.9%) and yield (14.4 q/ha). (**Table 79**).

Table 79. Effect of *Bt* formulations on pod damage and yield of pigeon pea

Treatment	Pod damage (%)	Seed damage (%)	Yield (q/ha)
T1: PDBC-BT1 @ 1%	19.5 ^{d}	17.3 ^{e}	13.1^{b}
T2: PDBC-BT1 @ 2%	14.7 ^{b}	11.9 ^{c}	14.3 ^{a}
T3: NBAII-BTG4 @ 1%	18.3 ^{c}	16.0 ^{d}	13.2^{b}
T4: NBAII-BTG4 @ 2%	11.9 ^{a}	10.5 ^{b}	14.4 ^{a}
T5: *B. bassiana* @ 1.5 kg/ha	25.2 ^{f}	22.1 ^{g}	10.3 ^{c}
T6: *B. bassiana* @ 2.0 kg/ha	22.1 ^{e}	20.0 ^{f}	10.2 ^{c}
T7: NSKE 5% suspension	20.4 ^{d}	17.8 ^{e}	11.1^{b}
T8: Chlorpyriphos 0.05%	11.4 ^{a}	8.4 ^{a}	15.9 ^{a}
T9: Untreated control	29.1 ^{g}	24.8 ^{h}	8.4^{c}
CD (p = 0.05)	0.82	0.81	2.40

PAU

The experiment was conducted at Entomological Research Farm, PAU Ludhiana in plot size of 100m^2 in randomized block design during 2012. There were ten treatments with four replications. These ten treatments were of liquid formulation of *Bacillus thuringiensis* Bt1 1%, Bt1 2%, NBAII-BtG4 1%, NBAII-BtG4 2%, *Beauveria bassiana* (Bb, Mycojaal) @ 1.5Kg/ha, *B. bassiana* (Bb, Mycojaal) @ 2.0Kg/ha, NSKE 5%, Chlorpyrifos 0.2%, Chlorpyrifos 0.04% and control.

The population of *H. armigera* larvae was lowest (0.33) in NBAII- BtG4 2% treated plot and was at par with NBAII- BtG4 1%, Bt1 1%, Bt1 2%, Bb @ 2.0Kg/ha and chemical control and were significantly better than other treatments. Lowest per cent pod damage (8.0%) due to *Maruca testulalis* was recorded in Bt1 2% which was at par with Bt1 1% (8.66%), NBAII- BtG4 1% (9.71%), NBAII- BtG4 2% (9.19%), Bb @ 2.0 Kg/ha (9.28%) and chemical control Chlorpyriphos 0.04% (10.05%) (**Table 80**). Seed damage was lowest (17.30) in NBAII BtG4 1%. The grain yield in BtG4 2% treated plot was maximum (11.75 q/ha) and was at par with Bt1 (2%) (10.85q/ha).

.

Table 80: Evaluation of bioagents against pigeon pea pod borer (*H. armigera*) and legume pod borer (*M. testulalis*)

Treatments	Pod damage (%)	Seed damage (%)	Mean of *H. a* larvae/5 plants	Mean of *Maruca* larvae/5 plants	Yield (q/ha)
Bt1 1%	8.66[a]	19.64[ab]	0.77[a]	1.77	10.08[b]
Bt1 2%	8.00[a]	18.78[ab]	0.55[a]	1.22	10.85[ab]
NBAII-BT G4 1%	9.71[a]	23.07[ab]	0.66[a]	1.99	10.33[b]
NBAII-BT G4 2%	9.19[a]	17.30[a]	0.33[a]	1.88	11.75[a]
Bb @ I.5Kg/ha	10.74[abc]	28.36[bc]	1.44[b]	1.33	8.61[c]
Bb @ 2.0Kg/ha	9.28[a]	25.98[b]	0.98[a]	1.22	8.84[c]
NSKE (5%)	13.71[bc]	29.35[bc]	1.99[bc]	2.22	7.23[d]
Chlorpyrifos 0.2%	10.36[abc]	23.26[ab]	0.77[a]	1.22	9.95[b]
Chlorpyrifos 0.04%	10.05[a]	20.93[ab]	0.66[a]	1.10	10.16[b]
Control	16.08[c]	36.39[c]	2.55[bc]	2.66	6.91[d]
CV	9.23	11.28	11.11	10.38	7.08

TNAU
Treatments : 9

1. PDBC-BT1 @ 1% spray
2. PDBC-BT1 @ 2% spray
3. NBAII-BTG4 @ 1% spray
4. NBAII-BTG4 @ 2% spray
5. *Beauveria bassiana* @ 1.5kg/ha
6. *Beauveria bassiana* @ 2.0kg/ha
7. NSKE 5%
8. Chlorpyriphos @ 0.04 % spray
9. Control

Spray schedule: 3 sprays (pre flowering, post flowering and pod emergence)

Design: RBD, **Replications**: 3

Crop / variety: pigeon pea (Co(RG)7, **Spacing**: 30 x 10 cm (pigeon pea)

Plot size: 5 x 8 m.

Observations: % pod damage, % seed damage, pest severity and yield data

Results

BTG4 @ 2% spray, PDBC-BT1 @ 2% spray, and chlorpyriphos 0.04% were highly effective in reducing the larval population of *Helicoverpa armigera* and *Maruca testulalis* in all stages *viz.*, pre-flowering, post flowering and pod emergence with lesser pod, and seed damage and recording higher yield (**Table 81**) NSKE 5%, *Beauveria bassiana* @ 2 kg/ha. and *Beauveria bassiana* @ 1.5kg/ha were moderate in managing the pest population and were significantly better than control.

Table.81. Evaluation of NBAII liquid formulations (PDBC-BT1 and NBAII-BTG4) *Bt* against pigeon pea pod borer (*Helicoverpa armigera*) and legume pod borer (*Maruca testulalis*).

Treatments	Pre flowering		Post flowering		Pod emergence		% Pod damage	% Seed damage	Yield Kg/ha
	H.a	*M.t*	*H.a*	*M.t*	*H.a*	*M.t*			
PDBC-BT1 @ 1% spray	10.4 [b]	7.0[c]	13.8 [b]	8.5 [b]	13.9 [b]	11.4 [bc]	14.1 [b]	10.3 [b]	1635 [b]
PDBC-BT1 @ 2% spray	6.6 [a]	2.0 [a]	7.6 [a]	5.4 [a]	11.5 [a]	6.2 [a]	10.3 [a]	8.2 [a]	1705 [a]
NBAII-BTG4 @ 1% spray	9.2[b]	4.2 [b]	13.6 [b]	7.2 [b]	14.6 [b]	10.0 [b]	13.2[b]	9.9 [b]	1631 [b]
NBAII-BTG4 @ 2% spray	5.8[a]	1.9 [a]	7.5[a]	4.6 [a]	9.6 [a]	3.8 [a]	9.1 [a]	7.6 [a]	1745 [a]
Beauveria bassiana @ 1.5kg/ha	27.4 [d]	8.6[c]	25.7 [c]	12.2 [c]	23.6 [d]	14.8 [cd]	19.5 [c]	16.3 [d]	1450 [c]
Beauveria bassiana @ 2 kg/ha	22.4 [c]	5.0[b]	20.8 [c]	8.4 [b]	17.1 [c]	12.8 [cd]	16.5 [c]	13.6 [c]	1500 [c]
NSKE 5%	21.7 [c]	5.3[b]	21.4 [c]	9.2 [b]	16.4 [c]	13.1 [cd]	15.6 [c]	12.8 [c]	1520 [c]
Chlorpyriphos @ 0.04 % spray	6.5[a]	3.0 [a]	7.5 [a]	3.1 [a]	8.6 [a]	4.4 [a]	9.8 [a]	7.8 [a]	1768 [a]
Control	32.5 [e]	14.8 [d]	31.1 [d]	16.2 [d]	34.3 [e]	19.2 [e]	26.2 [d]	22.5 [e]	1275 [d]

Means followed by a common letter in a column are not significant different by DMRT.

JNKVV- No Report

UAS-Raichur

Location : Main Agricultural Research Station, Raichur
Variety : TS3 R, Plot Size: 9.00 X 4.5m

Treatments : 9

1. PDBC *Bt* 1 @ 10 g/ml/lit
2. PDBC *Bt* 1 @ 20 g/ml/lit
3. NBAII BTG 4 @ 10 g/ml/lit
4. NBAII BTG 4 @ 20 g/ml/lit
5. *Beauveria bassiana* @ 1.5 g/ml/lit
6. Beauveria bassiana @ 2.0 g/ml/lit
7. NSKE @ 5 g/ml/lit
8. Chlorpyriphos @ 2 g/ml/lit
9. Untreated control

Results

NBAII BTG 4 *Bt* @ 2g/lit was found effective which recorded minimum pod damage of 14.38 per cent and it was statistically superior. The NBAII BTG 4 *Bt* @ 1g/lit recorded 16.49 per cent pod damage and was on par with all the dosages of PDBC *Bt* 1 @ 2g and 1g/lit which recorded 15.72. Untreated control recorded maximum pod damage of

27.35 per cent while, NBAII BTG 4 *Bt* recorded minimum seed damage of 1.14 per cent. NBAII BTG 4 *Bt recorded* higher grain yield of 10.49 q/ha which was on par with PDBC *Bt* 1 @ 2g/lit (10.18 q/ha) (**Table 82**).

Table 82. Evaluation of NBAII liquid formulations (PDBC *Bt 1* and PDBC *Bt 2*) and IARI *Bt* against pigeon pea pod borer (*Helicoverpa armigera*) and legume pod borer (*Maruca testulalis*) during 2012-13

Sl. No.	Treatment	Dosage (g/ml/lit)	% Pod damage	% Seed damage	Grain Yield (q/ha)
1	PDBC Bt 1	10	18.64 (25.58)	1.78 (7.67)	9.57
2	PDBC Bt 1	20	15.72 (23.36)	1.62 (7.31)	10.18
3	NBAII BTG 4	10	16.49 (23.96)	1.49 (7.01)	9.61
4	NBAII BTG 4	20	14.38 (22.28)	1.14 (6.13)	10.49
5	*Beauveria bassiana*	1.5	20.94 (27.23)	2.28 (8.68)	9.15
6	*Beauveria bassiana*	2.0	20.66 (27.03)	2.11 (8.35)	9.42
7	NSKE	5	12.87 (21.02)	1.08 (5.97)	10.74
8	Chlorpyriphos	2.0	10.13 (18.56)	0.78 (5.07)	11.32
9	Untreated control	--	27.35 (31.53)	8.92 (17.38)	7.57
C.D @ 5%			**0.85**	**0.49**	**0.38**

Figures in parenthesis are arcsine transformed values

2. Influence of crop habitat diversity of natural enemies in pigeonpea through FLD/OFD (ANGRAU, MPUAT)

ANGRAU

Treatments:

1. Pigeonpea intercropped with sunflower and maize as border crop
2. Pigeonpea intercropped with sunflower and sorghum as border crop
3. Pigeonpea as sole crop

For every 9 rows of pigeonpea one row of sunflower to be planted as intercrop and maize or sorghum to be planted as border crop as in Fig 1. Location specific recommended varieties of sunflower/maize or sorghum may be selected for planting.

Observations

1. Larval counts of pod borers to be taken on 10 plants as pre count and each segment at 15 days interval starting 30 days of planting.

2. Counts of natural enemies in 10 randomly selected plants in each segment at 15 days interval starting from 30 days of planting.

3. Per cent damage by *H. armigera* to be taken at harvest

4. Collect the larvae of pod borer at pod stage and observe for parasitisation by *Campoletischlorideae*and other parasitoids.

5. Collect the information on activity of pest/natural enemies on the border crops/intercrops in 10 randomly collected plants in each segment at 15 days interval starting from 30 days of planting.

6. Yield data of border crop /intercrop recorded individually.

Results

Among the three modules tested, pigeonpea module with sorghum as the border crop and sunflower as the intercrop recorded least population of *Helicoverpa armigera* larvae compared to the pigeonpea module with maize as the border crop and sunflower as the intercrop and the sole pigeonpea module. It also recorded maximum population of coccinellids compared to the pigeonpea module with maize as the border crop and sunflower as the intercrop and the sole pigeonpea module. The population of predatory stink bugs was more in the pigeonpea module with sorghum as the border crop and sunflower as the intercrop than pigeonpea module with maize as the border crop and sunflower as the intercrop and the sole crop. Yield was better in the pigeonpea module with sorghum as the border crop and sunflower as the intercrop than the other two modules respectively.

MPUAT

Treatments

1. Pigeon pea inter cropped with maize 2:2 line.
2. Pigeon pea inter cropped with & maize and sunflower as border crop.
3. Pigeon pea inter cropped with sorghum as a border crop.
4. Pigeon pea as a sole crop.

Results: Pigeon pea intercropped with maize and border crop of sunflower as a trap crop recorded the least population (13.71) of pod borers and the mean reduction in pod damage was 48.65 % over sole pigeon pea crop (**Table-83**).

3. Effect of bio-agents and botanicals on the incidence of pod borer and leaf tier in pigeon pea (MPUAT)

MPUAT

Treatments

1. Two sprays of NSKE 5%, 1st at flowering, and 2nd at 15 days after 1st spray.
2. Two spray of HaNPV, 1st at flowering and 2nd at 15 days after 1st spray.
3. Two spray of *Beauveria bassiana,* 1st at flowering. And 2nd at 15 days after 1st spray.
4. Two spray of 5% CASE (custard apple seed extract) 1st at flowering. And 2nd at 15 days after 1st spray.
5. Recommended insecticides.

Results: Field Experiments were conducted at 5 farmer's fields during 2012-13. To study the effect of bio-agents and botanicals on the incidence of pod borers and leaf tier in pigeon pea. Among the bio-agents and botanicals, 2 sprays of 5% CASE was more effective in reducing the mean pod damage (14.52%) followed by two sprays of *B. bassiana* (16.17%) (**Table 84**).

Table 83. Influence of crop habitat diversity on bio diversity of pests and their natural enemies in pigeon pea through FLD

Treatment	Leaftier/ 5plant	Mean pod damage /100 pods (%)						
		H. armigera	*E. atmosa*	*L. boeticus*	*M. testulalis*	*M. obtusa*	Total	Mean reduction in pod damage over sole crop (%)
Pigeon pea inter cropped with maize 2:2 line	7.33	4.76 (11.66)	3.36 (10.48)	1.62 (7.35)	2.52 (9.15)	4.8 (12.62)	17.06	46.70
Pigeon pea inter cropped with sunflower & maize an border crop	6.2	2.04 (9.35)	2.82 (9.46)	1.72 (7.55)	2.53 (9.46)	4.60 (12.36)	13.71	48.65
Pigeon pea inter cropped with sorghum on border crop	10.1	10.10 (19.58)	2.3 (8.72)	1.84 (7.84)	2.13 (8.55)	4.8 (12.69)	21.17	42.75
Pigeon pea on a sole crop	13.15	23.03 (16.56)	4.6 (12.24)	3.94 (11.04)	4.75 (12.48)	10.15 (8.32)	56.47	-
SEM ±		2.25	1.32	0.35	0.09	0.21		
CD at 5%		5.96	3.05	0.92	0.320	0.65		

Values in parentheses are arcsin transformed values

Table 84. Effect of bioagents and botanicals on the incidence of pod borer and leaftire in pigeon pea

Treatment	Leaftier /5plant	Mean pod damage (%)					
		H. armigera	***E. atmosa***	***L. boeticus***	***M. testulalis***	***M. obtusa***	**Total**
Two sprays of NSKE 5% 1st at flowering and 15 days after	5.1	10.52 (18.68)	1.76 (7.65)	0.94 (5.55)	2.2 (8.5)	4.7 (12.42)	20.12
2 spray of HaNPV	5.56	10.18 (18.61)	2.2 (8.55)	4.7 (12.42)	3.31 (10.48)	4.4 (12.14)	24.79
2 spray of *Beauveria bassiana*	3.25	5.47 (12.13)	2.35 (8.80)	2.82 (9.71)	3.2 (10.2)	20.33 (8.75)	16.17
2 spray of 5% CASE	2.90	6.9 (15.3)	2.18 (8.47)	0.93 (5.55)	1.15 (5.85)	3.36 (10.48)	14.52
Recommended insecticides	1.2	4.7 (12.42)	1.15 (6.15)	0.82 (5.15)	0.59 (4.35)	1.72 (7.55)	8.98
control	13.59	32.39 (34.59)	6.6 (14.3)	4.82 (12.15)	4.8 (12.14)	9.85 (18.26)	58.46
SEM		0 .82	0.050	0.63	0.42	0.46	1.25
CD at 5%		2.12	1.25	1.66	1.35	1.08	2.78

2.8. Oil Seeds

1. Biological suppression of safflower aphid, *Uroleucon compositae* (ANGRAU, MPKV)

ANGRAU

Treatments
T1 *Beauveriabassiana*; **T2** *Metarrhiziumanisopliae*; **T3** *Verticillium lecanii*
T4 Neemoil; **T5** Insecticidal check; **T6** Untreated Control

Plot size: 40 sq.mt (5 x 8m) , **No. of Replications** : 4 **Design:** RBD, **Variety:** Nari 11
Timing of Treatmental Applications:The first spray to be given on initial occurrence of the pest and rest based on abundance of pest. Cloth screento be used to avoid drift into neighboring plots.

Observational Protocol: Aphid population in 10 randomly selected plants (terminal shoots) from each plot was recorded before treatment and 10 days after each treatment. Yield per plot was recorded at harvest.

Results: *Verticilliumlecanii* wasbetter than *Metarrhiziumanisopliae* and*Beauveriabassiana* in bringing down population of aphids.*V.lecanii* was on par with Neem oil and together they were on par with the insecticidal check on its lower side in recording minimum aphid population (65-123aphids/10 plants) and maximum yield (469-509 kg/ha).Control recorded maximum aphid number (413-435aphids/10 plants) and minimum yield (245 kg/ha) (**Table 85**).

Table 85. Demonstration of biological suppression of *Uroleucon carthami* in non-spiny safflower varieties

S.No	Treatment	Aphid population (per 10 plants)		Yield (kg/ha)
		After fist application of package	After second application of package	
1.	*Beauveriabassiana*	234^{c}	120^{b}	412^{b}
2.	*Metarrhiziumanisopliae*	246^{c}	111^{b}	424^{b}
3.	*Verticilliumlecanii* @ 1.5 x 10^{13} conidia/ha	123^{b}	86^{ab}	469^{ab}
4.	Neemoil	119^{ab}	93^{ab}	472^{ab}
5.	Insecticidal check	65^{a}	71^{a}	509^{a}
6.	Untreated Control	413^{d}	435^{c}	245^{c}
CD		57	35	69

MPKV

A field experiment was laid out in randomized block design with safflower var. SSF 658 (non spiny) at the research farm of Botany Section, College of Agriculture, Pune during *rabi* 2012-13. The seed rate was 10 kg/ha with a spacing of 45x 20 cm. There were seven treatments and three replications. The treatments comprised release of *Chrysoperla zastrowi sillemi* @ 5,000 grubs/ha, spraying of *Verticillium lecanii, Beauveria bassiana, Metarhizium anisopliae* each @ 10^{13} conidia/ha, NSKE 5% suspension, insecticidal check dimethoate 30EC @ 1.45 ml/l and untreated control. Two releases of *Chrysoperla* and three sprays of remaining treatments were given at fortnightly intervals. Three sprays of

dimethoate @ 1.45 ml/lit at fortnightly interval were significantly superior over other treatments in suppressing the aphid population (4.4 aphids/5 cm apical twig) on non-spiny variety of safflower and increased the yield (11.2 q/ha) (**Table 86**). The treatments with *M. anisopliae* and NSKE 5% were statistically comparable with superior treatment in respect of safflower yield.

Table 86. Effect of different bioagents on aphid population and yield of safflower

Treatment	Aphid population/5 cm shoot/plant, 7 days after					Yield (q/ha)
	Pre-count	I spray	II spray	III spray	Average	
T1: *Chrysoperla* @ 5,000 grubs/ha	41.4 [a]	36.4 [c]	27.4 [c]	19.2 [d]	27.7 [e]	7.4 [b]
T2: *V. lecanii* @ 10^{13} conidia/ha	42.8 [a]	29.6 [c]	18.1 [b]	9.7 [c]	19.1 [d]	8.1 [b]
T3: *B. bassiana* @ 10^{13} conidia/ha	43.0 [a]	40.2 [d]	22.1 [c]	15.2 [d]	25.8 [e]	7.9 [b]
T4: *M. anisopliae* @ 10^{13} conidia/ha	41.0 [a]	14.3 [b]	5.4 [a]	1.8 [a]	7.2 [b]	10.7 [a]
T5: NSKE @ 5%	42.6 [a]	16.4 [b]	11.8 [b]	5.2 [b]	11.1 [c]	10.2 [a]
T6: Dimethoate .05%	41.8 [a]	9.1 [a]	3.6 [a]	0.4 [a]	4.4 [a]	11.2 [a]
T7: Untreated control	40.9 [a]	47.4 [d]	55.7 [d]	62.8 [e]	55.3 [f]	6.3 [b]
CD (p = 0.05)	NS	0.61	0.82	0.76	0.29	1.86

2. Biological control of Groundnut pests (OUAT)

Location : Central Agricultural research Station,O.U.A.T.,Bhubaneswar
Plot size: 5mx4m, **Replications:** 4 and **Design:** RBD
Treatments
1. Release of *Trichogramma chilonis* @ 1,00,000/ha, 3-4 times
2. Spray of *Bt*. @ 1 kg/ha twice at 15 day interval
3. Spray of NSKE 5% 3-4 times
4. Spray of *Beauveria bassiana* 2 kg/ha twice at 15 days interval
5. Insecticidal check
6. Control

Results

The pre treatment incidence of *S.litura,* Leaf miner and hairy caterpillars varied from4.2 to 5.2,3.9 to 4.9 and 0.4 to 1.2 larvae/10 plants. Insecticidal treatment recorded the lowest pest population in all cases with 0.7,0.4 and 0.1 larvae of *S.litura,*leafminer and hairy caterpillar respectively. In case of *S.litura,* incidence in Sl.NPV treatment (0.9) was at par with the insecticidal treatment (0.7). Treatment of Bt (1.4) and *B.bassiana* (3.0).*Trichogramma* (4.0) and NSKE (4.5) treatments which were not significantly effective against this pest. Against leafminer, Bt. treatment(0.9) was again at par with the insecticidal treatment (0.4) and was followed by *Trichogramma* (2.7) and NSKE (2.9). In case of hairy caterpillars, insecticide treatment recorded the lowest pest incidence (0.1) followed by Bt (0.4) and NSKE (0.6).

Sl NPV against *S.litura* was next to insecticide (0.2) followed by Bt (0.4). Against leafminer and hairy caterpillar, Bt (0.3) treatment followed the insecticide treatment. The yield was highest in insecticidal treatment (21.17 q/ha) followed by Bt (18.97 q/ha). Releases of *Trichogramma* was also responsible for good yield with 17.28q/ha. Control plots had the yield of 7.98 q/ha (**Table 87**).

Table 87. Incidence of Groundnut pests at Bhubaneswar in different biocontrol treatments during Kharif,2012

Treatments	No.of larvae/10 plants before treatments			No.of larvae /10 plants 5day after spraying			No.of larvae /10plants 15day after spraying			Yield (q/ha)
	S.litura	Leaf miner	Hairy caterpillars	*S.litura*	Leaf miner	Hairy caterpillars	*S.litura*	Leaf miner	Hairy caterpillars	
1.Release of *Trichogramma chilonis* @ 1,00,000/ha, 3 times at 7 day interval	4.2 (2.17)	4.8 (2.30)	0.8 (1.14)	4.0 (2.12)	2.7 (1.79)	0.8 (1.14)	2.7 (1.79)	1.0 (1.22)	0.7 (1.10)	17.28
2.Spray of *Bt*. @ 1 kg/ha twice at 15 day interval	4.7 (2.28)	4.9 (2.32)	1.2 (1.30)	1.4 (1.38)	0.9 (1.18)	0.4 (0.95)	0.4 (0.95)	0.3 (0.89)	0.3 (0.89)	18.97
3.Spray of NSKE 5% 3 times at 7 day interval	5.1 (2.37)	4.3 (2.19)	0.9 (1.18)	4.5 (2.24)	2.9 (1.84)	0.6 (1.05)	3.2 (1.92)	1.9 (1.55)	0.4 (0.95)	17.06
4.Spray of *Beauveria bassiana* 2 kg/ha twice at 15 days interval	4.7 (2.28)	3.9 (2.10)	0.8 (1.14)	3.0 (1.87)	2.4 (1.70)	0.2 (0.84)	2.2 (1.64)	1.7 (1.48)	0.0 (0.71)	13.60
5.Spray of Sl.NPV @250 LE/Ha twice at 10 day interval	4.7 (2.28)	4.0 (2.12)	0.7 (1.10)	0.9 (1.18)	3.8 (2.07)	0.8 (1.14)	0.2 (0.84)	2.9 (1.84)	0.6 (1.05)	13.75
6.Insecticidal check (Spray of Monocrotophos 1 lit/ha) twice at 15 day interval	4.6 (2.26)	4.3 (2.19)	0.6 (1.05)	0.7 (1.10)	0.4 (0.95)	0.1 (0.77)	0.1 (0.77)	0.0 (0.71)	0.0 (0.71)	21.17
7.Control (No sprays)	5.2 (2.39)	4.7 (2.28)	0.8 (1.14)	5.7 (2.49)	5.1 (2.37)	1.2 (1.30)	4.8 (2.30)	4.3 (2.19	1.0 (1.22)	7.98
CD(p=0.05)	NS	Ns	Ns	0.36	0.41	0.24	0.21	0.23	0.18	

Figures in parentheses are √(x+0.5) values

3. Evaluation of entomopathogens and botanicals against soybean pests' complex (MPKV, MPUAT)

MPKV

The experiment was conducted on the research farm of Botany Section, College of Agriculture, Pune during *Kharif* 2012. Soybean var. JS- 9305 was sown at 45 x 10 cm distance in 5 x 4 m plots.in a randomized block design with six treatments and four replications. The treatments comprised MPKV and NBAII strains of *Nomuraea rileyi* @ 10^8 conidia/ml, *Sl*NPV @ 250 LE/ha (1.5 x 10^{12} POBs/ha), EPN *Heterorhabditis indica* @ 1 billion IJs/ha, NSKE 5% suspension and untreated control. Three sprays were given at fortnightly intervals.

Three sprays of *Sl*NPV @ 250 LE/ha (1.5 x 10^{12} POBs/ ha) was significantly superior in suppressing the larval population of *S. litura* (3.0 larvae/m row) with 78.5 per cent mortality due to virus infection and gave maximum of 21.6 q/ha yield of soybean (**Table 88**). The PKV strain of *N. rileyi* showed av. 3.3 surviving larval population of *S. litura* per m row with 62.5 per cent mortality due to fungal infection and 19.8 q/ha yield followed by NBAII strain.

Table 88: Effect of entomopathogens on larval population of *S. litura* and yield of soybean

Treatment	Larval population/m row, 7 days after					Pathogenesity/ mortality (%)	Yield (q/ha)
	Pre-count	I spray	II spray	III spray	Aver-age		
T1: *N. rileyi* @ 10^8 conidia/ml - MPKV strain	5.6 [a]	4.2 [a]	2.0 [a]	1.2 [b]	3.3 [a]	62.5	19.8 [a]
T2: *N. rileyi* @ 10^8 conidia/ml - NBAII strain	6.5 [a]	4.1 [a]	2.1 [a]	1.1 [b]	3.5 [a]	60.0	19.4 [a]
T3: *Sl*NPV @ 250 LE/ha	5.9 [a]	4.0 [a]	1.8 [a]	0.3 [a]	3.0 [a]	78.5	21.6 [a]
T4: EPN-*H. indica* @ 1 billion IJs/ha	6.8 [a]	5.4 [a]	3.7 [b]	2.6 [c]	4.6 [b]	32.8	16.4 [b]
T5: NSKE 5% suspension	7.2 [a]	5.7 [a]	4.0 [b]	1.9 [c]	4.7 [b]	48.0	16.6 [b]
T6: Untreated control	6.3 [a]	8.7 [b]	11.4 [c]	14.9 [d]	10.3 [c]	5.5	12.5 [c]
CD (p = 0.05)	NS	0.44	0.36	0.31	0.18		2.88

MPUAT-No Report

4. Screening of EPN (Entomopathogenic Nematodes) against *Spodoptera litura* (Fab.) on soybean (JNKVV)

JNKVV- No-Report

2.9. Coconut

1. Surveillance and need-based control of coconut leaf caterpillar, *Opisina arenosella* in Kerala (CPCRI)

Medium level of *Opisina arenosella* incidence *was* noticed in Puthiyavila (Trivandrum) with leaf infestation of 59.6% and population of 141/100 leaflet. Awareness campaign was conducted in the area with collaboration of Parasite Breeding Station, Trivandrum and Dept. of Agriculture, Kerala. Regular monitoring and release of stage specific parasitoids resulted in 55.7% reduction of leaf damage and 94% reduction in pest population over a period of 8 months (**Table 89).** Outbreak of *O. arenosella* was also noticed in Kallara (Kottayam) region during August 2012 with leaf infestation of 83.4% and pest population 288/100 leaflets. Systematic monitoring and release of larval parasitoids *viz., Goniozus nephantidis* and *Bracon brevicornis* could reduce leaf damage (42%) and pest population (93%) in a period of 7 months.

Table 89. Coconut leaf damage (%) and population of the *Opisina arenoeslla* at Puthiyavila (Trivandrum)

Leaf damage in coconut by *O. arenosella*		**Population of *O. arenosella***
Period	**Mean percent leaf infestation ± SE**	***O. arenosella* (Number/100 leaflet)**
July 2012	59.56 ± 3.58	141
March 2013	26.38 ± 1.94	8
t value	12.42**	
Reduction in leaf damage	55.7%	94.3%

2. Scaling up and utilization of *M. anisopliae* through technology transfer (CPCRI)

Area wide Community Adoption of management practices for rhinoceros beetle was evolved and implemented in 520 ha covering more than 5500 farmers' plots and about 1 lakh palms. The social process was enumerated and through effective linkages and networking with stakeholders, community based treatment of rhinoceros beetle breeding sites with *Metarhizium anisopliae* (farm level production by women farmers group) was done in the entire 17 clusters (wards) of Edava Grama panchayath.

The technology of treating breeding sites with *M. anisopliae* was integrated with other ecofriendly IPM practices *viz.,* incorporation of *Clerodendron infortunatum* in the breeding sites, phyto sanitation and prophylactic leaf axil filling of juvenile and young palms with botanicals admixed with sand. The impact analysis indicated reduction of pest incidence in all the clusters proving the effectiveness of community adoption against this ubiquitous pest. The leaf cuts (typical major symptom of rhinoceros beetle infestation) reduced by 55.2% which was statistically significant at 1% level. The knowledge and skill of farmers also improved by more than 60%. Farmer to farmer technology dissemination achieved through trainings (18 trainings), sharing of experience, media publicity and providing *M. anisopliae* at low cost for farmer groups of other locations (four districts, 5000 packets).

3. EPN for red palm weevil management (CPCRI)

Four species of entomopathogenic nematodes *viz*., *Heterorhabditis bacteriophora*, *Heterorhabditis indica*, *Steinernema carpocapsae* and *Steinernema abbasi* were evaluated against red palm weevil grubs, *Rhynchophorus ferrugineus* (Olivier) on a filter-paper based bioassay. The local isolate *H. indica* was found to be more virulent inducing 92.5% mortality of red palm weevil grubs @ 1500 infective juvenile (IJ) /grub than *H. bacteriophora* which caused 65% mortality. At the same concentration *S. carpocapsae* and *S. abbasi* caused mortality to the tune of 20% and 15% respectively. Probit analysis of dose-mortality relationship of *H. indica* and *H. bacteriophora* against grubs of *R. ferrugineus* at 96 h revealed median-lethal concentration of *H. bacteriophora* as high as 613.5 IJ and that of *H. indica* was found to be 355.5 IJ for the same exposure time of 96 h indicating higher toxicity of *H. indica* against grubs of red palm weevil. Between the two stages of red palm weevil, pre-pupa was found to be more susceptible (82.5%) than the active grubs under laboratory bioassay with *H. indica* @ 400 IJ/grub. Synergistic interaction of *H. indica* (1500 IJ) with imidacloprid (0.002%) against red palm weevil grubs was observed accelerating the kill (95%) within a period of 48h in a cup- based bioassay. It was found that *Heterorhabditis* sp. was more virulent than *Steinernema* sp. and dose induced mortality of red palm weevil grubs with increase in concentration of EPN was indicated.

2.10. Tropical Fruits

1. Field evaluation of *Metarhizium anisopliae* against mango hoppers (ANGRAU, MPKV)

ANGRAU

Treatments

BLOCK-1

S. No	No. of trees	Details of treatment	Frequency of spray	Observation
1	25 -50	*M. anisopliae* $1x10^9$ spores/ml with adjuvants	one spray of *M. anisopliae* during off season (November/ December) +Weekly (a total of three-four sprays) (with the incidence of hoppers-first generation) If hopper population is very severe the spray can be done once in 5 days	Observations from 10 trees to be made from each tree four inflorescence No. of hoppers/ inflorescence (pre and post count on early, late and adult population separately may be made) No of fruits set.

BLOCK-2

S. No	No. of trees	Details of treatment	Frequency of spray	Observation
1	25 -50	*M. anisopliae* $1x10^9$ spores/ml with adjuvants	Weekly(a total of three-four sprays) (with the incidence of hoppers-first generation) If hopper population is very severe the spray can be done once in 5 days	Observations from 10 trees to be made from each tree four inflorescence. No. of hoppers/ inflorescence(pre and post count on early, late and adult population separately may be made) No of fruits set.

BLOCK-3

S. No	No. of trees	Details of treatment	Frequency of spray	Observation
1	25 -50	*M. anisopliae* $1x10^7$ spores/ml with adjuvants	Weekly(a total of three-four sprays) (with the incidence of hoppers-first generation) If hopper population is very severe the spray can be done once in 5 days	Observations from 10 trees to be made from each tree four inflorescence. No. of hoppers/ inflorescence (pre and post count on early, late and adult population separately may be made) No of fruits set.

BLOCK4

S. No	No. of trees	Details of treatment	Frequency of spray	Observation
1	25 -50	Check-Spray imidachlorprid @0.3ml/L	One spray at pre – flowering	Observations from 10 trees to be made from each tree four inflorescence No. of hoppers/ inflorescence (pre and post count on early, late and adult population separately may be made) No of fruits set.

BLOCK5

S. No	No. of trees	Details of treatment	Frequency of spray	Observation
1	25 -50	control	no spray	Observations from 10 trees to be made from each tree four inflorescence No. of hoppers/ inflorescence (pre and post count on early, late and adult population separately may be made) No of fruits set.

Results

After three sprays indicated that weekly sprays of *Metarrhiziumanisopliae*@ 1 X 10^9 spores/ml could reduce population of hoppers on mango effectively. Population of hoppers in treatments where offseason spray of *M.anisopliae*@1X$10^9$was given was on par with treatments where no offseason spray was given and the treatment where *M.anisopliae* was used at 1X10^7spores/ml. All the three treatments recorded 2.6-2.7 hoppers/inflorescence. The chemical spray however recorded least population (0.5 hoppers/inflorescence), while the control recorded maximum population (6.3 hoppers/inflorescence). No added advantage of the offseason spray was observed. Thus *M.anisopliae*showed its efficacy against mango hopper (**Table 90**).

Table 90. Field evaluation of *Metarhiziumanisopliae* against mango hoppers

S. N.	Treatment	Pre-count (mean number/inflorescence)	Post-count (mean number/inflorescence)
1.	T1 – Offseason spray of *M.anisopliae* @ 1 X 10^9 spores/ml + weekly sprays after hopper infestation	5.3	2.7^b
2.	T2 –Weekly sprays of *M.anisopliae* @ 1 X 10^9 spores/ml after hopper infestation starts	4.8	2.7^b
3.	T3 - Weekly sprays of*M.anisopliae* @ 1 X 10^7 spores/ml after hopper infestation starts	5.3	2.6^b
4.	T4 – Imidacloprid @ 0.3ml/L once at pre-flowering stage	4.8	0.5^a
5.	No Spray	5.2	6.3^c
CD		NS	0.3

MPKV

The trial was laid out in the mango orchards at Regional Fruit Research Station, Ganeshkhind, Pune in December 2012. Each treatment block had 40 trees which further divided into four sub-plots as replicates. The planting distance was 10 x 10 m. The treatments comprised application of *Metarhizium anisopliae* @ 1 x 10^9 spores/ml with adjuvant (sunflower oil 1 ml/l + Triton-X 100 @ 0.1 ml/l) during off-season followed by four sprays of the fungal preparation during flowering at weekly interval, four sprays of *M. anisopliae* @ 1 x 10^9 spores/ml with adjuvant during flowering, four sprays *M. anisopliae* @ 1 x 10^7 spores/ml with adjuvant during flowering, one spray of imidacloprid @ 0.3 ml/l during flowering and untreated control. The hopper population was recorded before treatment applications and post counts a week after each spray from four inflorescences per tree and as such 10 trees per plot as well as number of fruits set per inflorescence. The off-season spray of *M. anisopliae* was given on 6/12/2012 and subsequent four sprays were given during flowering starting from 24/01/2013. Data on surviving hopper population were transformed into $\sqrt{x+0.5}$ values before subjecting to analysis of variance.

The results in **Table 91** show that spraying of *M. anisopliae* @ 1 x 10^9 spores/ml during offseason in the month of December followed by four sprays of the pathogen mixed with adjuvant (sunflower oil 1 ml/lit + Triton- X 100 @ 0.1 ml/lit) at weekly interval during flowering found significantly superior over other treatments in suppressing the hopper population and increased fruit setting. The mean surviving population was recorded as 10.4 hoppers and 12.1 fruit sets per inflorescence in this treatment as against 52.1 hoppers and 6.0 fruits set of mango per inflorescence in untreated control block.

Table 91. Effect of *Metarhizium anisopliae* on hopper population and fruit set of mango

Treatment	Hopper population/ inflorescence, 7 days after spray						Fruit set / inflore scence
	Pre-count	I	II	III	IV	Aver-age	
T1: *M. anisopliae* @ 1 x 10^9 spores/ml with adjuvant - 1 spray in off-season + 4 sprays in flowering	34.7 [a]	20.9 [b]	10.7 [a]	6.7 [a]	3.3 [a]	10.4 [a]	12.1 [a]
T2: *M. anisopliae* @ 1 x 10^9 spores/ml with adjuvant -4 sprays in flowering	36.3 [a]	25.3 [b]	18.3 [b]	15.3 [b]	7.7 [b]	16.7 [b]	10.2 [a]
T3: *M. anisopliae* @ 1 x 10^7 spores/ml with adjuvant - 4 sprays in flowering	38.1 [a]	26.7 [b]	19.4 [b]	16.8 [b]	11.3 [b]	18.6 [b]	8.6 [b]
T4: Imidacloprid @ 0.3 ml/l -1 spray at pre-flowering	34.6 [a]	14.3 [a]	16.8 [b]	22.4 [c]	26.7 [c]	20.1 [c]	8.1 [b]
T5: Untreated control	37.5 [a]	44.9 [c]	50.1[c]	61.1[d]	52.3 [d]	52.1 [d]	6.0 [b]
CD (p = 0.05)	NS	0.75	0.75	0.83	0.71	0.50	1.86

2. Survey and record of incidence of papaya mealybug and its natural enemies on papaya and other alternate hosts (AAU-A, KAU, MPKV, TNAU, OUAT, IIHR)

AAU-A

Survey for ascertaining the outbreak of mealybug was carried out in agriculture campus as well as in farmers' fields in Anand and Kheda district. Only stray incidence was reported in campus and in a few farmers's fields. The samples of mealybug infested papaya fruits were brought in the laboratory and were reared on sprouted potato. The parasitoid viz., *Acerophagus papayae* was noticed parasitizing mealybug in laboratory condition.

Methodology: A regular survey was be made in 5 randomly selected villages in each district of middle Gujarat region to determine the infestation of P. *marginatus*. Farmers' fields were visited at fortnightly interval. Percentage of plants infested with mealybug was assessed by observing 25 randomly selected plants and intensity of damage (grade in the scale of 1-5) was determined.

Grade	Population
1	very low
2	low
3	medium
4	high
5	very high

Observations recorded

1. Date of survey

2. Name and full address of the farmer
3. Crop plants infested.
4. Non hosts crop and weeds infested
5. Chemical pesticides if any used with dose

6. Anticipated yield loss / ha (crop - wise)

7. Existing natural enemies in 25 randomly selected plants

Results: In order to monitor the entry of *Paracoccus marginatus* as invasive pest of papaya in Gujarat, a survey was carried out in papaya growing areas of Anand district. It was found that five fields in two villages were found infested with mealybug.

Status : Continued

KAU

Random survey was carried out in different districts of Kerala. The pest incidence was very low in all the areas. Survey showed that the parasitoid established very well in all the areas. Papaya mealybug incidence was observed on tapioca.

MPKV

The papaya orchards (36) were surveyed for incidence of PMB in five agro-ecological zones of western Maharashtra and its natural enemies as well as alternate hosts were recorded. The pest incidence was recorded on randomly selected 25 papaya plants from each orchard. The intensity rating of mealybug in 1-5 scale (1= very low; 2=low; 3=medium; 4=high; 5= very high population) from 5 plants per orchard and population of *A. papayae* per leaf were recorded.

The incidence of PMB was noticed to the extent of 12.5 to 24.0 per cent in Pune, Jalgaon, Dhule, Nandurbar and Ahmednagar districts covering plain zone, central Maharashtra plateau zone and scarcity zone in western Maharashtra. The average pest population density was relatively low during this year (36.5 mealybugs/ vein/ leaf) in Pune district followed by Jalgaon and Nandurbar. The population of parasitoid, *A. papayae* recorded as 4.8 adults/ leaf in Pune region (**Table 92**).

Table 92. Survey and record of papaya mealy bug in western Maharashtra.

District surveyed	PMB incidence (%)	Pest intensity rating	*A.papayae* adults/leaf
Pune	24.0	2.3	4.8
Ahmednagar	12.5	2.0	0
Jalgaon	22.5	2.0	3.4
Dhule	18.5	2.0	2.8
Nandurbar	21.5	2.5	3.5
Nashik	0	0	0
Solapur	0	0	0
Kolhapur	0	0	0
Satara	0	0	0
Sangli	0	0	0

In addition, three papaya orchards from Pune region were regularly visited twice a month during the period from March to December 2012 and PMB incidence and pest

intensity rating were recorded. Data in **Table 93** indicated that the incidence of PMB was recorded high during the period from March to July 2012 with peak (67.5 to 95.0%) in May 2012. Natural enemies particularly the parasitoid, *Acerophagus papayae* population was increased enormously during May to July 2012 (20 to 50 adults/leaf) which resulted in drastic decline in mealybug population in Baner and Loni Kand orchards in August 2012. Thereafter, the PMB incidence gradually declined till December 2012 (3.6 to 10.0%) with existence of the parasitoids (2.4 adults/ leaf). In Ganeshkhind orchard, the parasitoids *A. papayae* as well as *Pseudleptomaxtix mexicana* were recorded wherein the former one is more predominant than later. While, only *A. papayae* was noticed in other two orchards.

Table 93. Monitoring the incidence of papaya mealybug in Pune region of Maharashtra

Month	PMB incidence (%) and pest intensity rating		
	G1 (Baner)	G2 (Ganeshkhind)	G3 (Loni Kand)
March 2012	20.5 (1.1)	68.0 (3.9)	35.0 (2.9)
April 2012	45.0 (2.8)	79.5 (4.0)	76.0 (4.5)
May 2012	67.5 (3.4)	90.0 (5.0)	95.0 (5.0)
June 2012	55.0 (2.8)	83.0 (4.1)	85.0 (4.5)
July 2012	33.5 (1.8)	60.0 (3.0)	46.5 (2.4)
August 2012	3.5 (1.0)	47.0 (2.3)	10.5 (1.1)
September 2012	2.1 (1.0)	13.0 (1.2)	3.5 (1.0)
October 2012	3.8 (1.0)	2.5 (1.0)	7.8 (1.0)
November 2012	4.0 (1.0)	5.1 (1.0)	13.5 (1.4)
December 2012	3.6 (1.0)	4.8 (1.0)	10.0 (1.1)

Figures in bracket are pest intensity rating (1-5)

Natural enemies recorded in the papaya mealybug colonies:
Encyrtid parasitoid, *Acerophagus papayae* N. & S.
Pseudleptomastix mexicana N. & S.
Spalgius epius (Westwood)
Coccinella septempunctata Linn.
Scymnus sp.
Anthocorids
Mallada sp.
Brumoides sp.
Syrphids
Spiders

Alternate hosts of papaya mealybug in Maharashtra

During survey, the mealybug stages were observed on following weeds as well as other plants as alternate hosts in the vicinity of papaya orchards.

Parthenium (*Parthenium hysterophorus* L.)
Milk weed (*Euphorbia heterophylla* L.)
Kena weed or Day flower (*Commelina benghalensis* L.)
Tandulja (*Amaranthus dubius* L.)
Shoe flower (*Hibiscus rosa-sinensis* L.)
Safed chafa (*Plumeria alba*)
Mulberry (*Morus* sp.)

Teak (*Tectona grandis* L.)

TNAU

Natural enemies recorded on Mealybugs

The natural enemies of papaya mealybug collected from different districts of Tamil Nadu during the survey were identified as follows.

Parasitoids recorded

Acerophagus papayae Noyes & Schauff (Hymenoptera: Encyrtidae)
Anagyrus lockei Noyes & Menezes (Hymenoptera: Encyrtidae)
Promuscidea unfaciativentris Girault (Hym: Aphilinidae)
Prochiloneurus pulchellus Silvestri (Hym: Encyrtidae)
Aenasius bambawalei Hayat (Male) (Hym: Encyrtidae)
Chartocerus walkeri Hayat (Hym: Signiphoridae), *P. unfasciativentris*
Anagyrus agraensis Saraswat (Hym: Encyrtidae)
Elasmus ceylonicus Ferriere (Hym; Eulophidae)
Anastatus sp. (Hym: Eupelmidae)
Aenasius advena Compere (Hym: Encyrtidae)
Aenasius bambawalei (Female) (Hym: Encyrtidae)
Blepyrus insularis (Cameron) (Hym: Encyrtidae)

Predators recorded

Spalgis epius Westwood (Lepidoptera: Lycaenidae)
Cryptolaemus montrouzieri Mulsant (Coleoptera: Coccinellidae)
Scymnus coccivora Ayyar (Coleoptera: Coccinellidae)
Chrysoperla zastrowi sillemi Esben- Peterson (Neuroptera: Chrysopidae)
Mallada sp.
Brumoides suturalis Fabricius (Coleoptera: Coccinellidae)
Cheilomenus sexmaculata (Fabricius) (Coleoptera: Coccinellidae)
Hormonia octomaculata (Coleoptera: Coccinellidae)
Coccinella transversalis(Fabricius) (Coleoptera: Coccinellidae)
Coccinella septumpunctata Linnaeus(Coleoptera: Coccinellidae)
Chilocorus nigritus (Fabricius) (Coccinellidae: Coleoptera)

Natural enemy complex of different species of mealybugs on different crops in different seasons in Tamil Nadu

The two tailed mealybug, *Ferrissia virgata* (Ckll), pink mealybug, *Maconellicoccus hirsutus* (Green), the citrus mealy bug *Pseudococcus longispinus* Targioni Tozzeti, and *Rastrococcus iceryoides* (Green) are causing heavy damage to many horticultural crops in India. Four species of mealy bugs *viz*., *Phenacoccus solenapsis*, *Maconellicoccus hirsutus, Ferrissia virgata* and *Paracoccus marginatus* were recorded on cotton of which *Phenacoccus solenapsis* was the predominant species.

Papaya mealybug incidence recorded from different host crops: Survey were conducted in Coimbatore, Tirupur and Dindigul districts of Tamil Nadu on four host crops

viz., papaya, tapioca, cotton and mulberry and the results were as follow. The intensity of mealybug was assessed from the grades of zero to ten as worked out in previous years.

Papaya: In Oddanchatram of Dindigul district, the percentage of PMB infestation was high (40 %) during first fortnight of February, 2013. The infestation of PMB was low (22 %) during December 2012 and 16 % in first fortnight of April 2013. The infestation level during survey period varied from 12 to 40 per cent (**Table 94**).

Tapioca: The survey for PMB in tapioca crop was conducted in Annur, of Coimbatore district. The percentage of PMB infestation was high (36 %) during second fortnight of February, 2013. The infestation of PMB was low (20 %) in December 2012. The infestation level during the survey period of December 2012 to April 2013 varied from 20 to 36 per cent (**Table 95**).

Cotton: The survey for PMB in cotton crop was conducted in village Elugam valasu, Tirupur district. The percentage of PMB infestation was high (40 %) during first fortnight of February, 2013. The percentage infestation of PMB was low (12 %) in December 2012. The infestation level during survey period from December 2012 to April 2013 varied from 12 to 40 per cent (**Table 96**).

Mulberry: The survey of incidence of PMB in cotton crop was conducted in village Paruthiyur of Tirupur district. The percentage of PMB infestation was high (32 %) during first fortnight of February and March, 2013. The percentage infestation of PMB was low (12 %) in first fortnight of January 2013. The infestation level during the survey period from December 2012 to April 2013 varied from 12 to 32 per cent (**Table 97**).

Natural enemies: The parasitoid *Acerophagus papayae,* the lepidopteran predator, *Spalgis epius*, coccinellid beetles *viz*., *Brumoides suturalis*, *Scymnus coccivora* and *Cryptolaemus montrouzieri* played a major role in all the crops *viz*., papaya, tapioca, cotton and mulberry at all the locations, and the predators and parasitoids found in the survey locations were presented in **Table 98**. Among the natural enemies recorded on papaya, all the natural enemies S. No 1 to 14 (**Table 98**) were present, whereas in tapioca minimum of six natural enemies were observed. In cotton and mulberry the natural enemy population was optimum of 11.0 and 8.0 numbers respectively. Apart from natural enemies two hyperparasitoids from encyrtid family were also recorded. They were *Prochiloneurus aegyptiacus* (Mercet) and *Promuscidea unfasciativentris* (Girault). The details of the occurrence of mealybug species and their natural enemies on cotton were reported under cotton.

Table.94. Survey data of papaya mealybug in papaya field (Oddanchatram)

Grade	Number of plants infested by mealybug (Gradewise) out of 25 plants							
	2012	2013						
	December	January		February		March		April
	30	15	30	15	28	15	30	15
0	22	21	18	17	16	19	20	21
1	3	3	6	6	7	5	4	4
2	-	1	1	2	2	1	1	1
3	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-

8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-
Per cent infestation	12	16	28	40	36	24	20	16

Table 95. Survey data of papaya mealybug in tapioca field (Annur)

Grade	Number of plants affected by mealybug (Gradewise) out of 25 plants							
	2010	2011						
	December	January		February		March		April
	30	15	30	15	28	15	30	15
0	20	17	18	17	16	18	19	19
1	5	8	6	6	8	6	4	5
2	-	-	1	2	1	1	2	1
3	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-
Per cent infestation	20	32	28	32	36	28	24	24

Table.96. Survey data of papaya mealybug in cotton field (Elugam valasu)

Grade	Number of plants affected by mealybug (Gradewise) out of 25 plants							
	2010	2011						
	December	January		February		March		April
	30	15	30	15	28	15	30	15
0	22	20	18	15	17	16	18	19
1	3	5	7	7	5	7	6	5
2	-	-	-	3	4	2	1	1
3	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-
Per cent infestation	12	20	28	40	36	36	28	24

Table 97 . Survey data of papaya mealybug in mulberry field (Paruthiyur)

Grade	Number of plants affected by mealybug (Gradewise) out of 25 plants							
	2010	2011						
	December	January		February		March		April
	30	15	30	15	28	15	30	15
0	21	22	19	17	18	17	18	19
1	4	3	6	6	6	7	5	5

2	-	-	-	2	1	1	2	1
3	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-
Per cent infestation	16	12	24	32	28	32	28	24

Table 98. Natural enemies recorded on PMB from different host crops

S. No	Scientific Names	Family	Order	Host crops			
				Papaya	Tapioca	Cotton	Mulberry
1	*Spalgis epius* (Westwood)	Lycanidae	Lepidoptera	✓	✓	✓	✓
2	*Cryptolaemus montrouzieri* (Mulsant)	Coccinellidae	Coleoptera	✓	✓	✓	✓
3	*Scymnus coccivora* (Ayyar)	Coccinellidae	Coleoptera	✓	✓	✓	✓
4	*Brumoides suturalis* (Fabricius)	Coccinellidae	Coleoptera	✓	-	✓	✓
5	*Cheilomenes sexmaculatus* (Fabricius)	Coccinellidae	Coleoptera	✓	-	✓	✓
6	*Coccinella transversalis* (F.)	Coccinellidae	Coleoptera	✓	-	✓	✓
7	*Anegleis cardoni* (Weise)	Coccinellidae	Coleoptera	✓	-	-	✓
8	*Curinus coeruleus* (Mulsant)	Coccinellidae	Coleoptera	✓	-	-	-
9	*Chrysoperla zastrow*i sillemi (Esben-Petersen)	Chrysopidae	Neuroptera	✓	-	✓	-
10	*Oxyopes* sp.	Oxyopidae	Araneae	✓	✓	✓	-
11	*Tetragnatha* sp.	Tetragnathidae	Araneae	✓	✓	✓	-
12	*Acerophagus papayae* (Noyes and Schauff)	Encyrtidae	Hymenoptera	✓	✓	✓	✓
13	*Pseudleptomasti*	Encyrtidae	Hymenopter	✓	-	✓	-

	x mexicana (Noyes and Schauff)		a				
14	*Coccophagus cowperi* Girault	Aphelinidae	Hymenoptera	✓	-	-	-

OUAT

Report of Papaya Mealybug

Papaya plants in and around Bhubaneswar were found heavily infested with mealy bug *Paracoccus marginatus* during May, 2011 and subsequently report of its occurrence came from various districts of Odisha. There are very less farmers of Odisha who are doing papaya cultivation in large areas, but, almost all household in villages and even in urban areas have papaya in their backyards. This pest was also recorded from Guava, Okra, Brinjal, Hibiscus, and Teak and American silk cotton in and around Bhubaneswar. *Spalgis epius* was found to be feeding on this mealybug everywhere. Among other predators, *Cheilemenes sexmaculata, Scymnus coccivora* and green lace wing larva was found predating on this pest. The first consignment of *Acerophagus papayae* was obtained from NBAII in August 2011 and was released in OUAT and neighboring areas. The population of mealybug seemed to be reduced but not significantly. The second batch of *Acerophagus papayae* was released on 5.8.2011 in some infested areas in Bhubaneswar. By September, the infested plants recovered. Heavy rainfall in September also reduced the population of the mealy bugs. The third consignment of the parasitoid was released in some infested plants in January; 2012.The parasitoid is being multiplied on sprouted potatoes and has been supplied to farmers in and around Bhubaneswar. It was also recovered from the released sites and redistributed to other areas.

IIHR

Papaya orchards with very heavy infestion (54-68%) of exotic mealybug, *Paracoccus marginatus* were chosen in Ananthapur district, Andhra Pradesh (**Table 99**). Inoculative releases of exotic parasitoid *Acerophagus. papayae* numbering 350-850 adults / orchard / release were made. The parasitoid was found very aggressive and established very well. There were no natural enemies before release of the parasitoid (**Table 100**). The parasitoid recovered 15 days after release indicated the establishment of the parasitoid. Complete control of the mealybug was observed in 3- 4 months time. About 95-98% control in all the orchards was obtained. A total of 2600 adults were released in three orchards. In two other orchards, 1000 adults were released through the farmers whose orchards were there in Medak districts and there also the parasitoid gave excellent control.

Table 99. Details of release and control

Name of the farmer	Village & Mandal	No. of plants	% damage	No. of para-sitoid released	Remarks on control
Sri. Mutyal Reddy	Venkatampalle Chenne kothapalle	4000	68	350 750	Established in one generation and complete control of mealybug was observed in 4 months
Sri. G. Ramanji neyulu	Obulapuram Kalyandurg	6600	54	700	Established in one generation and complete control of mealybug was observed in 4

					months
Sri. Ramamohan Reddy	N.S.Gate Chenne kothapalle	4500	58	850	Established in one generation and complete control of mealybug was observed in 4 months

Table 100. Natural enemies' incidence before release of the parasitoid.

Natural enemies	Pre count	25 DAR	50 DAR	75 DAR
Cryptoleamus montrouzieri	0.00	0.00	0.00	0.00
Spalgis epeus	0.00	0.10	0.30	1.81
Scymnus sp.	0.00	0.00	0.00	0.00
Mallada boninensis	0.00	0.00	0.00	0.00
A. papayae	-	85.23	433.19	952.26

3. Extent of parasitism of *Acerophagus papayae* on tapioca in different agro climatic zones of Kerala (KAU)

KAU

Conducted survey in different agroclimatic zones of Kerala to study the extent of parasitism of *A. papayae* on tapioca. Collected the mealybug infested leaves of tapioca and kept for emergence of parasitoids. Details are given in **Table 101**.

Table 101 Extent of parasitism of *A. papayae* on tapioca

Agroclimatic zones	Area surveyed	Mealybug infestation	Extent of parasitism (mean no. /leaf)
Sub humid alluvium	Thalikulam Arattupuzha	Nil Nil	
Sub humid laterite	Pudukkad Panniyoor Thodupuzha Nedungapra	Low Nil Nil Medium	5.5 6.9
Wet laterite	Kambakodi	Nil	
Humid laterite	Thenjippalam	Nil	
Semi dry alluvium	Kizhakkunchery Wadakkumchery Alathur	Nil Nil Nil	
Semi dry forest loam	Ambalavayal Adimali	Nil Nil	

The mealybug incidence on tapioca was observed in two locations in sub humid laterite zones. Parasitoids were present in the two locations.

4. Biological suppression of mealybugs, *Maconellicoccus hirsutus* and *Ferrisia virgata* with *Scymnus coccivora* on custard apple (MPKV)

MPKV

A field evaluation of predators against mealybugs on custard apple was carried out in farmers' orchards at village Sakurde, Tal. Purandhar, Dist. Pune. The custard apple (cv. Balanagar) orchards were 5 years old and planted at 5 x 5 m distance. A separate orchard (0.15-0.20 R) was selected for release of each predators, *Scymnus coccivora* @ 5 and 10 grubs/infested tree, *Cryptolaemus montrouzieri* @ 5 grubs/tree and spraying of *Verticillium lecanii* @ 10^{13} conidia/ha. The applications of bioagents carried out twice during July-August 2012 at monthly interval. Untreated control plot was maintained separately. The incidence of mealybug species, *Maconellicoccus hirsutus* and *Ferrisia virgata* were recorded before release of the predators and post-counts at fortnightly interval from 10 fruits per tree and as such from 10 randomly selected trees per plot. Cumulative means were worked out from the surviving mealybugs population recorded at fortnightly interval. The data were transformed into √x+0.5 values for statistical analysis. The intensity rating of mealybugs on fruits was recorded in 1-5 scale from the same trees of each plot. The yield of marketable fruits per tree was recorded on weight basis at harvest.

Data in **Tables 102, 103 and 104** revealed that two releases of *Scymnus coccivora* @ 10 grubs per infested tree at monthly interval during July-August 2012 found to be significantly superior in suppressing the population of mealy bug species *viz.*, *M. hirsutus* (9.8 mealy bugs/fruit) and *F. virgata* (3.3 mealy bugs/fruit) in custard apple orchards and increased yield of marketable fruits (34.1 kg/tree). It was, however, at par with similar releases of *Cryptolaemus montrouzieri* @ 5 grubs per infested tree. The pest intensity rating was recorded low (1.0-1.1) in orchards with these treatments.

Table 102. Effect of release of predators for the control of *M. hirsutus* in custard apple

Treatment	Mealy bugs population /infested fruit					
	Pre-count	I release		II release		Average
		15 DAR	30 DAR	15 DAR	30 DAR	
T1: *S. coccivora* @ 5 grubs/tree	23.6 [a]	20.6 [a]	18.4 [b]	13.2 [b]	7.4 [b]	14.9 [b]
T2: *S. coccivora* @ 10 grubs/tree	24.2 [a]	18.1 [a]	13.1 [a]	6.7 [a]	1.3 [a]	9.8 [a]
T3: *V. lecanii* @ 10^{13} conidia/ha	24.8 [a]	21.2 [b]	20.3 [b]	14.3 [b]	5.9 [b]	15.4 [b]
T4: *C. montrouzieri* @ 5 grubs/tree	24.4 [a]	17.2 [a]	14.6 [a]	7.9 [a]	1.9 [a]	10.4 [a]
T5: Untreated control	24.0 [a]	29.8 [c]	36.7 [c]	39.7 [c]	55.4 [c]	40.4 [c]
CD (p = 0.05)	NS	0.43	0.52	0.48	0.60	0.33

Table 103. Effect of release of predators for the control of *F. virgata* in custard apple

Treatment	Mealy bugs population /infested fruit					
	Pre-count	I release		II release		Average
		15 DAR	30 DAR	15 DAR	30 DAR	
T1: *S. coccivora* @ 5 grubs/tree	9.8 [a]	8.9 [a]	4.0 [a]	3.4 [b]	1.7 [b]	4.5 [c]
T2: *S. coccivora* @ 10 grubs/tree	8.7 [a]	8.3 [a]	3.6 [a]	1.0 [a]	0.2 [a]	3.3 [a]

T3: *V. lecanii* @ 10^{13} conidia/ha	9.4 [a]	8.7 [a]	5.5 [b]	4.4 [b]	2.4 [c]	5.3 [d]
T4: *C. montrouzieri* @ 5 grubs/tree	10.1 [a]	8.0 [a]	4.6 [a]	1.6 [a]	1.1 [b]	3.8 [b]
T5: Untreated control	9.3 [a]	12.4 [b]	16.6 [c]	19.1 [c]	23.7 [d]	18.0 [e]
CD (p = 0.05)	NS	0.48	0.31	0.30	0.31	0.13

Table 104. Effect of release of predators on intensity of mealy bugs and yield of custard apple

Treatment	Pest intensity rating	Yield (kg / plant)
T1: *S. coccivora* @ 5 grubs/tree	1.4	29.2 [b]
T2: *S. coccivora* @ 10 grubs/tree	1.0	34.1 [a]
T3: *V. lecanii* @ 10^{13} conidia/ha	1.7	30.6 [a]
T4: *C. montrouzieri* @ 5 grubs/tree	1.1	32.9 [a]
T5:Untreated control	3.4	25.7 [b]
CD (p = 0.05)		4.27

5. Economic analysis of impact of release of *Acerophagus papayae* on papaya production, seed production, papaine industry, mulberry and tapioca (TNAU)

TNAU

Paracoccus menginatus was first noticed in India during June 2008 on papaya at Coimbatore, Tamil Nadu. A heavy infestation of papaya mealybug (PM) was noticed along the veins and the midribs of the older leaves and all areas of tender leaves and fruits. Young leaves become crinkled and older leaves turn yellow and dry up. Terminal shoots become bunchy and distorted. Affected trees drop flowers and fruits. In addition to injury, the mealybug secretes a honeydew-like substance that turns into a thick sooty mold growth, making the fruit inedible and unusable for the production of papain.

Since the establishment of papaya mealybug in Tamil Nadu, farmers and home gardeners have been using some chemicals and cultural control methods to control PM without much success. Some home owners cut papaya trees in their yards and the commercial growers abandoned papaya cultivation and lost hope for further rising of the crop.

The nucleus culture of the exotic parasitoids *Acerophagous papayae* Noyes& Schauff, *Anagyrus loecki* Noyes, and *Pseudleptomastix mexicana* Noyes& Schauff (Hymenoptera:Encyrtidae) were brought to Tamil Nadu Agricultural university (TNAU) through National Bureau of Agriculturally Important Insects (NBAII), Bangalore and mass production was made for large scale field release. Among the three parasitoids, *A. papayae* was found promising in Tamil Nadu and the results were reported during the last year.

Yield loss

Papaya mealybug, *Paracoccus marginatus* was first recorded in Tamil Nadu Agricultural University (TNAU) campus, Coimbatore, Tamil Nadu during July, 2008. Survey was conducted immediately throughout the state of Tamil Nadu from 2008 onwards to study the extent of damage spread and yield loss in papaya, mulberry and tapioca. The yield loss and economic analysis was worked out on papaya, mulberry and tapioca during this year.

Papaya: Cultivation for Fruits

1. Name of the farmer : Th. Kandasamy
2. Crop and variety : Papaya *Carica papaya* Linn., Var. Red Lady
3. Date of Planting : 9th July 2011
4. Planting distance : 2.0 X 2.0 m
5. Area under the crop : 1.0 ha. (2,500 plants)
6. Plant population/ha : 2,500 plants
7. Location : Malaiyandipudur, Sathiamangalam (TK)
8. Inputs used :

Seedlings/ha : 2500 seedlings/ha
Manures & fertilizers : FYM – 25 t/ha
NPK (200:200:200 g/plant) i.e. Urea- 1085 kg/ha
Super phosphate- 3125 kg/ha
Muriate of potash- 830 kg/ha

Cost of inputs/ha as per recommendations:

1. Seedlings (Rs. 10/- per seedling) : Rs. 25,000/-
2. Manures (FYM) : Rs. 15,000/-
3. Fertilizers : Rs. 40,000/-
4. Pesticides (fungicides, weedicides, insecticides) : Rs. 7,000/-
5. Labour (planting, inputs application, irrigation, harvesting): Rs. 18,000/-

Total :Rs. 105,000

Economic analysis of biological control of papaya mealybug with release of parasitoid *Acerophagus papayae* in farmer's orchard:

1. Yield of papaya fruits/ha (First Flush): av. 40 fruits/plant x 2,500 plants = 1, 00,000 fruits
   Yield on weight basis : av. 1.0 kg/fruit x 1, 00,000 fruits = 1, 00,000 kg/ha
   (Considering the weight fruits 1.0 kg/fruit in first flush)

2. Market value of papaya fruits (per ha) : av. Rs. 5/- per kg fruit x 1,00,000 kg = Rs. 5,00,000/- (The current market rate is Rs. 5 per kg fruit)

3. Yield of papaya fruits from second flush/ha : av. 30 fruits/plant x 2,500 plants
On number basis = 75,000 fruits/ha
On weight basis = 1.0 kg/fruit x 75,000 fruits
= 75,000 kg/ha

4. Market value of papaya fruits in the second flush (per ha): av. Rs. 5/- per kg fruit x75,000 kg = Rs. 3,75,000/-

Gross return for Two fushes = 5, 00,000 + 3, 75,000 = 8, 75,000 /-
Hence for one season = Rs.4, 37,500/-
Net profit = 4, 37,500 – 1, 05,000 = 3, 32,500 / ha.
Net profit for 2 flushes = Rs 6, 65,000

The incidence of papaya mealybug started in the month of October 2011 and about 45% of papaya fruits were infested with papaya mealybug during January 2012. Such papaya plants had bearing of Average of 22 fruits/plant.

Therefore, No. of infested plants/ha on farmer's field = 1125 plants/ha(45%)
No. of fruit loss due to PMB infestation = 18 fruits/plant X1125 infested plants

= 24,750 infested fruits/ha

5. Quantity fruit loss (wt. basis)/ha during first flush (May, June, July) = 1.0 kg/fruit X 24,750

   = 24,750 kg infested fruits/ha

6. Loss in terms of cash receipt = Rs.5/- per kg X 24,750 kg infested fruits= Rs 1,23,750/-

To control PMB infestation, the parasitoid *Acerophagus papayae* was released @ 100 adults/acre in the first week of January 2012 and February 2012 in the mealybug colonies on infested papaya plants in the farmer's orchard. The parasitoid population built-up rapidly and a population of 90-120 adults/leaf of parasitoid was observed on PMB infested fruits and leaves of papaya by first week of May 2012. Then the pest incidence was declined and during June-July 2012, it was less than 5 per cent. More than 95% control of PMB was observed in parasitoid released plots. During the second flush of the crop, the PMB infestation was very low due to release of parasitoid in the first flush.

7. Cost of inputs for 2 flushes = Rs. 2,10,000/-

Loss inflicted due to 45% infestation of PMB = Rs. 1,23,750/-

The expenditure incurred on inputs + Loss due to PMB = 2,10,000 + 1,23,750/-

= 3, 33,750/-

8. If the parasitoid release was not undertaken, total losses voided due to PMB = 6,65,000/-

(i.e. loss of entire crop) (For 2 seasons)

9. Due to parasitoid release, the losses voided by PMB = Rs. 3,32,500/-

10. Benefit to farmer due to release of parasitoid = Rs. 3,32,500-1,05,000 – Rs. 2,27,500/ one season

Cultivation for Latex

1. Name of the farmer : Th. Ram Kumar
2. Crop and variety : Papaya *Carica papaya* Linn., Var. East Coast Sincta
3. Date of Planting : 6th June 2011
4. Planting distance : 2.0 X 2.0 m
5. Area under the crop : 1.0 ha. (2,500 plants)
6. Plant population/ha : 2,500 plants
7. Location : Viruvedampalayam, Palladam
8. Inputs used :

Seedlings/ha : 2500 seedlings/ha

Manures & fertilizers : FYM – 25 t/ha

NPK (200:200:200 g/plant) i.e. Urea- 1085 kg/ha

Super phosphate- 3125 kg/ha

Muriate of potash- 830 kg/ha

Cost of inputs/ha as per recommendations:

1. Seedlings (Rs. 10/- per seedling) : Rs. 25,000/-
2. Manures (FYM) : Rs. 15,000/-
3. Fertilizers : Rs. 40,000/-
4. Pesticides (fungicides, weedicides, insecticides) : Rs. 7,000/-
5. Labour (planting, inputs application, irrigation, harvesting): Rs. 18,000/-

Total : Rs. 105,000/-

Economic analysis of biological control of papaya mealybug with application of parasitoid *Acerophagus papayae* in farmer's orchard:

1. Yield of papaya wet latex/ha (First Flush): 3000 kg

2. Market value of papaya latex (per ha) : av. Rs. 100/- per kg x 3,000 kg = Rs. 3,00,000/-
   (The current market rate is Rs. 100 per kg latex)

3. Yield of papaya latex from second flush/ha : 2750 kg

4. Market value of latex in the second flush (per ha): av. Rs. 100/- per kg x 2750 kg
   = Rs. 2,75,000/-

Gross return for Two fushes = . 3,00,000 + 2,75,000 =5,75,000 /=
Net profit = 5,75,000 – 2,10,000 = 3,65,000 / ha. for 2 flushes
The incidence of papaya mealybug started in the month of September 2011 and about 40% of papaya fruits were infested with papaya mealybug during December 2011.Such papaya plants had bearing of average of 30 fruits/plant.

Therefore, the wet latex yield inturn reduced to 2520 Kg in the first flush and 2700 kg in the second flush.

5. Quantity of latex loss /ha during first flush (March onwards)(3000-2520) = 480 kg
   Monetary loss during first flush = 480 x100 =Rs 48000 /ha
6. Quantity of latex loss /ha during second flush =2750-2700 = 50 kg

Monetary loss during second flush (papaya mealy bug was controlled by release of parasitoid in the first flush) = 50 x100 = Rs5000 /ha

7. Loss in terms of cash receipt = Rs.53,000/- for 2 flushes

To control PMB infestation, the parasitoid *Acerophagus papayae* was released @ 100 adults/acre in the first week of December 2011 and January 2012 in the mealybug colonies on infested papaya plants in the farmer's orchard. The parasitoid population built-up rapidly and a population of 60-90 adults/leaf of parasitoid was observed on PMB infested fruits and leaves of papaya by first week of March 2012. Then the pest incidence was declined and during May-June 2012, it was less than 5 per cent. More than 95% control of PMB was observed in parasitoid released plots. During the second flush of the crop, the PMB infestation was very low.

1. Cost of inputs for 2 flushes = Rs. 2,10,000/-

Loss inflicted due to 40% infestation of PMB = Rs. 53,000/-
The expenditure incurred on inputs + Loss due to PMB = 2,10,000 + 53,000/-
= 2, 63,000/-

2. If the parasitoid release was not undertaken, total losses voided due to PMB = 5,75,000/- (i.e. loss of entire crop) for 2 seasons
3. Due to parasitoid release, the losses voided by PMB = Rs. 2,87,500/- for one season
4. Benefit to farmer due to release of parasitoid = Rs. 2,87,500 – Rs. 1,05,000=Rs.1,82,500

Area under papaya cultivation in Tamil Nadu during 2011-12 = 2000 ha
Production of papaya fruits = 2,46,150 MT (1500 ha. Under fruit production)

As per the area under papaya fruit cultivation in Tamil Nadu (1500 ha) and total income Rs. 6.65 lakh per ha for 2 flushes.

Based on these figures, the estimated annual gain and loss due to PMB in Tamil Nadu:
Total revenue receipts for the state = 123.08 crores per annum from fruits alone)
Total revenue receipts for the state = 28.75 crores per annum from latex alone)
Total loss due to PMB in the state = 46.8+13.15= 59.95 crores per annum

Cultivation of Tapioca

1. Name of the farmer : Th. Azhagar
2. Crop and variety : Tapioca, Var. H 226
3. Date of Planting : 17.6.2012
4. Planting distance : 75 X 75 cm m
5. Area under the crop : 1.0 ha. (17000 setts)
6. Plant population/ha : 17000 plants
7. Location : Nallur pirivu, Pollachi, Coimbatore
8. Inputs used :

Seedlings/ha : 17000 setts/ha
Manures & fertilizers : FYM – 25 t/ha
NPK (90:90:240 kg/ha) i.e. Urea- 200 kg/ha
Super phosphate- 560 kg/ha
Muriate of potash- 400 kg/ha

Cost of inputs/ha as per recommendations:

1. Planting material (17000 setts) and sett treatment : Rs. 2,250/-
2. Manures (FYM) : Rs. 15,000/-
3. Fertilizers : Rs. 12,000/-
4. Pesticides (fungicides, weedicides, insecticides) : Rs. 6,000/-
5. Labour (planting, inputs application, irrigation, harvesting) : Rs. 23,500/-

Total : Rs. 58,750/

Economic analysis of biological control of papaya mealybug with the release of parasitoid *Acerophagus papayae* in farmer's field in tapioca:

1. Yield of Tapioca/ha : 42 tons/ha.
2. Market value of Tapioca (per ha) :. Rs. 3500/- per ton x 42
   = Rs. 1, 47,000/- (The current market rate is Rs. 3500 per ton.)

Gross return = Rs. 1, 47,000/-
Net profit =1, 47,000 - 58,750 =Rs 88,250 /

The incidence of papaya mealybug was noticed in the month of October 2012 and 35 per cent plants in the farmers field were infested with papaya mealybug.

Yield loss due to PMB infestation = 42x35/100 = 14.7 tonnes/ha

3. Monetary Loss /ha. = Rs.3500/ x14.7 = Rs 51450/ha.

To control PMB infestation, the parasitoid *Acerophagus papayae* was released twice @ 100 adults/acre in the last week of October 2012 and second week November 2012. The parasitoid population built-up rapidly and its population seen numerous (50-80 adults/leaf) on PMB infested plants by first week of January 2013. About 60% control of PMB was observed in parasitoid released plots.

Loss inflicted due to 35% infestation of PMB = Rs. 51,450/-

The expenditure incurred on inputs + Loss due to PMB = 58,750 + 51,450/-
= 1,10,200/-

4. If the parasitoid release was not undertaken, total losses voided due to PMB = 88,250/- (i.e. loss of entire crop)

5. Benefit to farmer due to release of parasitoid = Rs. 88,500/ season
6. Area under tapioca cultivation in Tamil Nadu during 2011-12 = 1,20,000 ha

7. Production of tapioca = 5.9645 million tonnes
8. Based on these figures, the estimated annual gain and loss due to PMB in Tamil Nadu:

Total revenue receipts for the state = Rs. 3500x5964500= Rs 2087 crores per annum)
Total loss due to PMB in the state 617.4 crores per annum

Economic analysis of biological control of papaya mealybug with the release of parasitoid *Acerophagus papayae* in farmer's field in Mulberry:

Loss due to papaya mealybug damage in mulberry

Name of the farmer : Th. Kumarasamy, Jothiarpatty.
Mulberry variety : V1/MR2
Silk worm race : CSR2 x CSR 4/ PM x CSR2/ Double hybrid
Crops/ year : 5 crops/year
Leaf yield V_1 :62500 kg/ha.
MR_2 :32500 kg/ha.

Total area of mulberry in Tamil Nadu : 13,200 ha.
Papaya mealybug affected mulberry area : 4,000 ha
Approximate average loss : upto 50 %
No of dfls / ha / yr : 3750 dfls
Expected Cocoon yield/ ha (@60 kg / 100 dfls): 2250 kg
Amount realized if no damage / ac : 2250 kg x Rs. 300 (per kg of cocoon)
: Rs. 6,75,000/-
For 4000 ha. : Rs. 270 crores

At 50 % loss due to PMB damage, the loss is: Rs. 135 crores

Savings due to non use of pesticides in mulberry

Total area of mulberry : 13,200 ha.
Papaya mealybug affected mulberry area : 4,000 ha.
Cost of pesticides for two sprays / crop : Rs. 1500 /-
Labour cost for spraying / crop / ha : Rs. 1000/-
Total cost for spraying / crop/ ha `: Rs. 2500/-
Total cost for spraying for five crops / ha : Rs. 12500/-
Total cost for spraying 4000 ha. : Rs. 5.00 crores / annum
Total Saving due to release of parasites in Tamil Nadu per annum is
(Rs. 135 cr. + Rs. 5 cr**)** **= Rs. 140 crore**

6. Bio-efficacy of EPNs against Citrus trunk borer, *Anoplophora versteegi* (CAU)

Field evaluation for bio-efficacy of seven strains (collections) of entomopathogenic nematodes (EPNs) *viz*. NBAII-01, NBAII-04, CAU-1, CAU-2 and CAU-3, CAUH-1 and CAUH-2 was carried out at two locations (Pasighat and Ringging) of Arunachal Pradesh against Citrus trunk borer, *Anoplophora versteegi*. The EPNs were applied in two types of application *viz.* stem injection and cadaver application (wrapping cadaver by muslin cloth and binding at one meter height from the ground level). Two rounds of application were made once during last week of April and the second application at second week of May. Observations were recorded at monthly interval starting one month after the first application of the EPNs upto August by counting the number of spots where fresh frass materials were expelled. For application of the EPNs, in each location three orchards were selected and in each orchard, five infested plants were selected for each treatment. One control treatment in each orchard was also maintained for comparison. Application of EPNs as cadaver did not showed any significant reduction in *A. versteegi* infestation in both the location. In case of stem injection, a significant reduction *A. versteegi* infestation in was observed after the second round of injection in May and observation recorded in July and August than the untreated control at Pasighat. Lowest infestation of 1.13 trunk borer/ plant was recorded in CAUH-1 during July and 0.87trunk borer/plant in NBAII-01 and CAU-1 in August. No significant difference was observed in trunk borer infestation between the different EPN collections during August. Similarly at Ringing, significantly lower infestation of trunk borer was observed in all the EPN collections than the untreated control during July and August except NBAII-01 (1.47 trunk borer/ plant) during July and CAU-2 (1.13 trunk borer/ plant) during August (**Table 105 & 106**).

Table. 105. Bio-efficacy of entomopathogenic nematodes against citrus trunk borer applied as cadaver against *Anoplophora versteegi* in *Citrus reticulate.*

Treatments	Pasighat (trunk borer/plant)				Ringging (trunk borer/plant)			
	One day before the first treat.	One month after the first treat.	Two month after the first treat.	Three month after the first treat.	One day before the first treat.	One month after the first treat.	Two month after the first treat.	Three month after the first treat.
NBAII-01	1.20 (1.30)	1.40 (1.37)	1.27 (1.33)	1.20 (1.30)	1.20 (1.30)	1.33 (1.35)	1.53 (1.42)	1.27 (1.33)
NBAII-04	1.27 (1.33)	1.53 (1.42)	1.40 (1.37)	1.27 (1.33)	1.13 (1.27)	1.47 (1.40)	1.47 (1.40)	1.20 (1.30)
CAU-1	1.13 (1.27)	1.60 (1.44)	1.47 (1.40)	1.33 (1.35)	1.27 (1.33)	1.33 (1.35)	1.53 (1.42)	1.20 (1.30)
CAU-2	1.40 (1.37)	1.67 (1.47)	1.33 (1.35)	1.13 (1.27)	1.20 (1.30)	1.47 (1.40)	1.40 (1.37)	1.27 (1.33)
CAU-3	1.20 (1.30)	1.53 (1.42)	1.47 (1.40)	1.13 (1.27)	1.27 (1.33)	1.40 (1.37)	1.67 (1.47)	1.33 (1.35)
CAUH-1	1.27 (1.33)	1.40 (1.37)	1.47 (1.40)	1.33 (1.35)	1.13 (1.27)	1.47 (1.40)	1.53 (1.42)	1.20 (1.30)
CAUH-2	1.20 (1.30)	1.73 (1.49)	1.33 (1.35)	1.27 (1.33)	1.13 (1.27)	1.60 (1.44)	1.50 (1.42)	1.27 (1.33)
Control	1.13	1.67	1.53	1.27	1.27	1.60	1.73	1.40

	((1.27)	(1.47)	(1.42)	(1.33)	(1.33)	(1.44)	(1.49)	(1.37)
SEd	0.05	0.05	0.03	0.08	0.04	0.09	0.05	0.06
$CD_{0.05}$	NS	NS	NS	NS	NS	NS	NS	NS
CV%	4.52	4.39	2.84	7.82	3.32	7.82	4.48	5.67

Figures in the parentheses are $(x+0.5)^{1/2}$ transformed values**.**

Table. 106. Bio-efficacy of entomopathogenic nematodes against citrus trunk borer applied as injection, *Anoplophora versteegi.*

Treatments	**Pasighat**				**Ringging**			
	One day before the first treat.	**One month after the first treat.**	**Two month after the first treat.**	**Three month after the first treat.**	**One day before the first treat.**	**One month after the first treat.**	**Two month after the first treat.**	**Three month after the first treat.**
NBAII-01	1.33 (1.35)	1.60 (1.44)	1.40 (1.37)	0.87 (1.17)	1.13 (1.27)	1.40 (1.37)	1.47 (1.40)	1.07 (1.25)
NBAII-04	1.40 (1.37)	1.53 (1.42)	1.33 (1.35)	1.00 (1.22)	1.20 (1.30)	1.33 (1.35)	1.20 (1.30)	1.00 (1.22)
CAU-1	1.33 (1.35)	1.53 (1.42)	1.33 (1.35)	0.87 (1.17)	1.27 (1.33)	1.33 (1.35)	1.33 (1.35)	1.07 (1.25)
CAU-2	1.33 (1.35)	1.40 (1.37)	1.33 (1.35)	0.93 (1.19)	1.27 (1.33)	1.40 (1.37)	1.33 (1.35)	1.13 (1.27)
CAU-3	1.40 (1.37)	1.47 (1.40)	1.40 (1.37)	1.07 (1.25)	1.07 (1.25)	1.33 (1.35)	1.40 (1.37)	0.93 (1.19)
CAUH-1	1.27 (1.33)	1.60 (1.44)	1.13 (1.27)	0.93 (1.19)	1.20 (1.30)	1.40 (1.37)	1.33 (1.35)	0.87 (1.17)
CAUH-2	1.27 (1.33)	1.53 (1.42)	1.27 (1.33)	1.00 (1.22)	1.20 (1.30)	1.33 (1.35)	1.20 (1.30)	0.93 (1.19)
Control	1.40 (1.37)	1.67 (1.47)	1.73 (1.49)	1.47 (1.39)	1.20 (1.30)	1.67 (1.47)	1.73 (1.49)	1.53 (1.42)
SEd	0.05	0.04	0.04	0.06	0.03	0.05	0.04	0.07
$CD_{0.05}$	NS	NS	0.08	0.12	NS	NS	0.10	0.15
CV%	4.63	3.43	3.20	5.72	2.92	4.39	4.03	7.13

Figures in the parentheses are $(x+0.5)^{1/2}$ transformed values.

7. Natural enemies associated with mango pulp borer (OUAT)

No Report

2.11. Temperate Fruits

1. Survey for identification of suitable natural enemies of codling moth (SKUAST)

Fewer numbers of endoparasitic ichneumonid and ectoparasitic braconid were found associated with overwintered larvae of codling moth in Kargil. The parasitoids were found both under the bark of principal host plant and other trees as well. The parasitoids overwintered in the host larvae and emerged during late June to early July. Attempts will be made during 2013 to collect, identify and rear the above mentioned parasitoids on *Corcyra*.

2. Field evaluation of mass released *Trichogramma embryophagum* against codling moth, *Cydia pomonella* on apple (SKUAST)

Two sequential releases of *Trichogramma embryophagum* and *T. cacoeciae* were done in the apple orchards of Kargil during June to July' 2012. Three different treatments, comprising *Trichogramma* only (T_1), Pheromone traps only (T_2) Trichogramma + traps (T3) were provided in nine different orchards. Each treatment was provided to three different orchards. Data was compared with untreated control. T_1 was given at Poyen Kharrol and Shanigund hill, T_2 at Mangmore, Bhag-e-Khomini and Hardas (Gongkuk), whereas T_3 at Shanigund plain, Mingy and Slikchey. Orchard at Hardas (Gond) was taken as control. *Trichogramma cacoeciae* were released at Poyen and Bagh-e-Khomini. Two sequential releases of *Trichogramma* spp. @ 2500- 3000 adult wasps/ tree and twice use of pheromone traps @ 4 traps/ orchard were made during the year 2012. Each orchard had approximately 20 to 100 fruit bearing apple trees. Data on per cent fruit damage was recorded for on tree fruit damage and dropped fruits specifically infested by Codling moth, *Cydia pomonella*. Ten trees were randomly selected for collecting data on fruit damage. For on tree fruit damage, data was recorded from all the four sides of the tree, whereas for dropped fruits, infested fruits were collected from ten trees and included only those apple fruits under observation with symptoms of codling moth damage. Average fruit damage was determined by taking mean of per cent damage on tree and fallen fruits. Percent decline in fruit damage was obtained by subtracting average damage under control condition from respective orchards under treatment. Pheromone traps were removed after one month from each location and each was counted for the number of trapped moths. Data obtained were analyzed statistically using Mini tab.

Average apple fruit damage (on tree + dropped) in treated orchards, during 2012, ranged 56.8 to 70.2 per cent, as compared to 79.5 per cent in untreated control (**Table 107**). Per cent reduction in fruit damage over control ranged 9.3 to 22.7 and was found statistically significant. Average catch of codling moth per trap during June and July ranged 119.8 and 41.6 respectively (**Table. 108**). Although average catch of codling moth location wise, both during the month of June and July were non-significant, nevertheless average catch during above mentioned period differed statistically significant when compared through Student's t- test. Average fruit damage (%) and per cent decline in fruit damage over control, as a result of treatments, T_1, T_2 and T_3 was recorded as 66.3(13.8), 63.2 (16.3) and 60.2 (19.3) respectively (**Fig. 3**). In terms of per cent reduction in damage over control, treatment T_3 (use of *Trichogramma* + pheromone) was found superior to both T_2 (traps only) and T_1 (use of *Trichogramma* only). Data on per cent decline in fruit damage over control when compared statistically through Students t- test also revealed significant difference between treatments such as, T3 and T1, T3 and T2 and, T1and T2. A

negative correlation between treatments and average fruit damage but positive correlation between treatments and per cent decline in fruit damage, however indicated the positive role of all the three treatments over control. Yield data from the studied orchards could not be obtained.

In view of above mentioned magnitude of damage, despite the treatments, the frequency of mass release program of *Trichogramma* spp., along with pheromone traps need to be much more intensive. Importation and release of other *Trichogramma* species like *T. platneri* is also need of the hour. The interest and cooperation of farmers however regarding adoption of certain important cultural practices like trunk banding, disposal of infested fruits and also selection of more suitable apple varieties, which might have significant impact on the reduction of the population of codling moth, is however still lacking and sole cause of codling menace in Leh.

Table 107. Impact of field releases of *T.embryophagum* and *T. cacoeciae* against codling moth, *Cydia pomonella* in apple orchards, at Kargil, during 2012

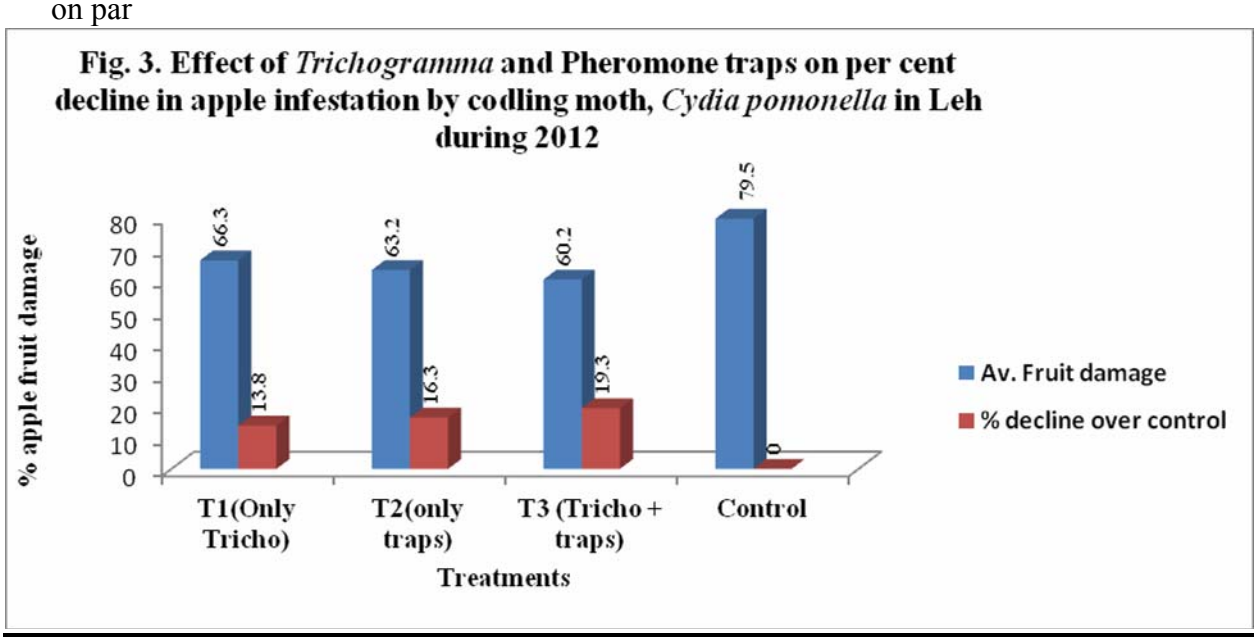
Locations	Damage of fruits on tree (%)	Damage in dropped fruits (%)	Average fruit damage (%)	% Reduction in fruit damage over control
Poyen	30.6 (33.3) [a]	97.6 (82.3) [c]	64.1 (53.4) [ab]	15.4 (22.9) [ab]
Kharrol	43.3 (41.2) [b]	95.0 (78.3) [bc]	70.2 (56.4) [b]	9.3 (17.9) [a]
Shanigund hill	33.6 (35.5) [a]	95.5 (78.6) [bc]	64.6 (53.6) [ab]	16.8 (22.5) [ab]
Mangmore	34.5 (36.1) [a]	91.0 (73.3) [b]	62.8 (52.5) [a]	16.8 (24.1) [b]
Bagh-e- Khomini	27.8 (31.6) [a]	95.5 (78.4) [bc]	61.7 (51.9) [a]	17.9 (24.0) [b]
Hardas(Gongkuk)	37.2 (37.6) [ab]	93.0 (75.4) [b]	65.1 (54.0) [ab]	14.4 (21.6) [a]
Shanigund plain	26.9 (31.1) [a]	86.7 (69.4) [a]	56.8 (49.0) [a]	22.7 (28.3) [c]
Mingy	28.7 (31.9) [a]	92.5 (75.1) [b]	60.6 (51.3) [a]	18.9 (25.7) [c]
Slikchey	31.1 (33.5) [a]	95.1 (78.1) [b]	63.1 (52.9) [ab]	16.4 (23.2) [ab]
Untreated Check	61.6 (51.9) [c]	97.5 (81.7) [c]	79.5 (63.4) [c]	--
C.D.(0.05)	**5.05**	**3.04**	**3.8**	**3.7**
C.V.=	40.7	5.13	12.3	46.6

- Figures in each column represent mean of 10 observations
- Values in parentheses are arc sin transformations
- Similar alphabets in a column indicate values statistically on par

Table 108. Mass trapping of codling moth, *Cydia pomonella* through pheromone traps in apple orchards at Kargil during 2012

Location	Average no. of codling moth trapped per trap		Stdent's t- test
	June	July	
Bagh-e- Khomini	167.75 (12.4)[a]	35.5 (5.9)[a]	-5.12**; d.f.= 32
Hardas(Gongkuk)	96.5 (9.6)[a]	34 (5.6)[a]	
Mangmore	126.75 (10.6)[a]	40.25 (6.07)[a]	
Shanigund plain	134.75 (11.3)[a]	46.25 (6.6)[a]	
Mingy	106.5 (10.06)[a]	48.5 (6.9)[a]	
Slikchey	87 (9.03)[a]	45.5 (6.7)[a]	
C.D. (0.05)	**4.4**	**2.03**	
c.v. (0.05)	**56.5**	**44.38**	

- Figures in each column represent mean of 4 observations; values in parentheses are square root transformations; similar alphabets in a column indicate values statistically on par



3. Observations on the natural enemies of seed infesting *Eurytoma* of apricots in Laddakh (SKUAST)

Examination of dropped fruits of apricot at Shanigund, Hardass and Mangmore, during late July of 2012, although indicated the presence of seed infesting *Eurytoma* sp., however no natural enemies could be observed in the examined samples, at any of the above mentioned location. Because of strict quarantine, the samples could not be brought in the valley for further laboratory study.

4. Evaluation of entomopathogenic fungi and EPNs for the suppression of Apple root borer, *Dorysthenes hugelii* under field conditions (YSPUHF).

Entomopathogenic fungi, *Beauveria bassiana* and *Metarhizium anisopliae* (10^6 conidia/ cm^2 each), and EPNs, *Steinernema carpocapsae, Heterorhabditis indica* (80IJ/ cm^2 each), were evaluated against apple root borer, *Dorysthenes hugelii* and compared with chlorpyriphos (0.06%) and untreated control in the farmer's field at Chopal, District Shimla, Himachal Pradesh. The experiment was conducted on bearing trees of apple (cv. Royal Delicious) in randomized block design with each treatment replicated four times. The treatments were applied during the month of October, 2012 and the observations were recorded during January, 2013 at the time of basins preparation. During observation number of live and dead larvae of *D. hugelii* were counted and pooled to get total number of larvae present in the tree basin for calculation of per cent mortality. Data presented in **Table 109** revealed that chlorpyriphos (0.06%) resulted in the highest grub mortality (86.4%) followed by (74.4%) by *Metarhizium anisopliae* (10^6 conidia/cm^2). Other biopesticides like *Beauveria bassiana* (10^6 conidia/cm^2), *Heterorhabditis indica* and *Steinernema carpocapsae*(80 IJ/cm^2 each) were moderately effective against apple root borer resulting in 34.0, 45.9 and 34.9 per cent mortality of the grubs, respectively, as against 8.5 per cent in untreated control.

Table 109: Evaluation of entomopathogenic fungi and EPNs against *Dorysthenes hugelii*

Sr. No	Treatment	Grub mortality (%)
1	*Steinernema carpocapsae* (80 IJ/cm²)	34.9 (36.1)[b]
2	*Heterorhabditis indica* (80 IJ/cm²)	45.9 (42.7)[b]
3	*Beauveria bassiana* (10^6 conidia/cm^2)	34.0 (35.4)[b]
4	*Metarahizium anisopliae* (10^6 conidia/cm²)	74.4 (59.9)[a]
5	Chlorpyriphos (0.06%)	86.4 (68.5)[a]
6	Control(Untreated)	8.5 (14.8)[c]
	CD(p=0.05)	(9.4)
	CV(%)	57.9

Figures in parentheses are arc sine transformed values

5. Evaluation of predatory mite in combination with horticultural mineral oils (HMO) for the management of phytophagous mites on apple (YSPUHF).

The experiment to evaluate predatory mite, *Neoseiulus longispinosus* along with HMO, NeemBaan and fenazaquin against phytophagous mites of apple was conducted on 2-3 years old young plants having statistically on par mite population of 7.4 to 9.0 mites /leaf during May to July, 2012. Each treatment module consisted of three applications/ release of acaricide/ predator at three weeks interval starting from May till July. Data on mite population was recorded 15 days after final release/spray. The experiment was laid in a randomized block design with each treatment module replicated 5 times. Data presented in Table 4 showed that three sprays of fenazaquin (0.0025%) at three weeks interval was the most effective as the average mite population in these trees was 2.4 mites/leaf. Three releases of *N. longispinosus* at three weeks interval and HMO (1.0%) + 2 releases of *N. longispinosus* were statistically on par with fenazaquin (0.0025%), as the average mite population in plants treated with these treatments was 3.4 and 5.4 mites/leaf, respectively. Plants sprayed with HMO (1.0%) and NeemBaan (3ml/l) also had significant lower mite population (9.2 and 9.8 mites/leaf, repectively) than untreated plants (23.8 mites/ plant). (**Table 110**)

Table 110: Evaluation of predatory mite in combination with horticultural mineral oils (HMO) against phytophagous mites on apples

Sr. no	Treatment module	Average mite population/leaf	
		Before treatment	15 days after final treatment
1	*N. longispinosus* (150/plant) (3 releases)	8.4	3.4[a]
2	HMO (1.0 %) (3 sprays)	7.4	9.2[b]
3	HMO (1.0 %)+ *N. longispinosus* (2 releases)	8.2	5.4[a]
4	NeemBaan (1500 ppm; 3 ml/l) (3 spray)	7.4	9.8[b]
5	Fenazaquin (0.0025%) (3 sprays)	7.8	2.4[a]
6	Control(Untreated)	9.0	23.8[c]
7	CD(p=0.05)		3.5

2.12. Vegetables

1. Developing bio intensive IPM package for the pests of Cole crops (AAU-J, PAU, SKUAST, and YSPUHF)

AAU-J

The field experiment was carried out in farmers' field located at Allengmora, Jorhat to evaluate the bio control based IPM package against cabbage aphid *Brevicoryne brassicae* and other lepidopteran pests of cabbage during *rabi* 2012-13. The IPM package was compared with farmers' practice (chemical control) and untreated check.

The plot size was 4x4 m with 5 replications. The cabbage (var. Golden Acre) was transplanted during first week of November'2012. The IPM package included border plantation of mustard crop to collect and destroy eggs of *Plutella xylostella* (DBM), release of *Chrysoperla zastrowi sillemi* @ 5 larvae /plant against *Brevicoryne brassicae,* three releases of *Trichogramma chilonis, T. brassicae* @ I,00,000/ha against DBM and *T. pieridis* @ 1,00,000/ha against *Pieris brassicae* at 7-days interval when moths and eggs of the lepidopteran pests were seen in the field, mechanical collection of egg masses and early instar larvae of lepidopteran pests, spray of NBAII Bt (1 kg/ha) at 15-days interval and NSKE 5% against DBM and *P. brassicae*. at 10- days interval for 3 times. A separate area was maintained at an isolated distance, about 50 – 60 m away from IPM plots for both farmers' practice and untreated control.

First spray and release of bio agents was started 25 days after transplanting (DAT) on spotting nymphs of *B. brassicae* and eggs of *P. brassicae* and DBM, respectively. Subsequently, the treatments were imposed in IPM plot at weekly interval. In farmer's practice, malathion 50 EC @ 0.05% was sprayed at 25 DAT. Altogether 5 sprays were given at ten days interval. All treatments were compared with control plot.

Observations on pre and post count were recorded on number of *B. brassicae* (3 leaves/plant), larvae of *P. brassicae* and DBM/5 plants/replicate at 10 days intervals in 3 different locations. Population of natural enemies observed on plant was also assessed. Yields of marketable heads also determined for each treatments.

The results presented in the **Table 111** showed that the population of *P. brassicae* and DBM significantly reduced from 2.45 to 1.34 and 4.85 to 1.94 where as in farmer's practice they were 2.6 to 1.4 and 4.65 to 1.97, respectively after 55 DAT (third spray). While considering the population of *B. brassicae*, no significant differences was observed in between BIPM and farmers practice. Maximum yield (169.9q /ha) was registered in IPM package which was significantly superior to farmer's practice (163.7 q /ha). The minimum yield (78.3 q/ha) was observed in control plots. The occurance of coccinellids was higher in IPM plot than farmers' practice. It was concluded that the IPM package was as effective as chemical control in reducing the incidence of sucking and lepidopteran pests and thereby increasing the marketable yield of cabbage.

Table 111: Developing BIPM package for the pests of cabbage

Treatment	*B. brassicae*/leaf				*P. brassicae*/plant				*P. xylostella*/plant				Yield q/ha
	Pre count	Post count* after sprays			Pre count	Post count* after sprays			Pre count	Post conut* after sprays			
		1st	2nd	3rd		1st	2nd	3rd		1st	2nd	3rd	
IPM plot	15.85	10.66[a]	8.47[a]	5.14[a]	2.45[a]	2.05	1.85[a]	1.34[a]	4.85	4.03[a]	3.05[a]	1.94[a]	169.9[a]
Farmers' Practice	16.04	9.42[a]	7.00[a]	4.47[a]	2.60	2.17[a]	1.51[b]	1.40[b]	4.65	4.34[a]	2.57[a]	1.97[c]	163.7[b]
Untreated control	17.18	19.56[b]	20.56[b]	23.18[b]	2.54	2.94[b]	2.77[c]	3.25[c]	4.42	4.68[b]	6.05[b]	6.80[b]	78.3[c]
SEd±	0.67	0.34	0.41	0.64	0.15	0.14	0.13	0.15	0.19	0.16	0.27	0.32	2.53
CD at (=0.05)	1.44	0.75	0.90	1.40	0.32	0.31	0.28	0.32	0.41	0.35	0.60	0.70	5.52
CV (%)	10.74	6.93	9.18	15.65	15.71	15.91	16.8	19.9	10.87	9.93	18.85	23.8	4.88

*Mean of 2 observations. Means in the same column by common letter are not significantly different

PAU

The experiment on developing BIPM for the management of pests was conducted on cauliflower (S-41 hybrid) from late November 2012 to March 2013 at Entomological Research Farm PAU, Ludhiana. The experiment was conducted on a plot size of 66 m^2 in the RBD with 3 replications for each treatment. The incidence of *B. brassicae* and DBM was negligible. However, there was very high incidence of *P. brassicae* during the second week of February and the following treatments were applied.

Treatments

i. Release of *C. z. sillemi* @ 5 larvae/plant at weekly interval.
ii. Planting of mustard crop to collect and destroy eggs of *P. brassicae*.
iii. Spray of Neemazal (1%) @ 600 ml/ac.
iv. Release of *T.pieridis* @ 1,00,000/ ha against *P. brassicae*.
v. Mechanical collection and destruction of *P. brassicae* eggs
vi. Dipel 8L @ 300 ml/ ac
vii. Farmers' practice: Quinalphos 25 EC @ 400 ml/ ac
viii. Control

The data was recorded from five plants/ replication at 3rd, 7th and 10th day after treatment (DAT). The data presented in **Table 112** revealed that after 3 DAT, spray of Dipel (4.9 larvae/ plant) was better in reducing the number of larvae of *P. brassicae* on the cauliflower and it was significantly at par with Quinalphos (5.8 larvae/ plant). Both the treatments i.e. Dipel and quinalphos were significantly better than mechanical collection (11.6 larvae/ plant), planting of mustard crop (12.2 larvae/plant), release of *T. pieridis* @ 1,00,000/ha (12.8 larvae/ plant) and spray of 5% NSKE (16.4 larvae/plant) which were significantly at par with one another. However, all the treatments were significantly better than untreated control. After 10 DAT, Dipel (3.13 larvae/plant) and Quinalphos (4.36 larvae/ plant) were found best being at par with each other, followed by spray of 5% NSKE (8.4 larvae/ plant) and release of *T. pieridis* @ 1,00,000/ ha (11.3 larvae/plant). The yield was high Dipel (200.8 q/ha) and Quinalphos (205.4 q/ha) being at par with each other, followed by NSKE 5% (188q/ha) and *T. pieridis* (188.6 q/ha) which were at par with each other. The pooled data of 10 days indicated that both Dipel and Quinalphos were at par with each other and better than all other treatments including control in minimizing the population of *P. brassicae* and increasing the cauliflower yield. The influence of rest of the treatments on the incidence of *P. brassicae* was significantly at par with one another and better than control.

Table 112: Evaluation of different bioagents against *P. brassicae* on cauliflower

Treatments	Mean No. of larvae/plant after spray or release*					Marketable yield**
	Pre-count	3 DAT	7 DAT	10 DAT	Mean	Q / ha
Planting of mustard crop on the borders	5.6	12.2^{b}	13.2^{bc}	13.8^{c}	13.1^{b}	179.2^{c}
NSKE 5%	21.1	16.4^{b}	17.2^{c}	8.4^{b}	14.0^{b}	188.02^{bc}
Release of *T. pieridis* @ 1,00,000/ ha	22.0	12.8^{b}	11.3^{b}	11.3^{bc}	11.8^{b}	188.6^{abc}
Mechanical collection and destruction of *P. brassicae* eggs	25.6	11.6^{b}	13.5^{bc}	14.6^{c}	13.2^{b}	185.7^{c}
Spray of Dipel 8L	20.3	4.9^{a}	1.9^{a}	3.1^{a}	3.3^{a}	200.8^{ab}
Quinalphos 25 EC	25.0	5.8^{a}	2.6^{a}	4.3^{a}	4.3^{a}	205.4^{a}
Untreated control	24.2	26.4^{c}	37.5^{d}	49.8^{d}	37.3^{c}	152.8^{d}

Note: * Mean of three replications and in each replication number of larvae was recorded from five plants ** Sum of three pickings: DAT- Days after transplanting

SKUAST

This experiment was conducted in the Ganderbal district of Jammu and Kashmir on knol khol, *Brassica oleracea* var. *gongylodes* during June to July' 2012. The impact of 5 releases of *Trichogramma* spp. was observed in two treated plots (approx. 500 sqm) at Zuzina and compared with untreated control. The treated plots at Zuzina were isolated by about 500 m. Five weekly releases of *T. chilonis* and *T. brassicae* @ 1.0 lakh/ha were made during first week of June to July' 2012 and data on larval density was recorded from 10 plants/plot, before and after every release. The data was statistically analyzed using Minitab.

The numerical density of DBM in untreated plot at Sumbul increased gradually from 5.7 to 15.8$^{-\text{ plant}}$ from first to last week of June, but declined slightly to 13.8$^{-\text{ plant}}$. Average larval density in untreated plot was 13.09 (**Table 113**). As a result of periodic releases of *T. chilonis* and *T. brassicae*, obvious decline in larval density in the treated plots was observed until after 3rd release. Nevertheless, in comparison with the control, decline in larval density$^{-\text{ plant}}$ in treated plots was statistically significant. Except pre treatment larval density, which was worked out statistically on par, in the three observed plots (F= 2.83NS; d.f. 2(98); p= 0.064), the larval densities, after every release, when compared for the plots, through ANOVA, were found statistically significant after first (F= 12.04**; d.f. 2(98); p= 0.000), after second (F= 22.5**; d.f. 2(98); p= 0.000), after third (F= 20.91**; d.f. 2(98); p= 0.000)and after fourth releases (F= 25.49**; d.f. 2(98); p= 0.000). Average larval density, at the end of experiment, was 7.9, 10.2 and 13.09 (Table 4). Although the larval density in treated fields was statistically on par, but different when compared with the untreated plot. Comparison of *T. chilonis* and *T. brassicae*, in terms of reduction of DBM larvae after each release through Student's t-test indicated significant difference between the two species used (t= 3.3*; d.f.= 473). Overall per cent decline in larval density caused by *T. chilonis* and *T. brassicae* was 33.7 and 20.1, respectively which indicated the supremacy of *T. chilonis* over *T. brassicae* against DBM on Knol khol. The larval parasitoids of DBM both ichneumonids and braconids, were found more active from ending June to the observed weeks of July in all the three plots, and, this might have been the reason of significant reduction of the larval density in untreated plot, from fourth week of June onwards.

Table 113. Impact of field releases of *Trichogramma* spp. against Diamond Back moth, *Plutella xylostella* on Knol khol, *Brassica oleracea* var. *gongylodes* at Gander bal, Kashmir during 2012

***Trichogramma* spp.**	**Weekly larval population $^{-\text{ plant}}$**						
	Pre treatment	**After first release**	**After 2nd release**	**After 3rd release**	**After 4th release**	**Average Larval population**	**% decline in larval population**
Trichogramma Chilonis	4.06 (2.02)^{a}	7.4 (2.8)^{a}	9.6 (3.1)^{a}	9.7 (3.1)^{a}	8.1 (2.8)^{a}	7.9 (2.8)^{a}	33.7
T. brassicae	4.8 (2.2)^{a}	10.0 (3.1)^{b}	16.5(4.05)^{b}	10.8 (3.3)^{a}	9.02 (3.02)^{b}	10.2 (3.09)^{a}	20.1
Untreated (Control)	5.7 (2.4)^{a}	12.8 (3.5)^{c}	17.4 (4.2)^{c}	15.8 (3.9)^{b}	13.8 (3.7)^{c}	13.09 (3.5)^{b}	--
C.D. (0.05)	**0.24**	**0.25**	**0.23**	**0.22**	0.2	0.8	

Figures in each column represent mean of 50 observations; values in parentheses are √n+0.5; similar alphabets in a column indicate values statistically on par

YSPUHF

The experiment is in progress.

2. Evaluation of microbial pesticides against diamond back moth (DBM) (CAU)

An experiment was conducted to study the bio-efficacy of entomopathogenic microbes against DBM in cabbage during *rabi*, 2012-13. Two fungal species *viz*. *Metarrhizium anisopliae* (Metagreen, Green Harvest Bio-tech Pvt. Ltd., Mumbai) and *Beauveria bassiana* (Beauvegreen, Green Harvest Bio-tech Pvt. Ltd., Mumbai); two (EPNs) *viz. Steinernema* sp. (CAU-1) and *Heterorhabditis* sp. (CAUH-1) and Bt-NBAII were evaluated. The experiment was laid out in RBD. Cabbage (variety 'rareball') was used for the experiment and transplanted at 50X50 cm spacing. Two rounds of spray ware made (at 35 and 45 DAT). Observations were recorded on 3rd and 7th DAT. After the first round of spray profenophos recorded lowest mean population of DBM (0.02 larvae/leaf) followed by EPN (CAUH-I), Bt (NBAII) and EPN (CAU-I). The population of *M. anisopliae* and *B. bassiana* were comparable with the untreated control. After the second round of spray, profenophos again recorded the lowest population (0.03 larvae/leaf). Among the entomopathogenic microbes, Bt (NBAII) recorded the lowest population (0.22 larvae/leaf). The two EPNs *viz.* CAU-I and CAUH-1 recorded 0.40 and 0.42 laevae/leaf, respectively. *M. anisopliae* were found as least effective microbes (0.70 larvae/leaf). DBM in untreated control was 0.93 larvae /leaf which was significantly higher than the other treatments after the second round of spray (**Table 114**).

Table 114 . Bio-efficacy of entomopathogenic microbes against DBM in cabbage during *rabi*, 2012-13

Treatments	One day before first spray (Larvae/leaf)	After 1st spray(Larvae/leaf)			One day before second spray (Larvae/leaf)	After 2nd spray(Larvae/leaf)		
		3rd day	7th day	Mean		3rd day	7th day	Mean
B. bassiana @10ml/lit	0.36 (0.93)	0.35 (0.92)	0.40 (0.95)	0.38 (0.94)	0.56 (1.03)	0.56 (1.03)	0.57 (1.04)	0.57 (1.04)
M.anisopliae@10ml/ lit	0.40 (0.95)	0.41 (0.96)	0.51 (1.00)	0.46 (0.98)	0.69 (1.09)	0.69 (1.09)	0.71 (1.10)	0.70 (1.10)
EPN (CAU-1) @50ijs/ml	0.39 (0.94)	0.32 (0.90)	0.36 (0.93)	0.34 (0.92)	0.49 (1.00)	0.41 (0.96)	0.39 (0.94)	0.40 (0.95)
EPN (CAUH-1) @50ijs/ml	0.41 (0.96)	0.29 (0.89)	0.33 (0.91)	0.31 (0.90)	0.56 (1.03)	0.45 (0.98)	0.39 (0.96)	0.42 (0.97)
Bt (NBAII) 5ml/lit	0.41 (0.96)	0.39 (0.94)	0.27 (0.87)	0.33 (0.91)	0.32 (0.91)	0.29 (0.89)	0.15 (0.81)	0.22 (0.85)
Profenophos	0.37 (0.93)	0.01 (0.72)	0.03 (0.73)	0.02 (0.73)	0.12 (0.79)	0.00 (0.71)	0.05 (0.74)	0.03 (0.73)
Untreated control	0.43 (0.96)	0.47 (0.98)	0.53 (1.02)	0.50 (1.00)	0.79 (1.13)	0.89 (1.31)	0.97 (1.21)	0.93 (1.26)
SEd±	0.04	0.03	0.02	0.03	0.03	0.04	0.03	0.03
$CD_{0.05}$	NS	0.06	0.04	0.07	0.06	0.08	0.07	0.08

Figures in the parentheses are $(x+0.5)^{1/2}$ transformed values.

3. Field evaluation of thelytokous and arrhenotokous strains of *Trichogramma pretiosum* against *H. armigera* on tomato (MPKV)

The trial was laid out on the research farm of Entomology Section, College of Agriculture, Pune. Transplanting of tomato seedlings var. Abhinav carried out on 26/12/2011 at 60 x 45 cm spacing in the blocks of 20 x 10 m size. Each block divided into 10 sub-plots as replicates. The isolation distance of 10 m was maintained between the treatment blocks. Also, each block was surrounded with paired row of maize as border crop. The marigold plants rose at 5% of the total plant population in each block. The treatments comprised six releases of thelytokous and arrhenotokous strains of *T. pretiosum* each @ 1 lakh/ha at weekly interval and untreated control for comparison. Release of parasitoids started from 15/02/2012. Larval population of *H. armigera* recorded on randomly selected 10 plants/plot before release of the parasitoids and post counts at weekly interval till termination of parasitoid releases. The egg parasitism recorded through retrieval by displaying sentinels egg-cards of *Corcyra* at 48 h after release of the parasitoids and collected after 24 h. Fruit damage was recorded from 10 randomly selected plants/plot, while yield of healthy marketable fruits recorded from each treatment plots at each picking. The harvesting of tomato was completed on 18/4/2012. Data on larval population were converted into $\sqrt{x+0.5}$ and per cent fruit damage into arc sin transformation and yield data of marketable fruits converted into q per ha before statistical analysis. The results indicated that six releases of *T. pretiosum* thelytokous strain @ 1 lakh parasitoid/ha at weekly interval was significantly superior in suppressing the *H. armigera* (1.9 larvae/10 plants) and increasing marketable fruit yield of tomato (223.5 t/ha) to arrhenotokous strain of the parasitoid. However, both the strains were statistically on par with each other in respect of fruit damage but differed from untreated control. The parasitism was higher in thelytokous (56.2%) than arrhenotokous (46.5%) strain of the parasitoid (**Table 115**).

Table 115. Effect of thelytokous and arrhenotokous strains of *T. pretiosum* against *H. armigera* on tomato (2011-12)

Treatment	Larval population/10 plants		Fruit infestation (%)		Parasitism (%)	Yield (t/ha)
	Pre-count	Post count	No. basis	Wt. basis		
T1: *T. pretiosum* thelytokous	10.6 [a]	1.9 [a]	16.2 [a]	13.6 [a]	56.2	223.5 [a]
T2: *T. pretiosum* arrhentokous	10.0 [a]	4.8 [b]	18.8 [b]	16.4 [a]	46.5	194.1 [b]
T3: Untreated control	10.0 [a]	18.4 [c]	34.4 [c]	34.6 [b]	0.0	161.2 [c]
CD (p = 0.05)	NS	0.36	4.59	4.61		24.80

This experiment was conducted for 3 years (2009-2010 to 2011-2012). Pooled analysis of data revealed that six releases of *T. pretiosum* thalytokous strain @ 1 lakh/ha at weekly interval starting from 45-50 days after transplanting found significantly superior to arrhenotokous strain of the parasitoid as well as untreated control in reducing the larval population (2.3 larvae/10 plants) and fruit damage (14.5%) and increased the yield of marketable fruits (223.3 t/ha). The parasitism was recorded higher in thelytokous (55.9%) than arrhenotokous (45.1%) strain of *T. pretiosum* (**Table 116**).

Table 116. Effect of thalytokous and arrhenotokous strains *T. pretiosum* against *H. armigera* on tomato (pooled data of 2009-10, 2010-11 and 2011-12)

Treatment	Larval population/10 plants		Fruit damage (%)		Parasitism (%)	Yield (t/ha)
	Pre-count	Post count	No. basis	Wt. basis		
T1:*T. pretiosum* thalytokous	11.1 [a]	2.3 [a]	14.4 [a]	14.5 [a]	55.9	223.3[a]
T2: *T pretiosum* arrhenotokous	11.2 [a]	4.5 [b]	17.9 [b]	18.0 [b]	45.1	193.9 [b]
T3:Untreated control	11.5 [a]	18.5 [c]	35.4 [c]	36.6 [c]	-	146.5 [c]
CD (p = 0.05)	NS	0.17	2.18	2.15	-	8.93

4. Evaluation of different BIPM modules against shoot and fruit borer, *Leucinodes orbonalis* in brinjal (MPKV, JNKVV, OUAT)

MPKV

The experiment was laid out on the research farm of Entomology Section, College of Agriculture, Pune. Transplanting of brinjal seedlings var. Panchaganga was done on 27/12/2011 at 75 x 60 cm spacing in 15 x 6 m size blocks. Each block further divided into 3 subplots as replicates. Five modules formed with combination of biological components like *T. chilonis* @ 50,000/ha, NSKE @ 5% suspension and *Bt* @ 1 lit./ha compared with farmer's practice (profenophos 0.05%). Untreated control block was maintained separately. Each treatment block surrounded with paired row of maize.

Treatments

T1: *T. chilonis* (*Tc*) @ 50,000/ha, 6 releases
T2: *T. chilonis* + NSKE 5% suspension (*Tc* + *Tc* + NSKE + *Tc* + *Tc* + NSKE)
T3: *T. chilonis* + *Bt* @ 1 lit./ha (*Tc* + *Tc* + *Bt* + *Tc* + *Tc* + *Bt*)
T4: NSKE + *Bt* (NSKE + NSKE + *Bt* + NSKE + NSKE + *Bt*)
T5: *T. chilonis* + NSKE + *Bt* (*Tc* + NSKE + *Bt* + *Tc* + NSKE +*Bt*)
T6: Farmer's practice- three sprays of profenophos (0.05%) at 15 days interval
T7: Untreated control

Hand collection and destruction of infested shoots along with larval stages of *L. orbonalis* was followed before flowering in all the treatment plots. Application bioagents with release of parasitoids and/or spraying of NSKE and *Bt* were given at weekly interval starting from 15/02/2012. Whereas, three sprays of profenophos 0.05% were given at fortnightly intervals as farmer's practice. The observations on shoot infestation (%) before initiation of treatments and shoot and fruit infestation at weekly interval during treatments application were recorded from 5 randomly selected plants/treatment plot. Parasitism by *T. chilonis* was recorded through retrieval by placing sentinel egg-cards of *Corcyra* at 3 spots in each treatment blocks. The harvesting was completed on 25/5/2012. Data on shoot and fruit damage (%) transformed to arc sin values and yield of marketable fruits/plot at each picking was summed and converted into q/ha before statistical analysis.

The results in **Table 117** showed that 3 sprays of profenophos (0.05%) at fortnightly interval found significantly superior in reducing the shoot (9.0%) and fruit

(9.6%) infestation and gave maximum marketable yield (228.7 q/ha). However, the BIPM module consisting release of *T. chilonis f*ollowed by spraying of NSKE 5% and *Bt* @ 1 lit./ha twice at weekly interval was the next best treatment showing 9.9% shoot and 15.3% fruit infestation with 42.5% parasitism *T. chilonis* and gave 218.4 q/ha yield. It was on par with modules consisting *T. chilonis* + *Bt* (T3) and NSKE +*Bt* (T4).

Table 117.Effect of different BIPM modules on infestation of *L. orbonalis* and yield of brinjal

Treatment	Shoot damage (%)		Fruit damage (%)		Parasitism (%)	Yield (q/ha)
	Pre-count	Post count	No. basis	Wt. basis		
T1: BIPM with *T. chilonis*	20.6 [a]	11.9 [d]	17.9 [c]	17.8 [e]	62.0	202.1 [d]
T2:BIPM with *T.chilonis*+NSKE(5%)	20.5 [a]	11.6[c]	17.2 [c]	17.3 [d]	48.5	210.3 [c]
T3: BIPM with *T. chilonis* + *Bt*	19.8 [a]	10.9 [c]	16.6 [c]	15.9 [d]	45.6	213.3 [b]
T4: BIPM with Neem + *Bt*	20.5 [a]	10.6 [b]	16.1 [b]	15.8 [c]	12.0	214.3 [b]
T5: BIPM with *T. chilonis*+ NSKE +*Bt*	19.9 [a]	9.9 [b]	14.6 [b]	15.3 [b]	42.5	218.4 [b]
T6: Profenophos (0.05%)	19.9 [a]	9.0 [a]	10.6 [a]	9.6 [a]	0.0	228.7 [a]
T7: Untreated control	20.0 [a]	13.4 [e]	19.9 [d]	20.6 [f]	0.0	175.4 [e]
CD (p = 0.05)	NS	0.73	1.38	1.27		7.90

JNKVV-No Report

OUAT

Different BIPM modules against shoot and fruit borer *L. orbonalis* in brinjal

BIPM Followed

- Pheromone traps erected @ 25/ha after 15 DAP
- Weekly release of *T. chilonis* @50,000/ha / week after 20 DAP (total of 15 releases released till the final harvest)
- Two spray Bt (Dipel) @2 ml/l at 10 days intervals at peak flowering

Farmers' practice: Rynaxypyr (Coragen) @0.3ml/l at fortnightly intervals and the plot size was: 2×5 m; RBD design was used with 4 replications.

Least incidence of the shoot borer was recorded in the insecticidal treatment. The incidence of shoot borer ranged from 8.8 to 11.6 % in rynaxypyr at various locations. However, BIPM treatment was at par with the rynaxypyr in all locations recording 11.4 to 12.8% shoot borer incidence as against 29.3 to 29.9 % in untreated control. But, fruit borer incidence was least in BIPM recording 18.7 to 19.2 % at different locations where as, rynaxypyr recorded 18.8 to 21.2 % incidence though both BIPM and rynaxypyr were at par in their effectiveness. The control plots recorded 36.0 to 39.7% fruit damage (**Table 118**).

Table 118. Validation of different BIPM modules against *L. orbonalis* in brinjal

Treatments	Shoot damage (%)*	Fruit damage (%)**	Markatable fruits(q/ha)	Average no. of moths caught in the trap/week
Location : Nandapur				
BIPM	14.5(3.87)	19.8(26.42)	306.4	136.9
Rynaxypyr (Coragen)	11.6(3.48)	24.0(29.33)	279.7	
Control(No spray)	29.3(5.43)	39.7(39.06)	148.9	
CD(p=0.05)	0.41	3.18	28.73	
Location : Badasila				
BIPM	11.4(3.45)	18.7(25.62)	312.1	154.6
Rynaxypyr (Coragen)	8.8(3.05)	21.2(27.42)	295.4	
Control(No spray)	29.9(5.51)	36.0(36.87)	160.2	
CD(p=0.05)	0.47	2.21	20.23	
Location : Chandapur				
BIPM	12.8(3.65)	19.2(25.99)	296.7	129.8
Rynaxypyr (Coragen)	10.2(3.27)	18.8(25.700	317.8	
Control(No spray)	29.4(5.47)	38.4(38.29)	147.3	
CD(p=0.05)	0.41	3.43	25.61	

Figures in parentheses are * $\sqrt{(x+0.5)}$ and ** Arcsin $\sqrt{x}$ values

5. Biological suppression of onion thrips, *Thrips tabaci* with predatory anthocorid and microbial agents (MPKV, IIHR)

MPKV

The experiment was conducted on the research farm of Entomology Section, College of Agriculture, Pune during *rabi* 2012-13. Onion seedlings var. Phursungi was transplanted on 25/12/2012 in flat beds at 12.5 x 8 cm spacing in 3 x 2 m plots. The treatments comprised six releases of anthocorid, *Blaptostethus pallescens* @ 10 and 20 nymphs/m row at weekly interval, three sprays of *M. anisopliae*, *B. bassiana*, *V. lecanii* each @ 10^8 cfu/ml and profenophos 0.05% at 15 days interval and untreated control. Sandovit (0.1%) added as surfactant in spray fluid. Thrips population was recorded on 10 randomly selected plants/plot a day before initiation of treatments and post counts at 7 days after each release of anthocorids /spray of microbial agents. Data on thrips population transformed into $\sqrt{x+0.5}$ values and then subjected to ANOVA. The intensity of white patches on leaves recorded on 10 plants from each plot and graded in 1-5 scale. Harvesting is not yet carried out.

Data in **Table 119** revealed that three sprays of profenophos at fortnightly interval found significantly superior over other treatments in suppressing thrips (av. 3.1 thrips/plant) with 1 rating of intensity of white patches. However, 3 sprays of *M.*

anisopliae @ 10^8 cfu/ml which showed av. 7.5 thrips/plant and 1.5 rating of white patches on leaves was the next best treatment in this respect.

Table 119: Effect of anthocorid and microbial agents on suppression of thrips on onion

Treatment	Thrip population/plant, 7 days after spray					Intensity of white patches
	Pre-count	I	II	III	Average	
T1: *B. pallescens* @ 10 nymphs/m	18.4[a]	16.2[b]	11.9[c]	8.7[c]	12.3[c]	2.3
T2: *B. pallescens* @ 20 nymphs/m	19.6[a]	13.1[b]	9.4[b]	7.1[c]	9.9[c]	2.0
T3: *M. anisopliae* @ 10^8 cfu/ml	18.9[a]	11.2[a]	7.3[b]	4.1[b]	7.5[b]	1.5
T4: *B. bassiana* @ 10^8 cfu/ml	20.4[a]	17.5[b]	13.8[c]	12.1[d]	14.5[d]	2.6
T5: *V. lecanii* @ 10^8 cfu/ml	19.3 [a]	15.3[b]	12.9[c]	7.4[c]	11.9[c]	2.2
T6: Profenophos 0.05%	18.9 [a]	7.3[a]	1.7[a]	0.3[a]	3.1[a]	1.0
T7: Untreated control	21.2 [a]	24.6[c]	29.6[d]	34.6[e]	29.6[e]	3.7
CD (p = 0.05)	NS	0.76	0.67	0.58	0.37	

IIHR- No Report

6. Identification of major aphid parasitoids and their extent of parasitism in mustard and cabbage (MPUAT)

Field trials were conducted at Horticulture farm RCA, MPUAT, Udaipur to study the extent of parasitism of aphids in mustard and cabbage. The crop was monitored regularly from January to March at weekly interval to observe parasitoids and parasitized (mummified) aphids. After mid January, parasitized aphids were recorded in the field. The extent of parasitism increased with the rise in temperature and maximum parasitization was recorded in the third week of March which was as high as 88.6% in mustard and 92.6 %in cabbage.

7. Validation of BIPM of major insect pests in tomato at farmer's field (MPUAT)

Treatments

1. Six release of *T. pretiosum* Arrhenotokous @1.5 lakh/ha.
2. Six release of *T. pretiosum* Thelytokous @1.5 lakh/ha.
3. Two sprays of Ha.NPV @250 LE.
4. Two sprays of BTK @1Kg/ha

The experiment was conducted during 2012-13 on tomato at different locations (5farmer fields at Piladar, Udaipur). BIPM module data of different locations revealed that field parasitism gradually increased to a maximum in *T. pretiosum* thelytokous showed less mean fruit damage (15.2%), over rest of treatments. However treatments six release of *T.*

pretiosum arrhenotokous, two sprays of Ha.NPV @250 LE and two sprays of Btk @1Kg/ha were found at par (**Table 120**)

Table 120. Effect of BIPM module on fruit damage (%) and and yield in Tomato

S. No.	Treatments	Mean fruit damage (%)	Yield (q/ha)
1	Six release of *T. pretiosum* (Arrhenotokous) @1.5 lakh /ha	17.4	145.00
2	Six release of *T. pretiosum* (Thelytokous) @1.5 lakh/ha	15.2	165.50
3	Two sprays of Ha.NPV @250 LE	19.5	136.00
4	Two sprays of BTK @1Kg/ha	18.35	143.5
3	Control	48.5	115.00
	S.Em±	0.78	1.29
	C.D. at 5%	2.25	3.56

8. Evaluation of anthocorid predator *B. pallescens* against mite, *Tetranychus urticae* on brinjal and okra (OUAT, PAU)

OUAT

Brinjal

Mite population before implementation of treatments varied from 439.88 to 680.80/10 plants. Seven days after imposition of treatments Propargite (@ 2ml/lit) was registered the lowest mite population of 98.8/10 plants followed by *B. pallescens* (@ 30/plant) (138.30/10 plants) and @ 20/plant (146.70/10 plants). Release of *B. pallescens* @ 10/plant recorded 240.0 mites/10 plants which was also far superior in controlling the mite. The control plots had 721.50 mites/10 plants.The same trend continued 15 days after release of predator. Propargite was the most effective treatment with 33.75 mites/10 plants followed by release of 30 and 20 anthocorids which recorded 84.80 and 91.30 mites/10 plants, respectively. These two treatments were at par in respect of their effectiveness in controlling the mite. Release of *B. pallescens* @ 10 per plant recorded 110.40 mites/10 plants which was far superior in respect of mite control as the untreated plots recorded 765.80 mites/10 plants. Maximum webbings/10 plants was observed in control plots (29.75) followed by the predator released plots at 30, 20 and 10 *B. pallescens*/10 plants, respectively (**Table 121**).

Table 121. Evaluation of anthocorid predator *B. pallescens* against mite, *T. urticae* on brinjal

Treatments	Mite/10 plants* Before release	Mite /10 plants* at 7DAR	Mite/10 plants* At 15 DAR	No.of leaves with webbings/10 plants**	Markatable yield(Kg/ha)
B. pallescens @ 10/plant	448.30(2.65)	240.0(2.38)	110.4(2.04)	2070(4.55)	264.7
B. pallescens @ 20/plant	497.05(2.70)	146.70(2.17)	91.30(1.96)	18.65(4.32)	297.3
B. pallescens @ 30/plant	439.85(2.64)	138.30(2.14)	84.80(1.93)	16.60(4.07)	308.4
Propargite	510.70(2.71)	98.80(1.99)	33.7591.53)	12.30(3.51)	341.5
Control	680.80(2.83)	721.50(2.86)	765.80(2.88)	29.75(5.45)	207.8
CD (p=0.05)	NS	0.21	0.27	0.33	23.6

DAR: Days after release: Figures in parentheses are * Log x transformation, ** √x transformation

OKRA

The mite population before implementation of treatments varied from 276.5 to 320.6/10 plants. Seven days after imposition of treatments Propargite registered the lowest mite population (65.2/10 plants) followed by *B. pallescens* @ 30/plant (97.4/10 plants) and @ 20/plant (108.7/10 plants). Release of *B. pallescens* @ 10/plant recorded 197.2mites/10 plants which was also far superior in suppressing the mite. The control plots had 312.5 mites/10 plants.

The same trend continued 15 DAR after release of predator. Propargite was the most effective treatment with 51.4 mites/10 plants followed by release of 30 and 20 anthocorids which recorded 77.9 and 81.6 mites/10 plants, respectively. These two treatments were at par in respect of their effectiveness in controlling the mite. Release of *B. pallescens* @ 10/plant recorded 151.30 mites/10 plants which was far superior compared to untreated plots (326.8 mites/10 plants).

Maximum webbings/10 plants was observed in control plots (21.4) followed by *B. pallescens* released plots at 30, 20 and 10 /10 plants, respectively (**Table 122**).

Table 122. Evaluation of anthocorid predator *B. pallescens* against okra mite

Treatments	Mite (no.) before release*	Mite (no.) 7 DAR*	Mite (no.) 15 DAR*	No. of leaves with webbings**	Markatable yield(q/ha)
B. pallescens @ 10/plant	276.5(2.44)	197.2(2.29)	151.3(2.18)	12.9(3.66)	142.8
B. pallescens @ 20/plant	299.1(2.48)	108.7(2.04)	81.6(1.91)	8.2(2.95)	154.4
B. pallescens @ 30/plant	320.6(2.51)	97.4(1.99)	77.9(1.89)	7.8(2.88)	158.2
Propargite	315.8(2.50)	65.2(1.81)	51.4(1.71)	5.9(2.53)	168.3
Untreated control	308.1(2.49)	312.5(2.49)	326.8(2.51)	21.4(4.68)	112.9
CD (p=0.05)	NS	0.19	0.18	0.26	8.42

DAR: Days after release; Figures in parentheses are * Log x transformation, ** √(x + 0.5) transformation

PAU

Brinjal

The experiment on evaluation of *B. pallescens* against mite, *T. urticae* on brinjal (variety Punjab Sadabahar) was conducted at Entomological Research Farm, PAU, Ludhiana. The brinjal was transplanted in the earthen pots in poly house during August, 2012 at the farm. The mites were released to establish on the plants. When the mite was fully established on the brinjal plants, the pre-treatment data was taken and the predator was released to conduct the experiment. There were ten replications for each treatment and 5 plants/replication. There were 4 releases/ sprays of predator/ acaricides at weekly interval. When the 6-7 days old nymphs of *B. pallescens* were released for 4 times at weekly interval on the brinjal under poly house condition, it was observed that the population of mites significantly reduced (**Table 123**). All the doses of *B. pallescens* i.e. @ 10, 20 and 30 nymphs/ plant were at par with one another and better than untreated control in minimizing the population of mites on the brinjal. The population of mites on the brinjal leaves before the release of anthocorid nymphs ranged from 63.5-69.0/plant and the

population of mite reduced to 14.1-31.3/ plant. However, Omite @ 300ml/ plant was found better than *B. pallescens* releases/plant and untreated control. In Omite treated, the population reduced to 1.0- 1.6 mites/plant and mite in control mites was 41.0 -60.8/plant). It can be concluded that *B. pallescens* along with Omite/ac can be included in the IPM of *T. urticae* on brinjal in poly house.

Table 123: Evaluation of anthocorid predator, *B. pallescens* against spider mite, *T. urticae* on brinjal in poly house condition

Treatments	Mite/ 3 leaves/ plant (Nos)					
	Before release	After release/ spray*				
		I	II	III	IV	Mean
*B. pallescens @ 10/ plant	66.1	25.7[b]	20.6[b]	28.6[b]	24.4[b]	**24.8**
*B. pallescens @ 20/ plant	63.5	21.1[b]	22.1[b]	31.3[b]	21.1[b]	**23.9**
*B. pallescens @ 30/plant	69.0	19.9[b]	15.5[b]	14.1[b]	16.4[b]	**16.4**
**Omite	62.2	1.3[a]	1.1[a]	1.6[a]	1.0[a]	**1.2**
Control (untreated)	60.8	43.6[c]	53.5[c]	58.8[c]	41.0[c]	**49.2**
CV	12.0	28.7	26.4	19.9	18.6	**23.4**

*Four releases at seven days interval. **Four sprays at ten days interval

Okra

Okra plants were raised as mentioned in Brinjal. When the 6-7 days old nymphs of *B. pallescens* were released for 2 times at weekly interval on the okra plants under poly house condition, it was observed that the population of mites significantly reduced on the plants (**Table 124**). *B. pallescens* @ 30 nymphs and 20 nymphs/plant and Omite were found better than *B. pallescens* @ 10 nymphs/plant and untreated control. Among the *B. pallescens* releases, release of *B. pallescens* @ 30 nymphs/ plant was found best (11.40 mites/ plant) and it was significantly at par with *B. pallescens* @ 20 nymphs/plant (17.80 mites/plant) in reducing the mites. Both of these bio-agent release doses were also significantly at par with omite (9.53 mites/ plant). Release of *B. pallescens* @ 10 nymphs/ plant (32.60 mites/ plant) was less effective and it was at par with untreated control (59.73 mites/ plant). It was concluded that *B. pallescens* @ 20 nymphs and 30 nymphs/plant along with Omite 300 ml/ac can be included in the IPM *T. urticae* on okra in net house.

Table 124: Evaluation of anthocorid predator, *B. pallescens* against spider mite, *T. urticae* on okra in poly house condition.

Treatments	Number of mite/ plant				
	Before release	After release*			
		I	II	III	Mean
*B. pallescens @ 10 nymphs/ plant	30.5	27.80[b]	26.80[b]	43.40[b]	**32.60[b]**
*B. pallescens @ 20 nymphs/ plant	31.6	10.80[a]	18.40[a]	24.20[a]	**17.80[a]**
*B. pallescens @ 30 nymphs/ plant	30.4	7.20[a]	12.80[a]	14.20[a]	**11.40[a]**
**Omite @ 300ml/ ac	37.2	6.00[a]	10.40[a]	12.20[a]	**9.53[a]**
Control (untreated)	38.8	29.00[b]	47.60[b]	102.6[b]	**59.73[b]**

*Two releases at seven days interval. **Two sprays at ten days interval

9. Evaluation of entomopathogens against sucking pests of capsicum (JNKVV)

No Report

10. Development of biocontrol based IPM module against pests of okra (AAU-J)

Field experiment on biocontrol based IPM package on okra (Akra anamika) was evaluated in comparison with farmers' practice (Deltamethrin) and untreated check at Allengmora village, Jorhat. The IPM package included use of Yellow Sticky Traps @ 10/ha against *Bemisia tabaci* and *Amrasca biguttula biguttula,* three releases of *T. chilonis* @ 50,000/ha/week against fruit borer at bud initiation stage, spray of Bt 1 kg/ha, removal & destruction of infested fruits/shoots, roughing of YMV infested plants and need based application of insecticides. The IPM package was compared with farmers' practice and untreated control.

The plot size was 100 sq.m. and the plot was sub divided in to four sub plots to serve as 4 replicates in case of IPM package and farmers' practice. Observations were made on pre and post count for shoots and fruit damage before or after each spray at 3 and 7 day intervals. In case of *A. biguttula* and *B. tabaci*, observation was recorded from upper, middle and lower leaf/plant from randomly selected 10 plants from each replication. Yield of fruits at each harvest was recorded. In IPM package, Malathion 50 EC @2ml/lit was sprayed twice as need based insecticide. In farmer's practice, Deltamethrin (2.8 EC @ 0.5 ml/lit) was sprayed against *Earias vittella*, *A. biguttula biguttula* and *B. tabaci.*

The study revealed that no significant differences were observed in IPM package and farmer's practice in respect of the population of *A. biguttula biguttula* and *B. tabaci*. The *A. biguttula* and *B. tabaci* population/plant were 0.98 and 0.76 in IPM package and the same were 1.03 and 0.74, respectively in farmers' practice, after third spray **(Table 125)**. But in case of percent fruit damage, the minimum (8.17) was obtained in deltamethrin plots as against 9.06 in IPM plot, although they were on par with each other. In case of untreated check, fruit damage (14.10 %) was significantly different from IPM package and farmers' practice. Maximum yield (102.2q/ha) was registered in IPM package followed by farmer's practice (98.5q/ha) although they were statistically on par with each other**.** But on contrary, the highest CB ratio (1: 8.98) was observed in farmers' practice compared to IPM plot (1:7.46) (**Table 126**). The untreated control contributed yield only 69.1 q/ha only. It can be concluded that IPM package proved as effective as chemical control on large scale for the management of insect pest of okra.

Table 125. Effect of IPM module on incidence of insect pests of okra

Treatments	Pre count/leaf		Post count/leaf*						Fruit Damage (%)	Fruit yield (q/ha)
			After 1st spray		After 2nd spray		After 3rd spray			
	A. biguttula	*B. tabaci*	*A.biguttula*	*B. tabaci*	*A.biguttula*	*B.tabaci*	*A.biguttula*	*B. tabaci*		
IPM	4.19	3.09	2.8 [a]	2.81 [a]	1.28 [a]	1.47 [a]	0.98 [a]	0.76 [a]	9.06 [a] (17.46)	102.2 [a]
Farmers' practice	4.47	3.0	2.71 [a]	2.61 [a]	1.52 [a]	1.18 [a]	1.03 [a]	0.74 [a]	8.17 [a] (16.57)	98.57 [b]
Untreated check	4.14	3.14	3.85 [b]	3.57 [b]	3.42 [b]	3.52 [b]	3.57 [b]	2.76 [b]	14.10 [b] (22.00)	69.14 [c]
S Ed ±	0.24	0.14	0.15	0.23	0.23	0.19	0.17	0.08	0.84	1.43
CD at 5%	NS	NS	0.34	0.50	0.51	0.42	0.37	0.18	1.83	3.12

*Mean of 2 observations; Values in parenthesis are angular transformed
Means in the same column by common letter are not significantly different

Table 126. Cost benefit ratio

Treatments	Observed Yield (Kg/ha)	Yield gain over control (Kg/ha)	Cost of plant protection (Rs/ha)	Grain threshold (Kg/ha)	Net profit		Cost benefit ratio
					Kg/ha	Rs/ha	
IPM Package	10220	3310	3912	391.2	2918.8	291880	1:7.46
Farmers' practice	9850	2940	2944	294.4	2645.6	264560	1:8.98
Control	6910	-	-	-	-	-	

- Cost of produce/kg = Rs 10.00

11. Study on effectiveness of bioagents and botanicals against aphid, *Lipaphis erysimi* infesting mustard (MPUAT)

MPUAT

Treatments
1. *V. lecanii*@ $1.5x10^{13}$ conidia/ha.
2. *B. bassiana* @ $1.5x10^{13}$ conidia/ha .
3. *M. anisopliae* @ $1.5x10^{13}$ conidia/ha.
4. NSKE 5 %
5. *Paecilomyces fumosoroseus* @ $1.5x10^{13}$ conidia/ha.
6. Imidacloprid (recommended dose).

Results showed that among the different bioagents and botanicals, the mean per cent reduction in aphid population was more in 2 sprays of NSKE 5% (54.82), which was statistically at par with 2 sprays of *Veticilium* sp. (52.58) However, 2 sprays of imidacloprid was most effective in mean per cent reduction (79.74) of *L. erysimi* population at 7 days after 2nd spray and yielded 9.52, 9.44, 10.85 q/ha, respectively over control 6.20 q/ha. (**Table-127**)

Table 127. Effectiveness of bioagents and botanicals against aphid, *Lipaphis erysimi* infesting mustard

S. No.	Treatments	Mean reduction in aphid population- days after spray								Yield q/ha
		I spray				II spray				
		3	5	7	10	3	5	7	10	
1	*V. lecanii*	43.67 (41.15)	46.96 (43.56)	47.38 (44.22)	44.44 (42.11)	47.7 (44.35)	48.79 (44.75)	52.58 (46.71)	47.84 (44.41)	9.44
2	*B. bassiana*	36.25 (39.12)	38 (36.15)	39.65 (38.41)	36.76 (39.05)	38.87 (37.02)	39.07 (38.65)	41.67 (40.08)	37.64 (36.69)	8.75
3	*M. anisoliae*	38.52 (36.85)	40.79 (39.62)	41.77 (40.19)	37.11 (37.53)	41.1 (39.85)	41 (39.72)	44.33 (41.62)	39.97 (38.52)	9.20
4	NSKE 5 %	49.58 (44.68)	53.59 (46.68)	56.1 (48.82)	50.04 (45.02)	52.46 (46.66)	53.22 (46.12)	54.82 (47.28)	55.04 (48.11)	9.52
5	*Paecilomyces* sp.	42.02 (40.02)	44.43 (41.10)	45.95 (42.38)	41.17 (39.89)	44.9 (42.54)	45.31 (42.06)	48.93 (44.65)	42.79 (40.50)	9.24
6	Imidacloprid	62.25 (52.35)	66.82 (56.89)	71.09 (57.11)	65.98 (55.36)	70.13 (57.02)	72.16 (60.33)	79.74 (62.65)	73.32 (60.12)	10.85
7	Untreated control	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	6.20
	S.Em±	0.851	1.029	0.732	0.687	0.952	1.190	0.957	0.941	
	C.D. at 5%	2.45	3.08	2.15	1.84	2.75	3.48	2.56	2.69	

2.13. Tea Mosquito Bug

1. Evaluation of *Beauveria bassiana* Against Tea mosquito bugs in tea (AAU-J)

The investigation will be continued for 2013 -14.

2. Population dynamics of tea mosquito bugs in tea and its natural enemies (AAU-J)

The field experiment was conducted at Assam Agricultural University, Jorhat during 2012-13.The general monthly average weather parameters of Jorhat w.e.f. April 2012 to March'2013 were taken for the entire period for conducting the present investigation.

An area of 200 m.sq. Was selected for the study of population dynamics of *Helopeltis theivora* which contain four quadrants to serve as four replicates .The clone of the tea plants was TV 23. The plots were kept completely free from insecticidal or herbicidal contamination.

To study the seasonal incidence and extent of damage, forty tea plants were randomly selected (10 plants / individual quadrants) and all the selected plants were inspected for counting the tea mosquito bug and to assess the damage percentage of the pest (Fig 41 and 42). Three numbers of infested shoot /plant were selected for counting the bug population. Moreover, a simple correlation analysis was worked out between.

a. Weather parameters and population of *H. theivora*
b. Weather parameters and population of natural enemies
c. Population of *H. theivora* and percent infestation of the pest
d. Population of *H. theivora* and population of *Oxyopes spp.*

During the investigation period, six numbers of different species of spiders were collected from tea ecosystem and predatory efficiency of the spiders was carried out at Bio control laboratory with five replications by providing ten numbers of nymphs of *H. theivora to* each of the predators and observation was made at 24h interval. The results revealed that except Oxyopes sp. no other was observed to predate on the host provided. The predation rate of *Oxyopes sp*. was 7.80 only.

Results

Seasonal incidence of *H. theivora* in relation to weather factors

The data presented in the **table 128** showed the occurrence of *H. theivora* from first week of April'2012 to March '2013.The incidence of *H. theivora* in April'2012 was initially low with a population of 4.67 / 3 shoots. .However, peak population of the pest was recorded in September '2012 with a population level of 25.00 /3 shoots. During this month the average temperature (maximum & minimum) was 27.4^0C with 87.5 per cent relative humidity. The second highest population (18.67/3shoots) *was* observed during October '2012. The nymphal population of *H. theivora* decline abruptly from November'2012. The abrupt decline was mainly due to the fact that the crops by then were approaching pruning and there was lack of fresh new shoots to sustain the pest. The population completely disappeared from the field

from January and February 2013. The population started to reappear again in the field from March 2013 with a population of 3.30/3 shoots.

Table 128. Seasonal incidence of *H. theivora* in relation to weather factors

Month, 2012	Mean population of TMB/ 3 shoot	Temperature (^{0}C)			RH% (mean)	No. Of rainy days	Total rainfall (mm)	BSSH
		Max.	Min.	Mean				
April	4.67	27.3	19.1	23.2	82.5	24.0	931.8	4.5
May	5.67	32.4	22.1	27.2	77.5	14.0	137.7	6.2
June	11.67	30.0	25.4	27.7	84.0	20.0	215.9	2.9
July	14.0	31.4	25.6	28.5	82.5	26.0	401.3	4.6
Aug	13.33	32.6	25.7	29.1	83.0	23.0	307.8	4.7
Sep	25.00	30.5	24.4	27.4	87.5	22.0	234.8	2.8
Oct	18.67	29.7	20.9	25.3	76.5	12.0	80.6	7.8
Nov	17.33	27.7	15.0	21.3	76.5	0.0	0.0	7.9
Dec	7.33	23.0	11.1	17.0	79.0	3.0	6.8	7.9
Jan	0.00	23.3	8.3	15.8	72.0	1.0	0.5	60.9
Feb	0.00	27.7	12.1	19.9	69.5	1.0	9.3	64.6
Mar	3.30	27.7	14.9	21.3	71.5	5.0	36.7	5.2
r		0.484	0.626*		0.672*	0.436	0.046	-0.605*
remarks		NS	S		S	NS	NS	S

r* significant at (= 0.005 %)

Correlation studies were carried out between the population of *H. theivora* and weather parameters.

The data indicated that amongst the different weather parameters, the minimum temperature and relative humidity only showed positive and significant correlation (r =0.626 and 0.672) in the population build up of *H. theivora*, respectively. There was no significant impact in population build up of *H. theivora* in case of maximum temperature, number of rainy days and total rainfall. A significant but negative relationship was observed in bright sunshine hours (r = -0.605)

Seasonal incidence of *Oxyopes* sp. in relation to weather factors

The population of *Oxyopes* sp. appeared in tea ecosystem from April'2012and it was 2.00 /plant. The population was observed to increase gradually up to September'2012. The population reached its peak in September with a population of 4.60/ plant followed by October (4.25) '2012. The activity of the pest was observed to fluctuate at various time intervals. The spider showed density dependent fluctuation in relation to *H. theivora*. During January and February'2013, the population was seen to be completely disappeared from the field till March'2013. (**Table 129**)

Table 129 : Seasonal incidence of *Oxyopes* sp. in relation to weather factors

Month, 2012	Population of *Oxyopes* (mean)	Temperature (^{0}C)			RH% (mean)	No. Of rainy days	Total rainfall (mm)	BSSH
		Max.	Min.	Mean				
April	2.00	27.3	19.1	23.2	82.5	24.0	931.8	4.5
May	2.25	32.4	22.1	27.2	77.5	14.0	137.7	6.2
June	3.30	30.0	25.4	27.7	84.0	20.0	215.9	2.9
July	3.40	31.4	25.6	28.5	82.5	26.0	401.3	4.6
August	3.55	32.6	25.7	29.1	83.0	23.0	307.8	4.7
September	4.60	30.5	24.4	27.4	87.5	22.0	234.8	2.8
October	4.25	29.7	20.9	25.3	76.5	12.0	80.6	7.8
November	3.90	27.7	15.0	21.3	76.5	0.0	0.0	7.9
December	2.75	23.0	11.1	17.0	79.0	3.0	6.8	7.9
January	0.00	23.3	8.3	15.8	72.0	1.0	0.5	60.9
February	0.00	27.7	12.1	19.9	69.5	1.0	9.3	64.6
March	0.00	27.7	14.9	21.3	71.5	5.0	36.7	5.2
r		0.492	0.681*		0772**	0.523	0.177	-0.692*
Remarks		NS	S		S	NS	NS	S

The correlation studies between *Oxyopes* sp. and different weather parameters was of the, same trend as observed with that of *H. theivora* . A positive significant correlation with minimum temperature(r =0.681)and relative humidity (r = .0772) was noticed in population build up of *Oxyopes* sp. Moreover, bright sunshine hours registered a negative non significant correlation with the population.

Correlation between mean population of *H. theivora* and *Oxyopes* sp.

A highly positive significant correlation exist in between *H. theivora* and spider population with r = 0.926. It indicated that the spider population increased with the increase of *H. theivora*. During April'2012 to March'2013, highest average population of *H. theivora* and *Oxyopes* sp was recorded (25.00/3 shoot and 4.60 / plant, respectively) during September'2012. (**Table 130**)

Table 130: Correlation between mean population of *H. theivora* and *Oxyopes* sp.

Month, 2012	Mean population of TMB/ 3 shoot	Population of *Oxyopes* (mean)
April	4.67	2.00
May	5.67	2.25
June	11.67	3.30
July	14.0	3.40
Aug	13.33	3.55
Sep	25.00	4.60
Oct	18.67	4.25
Nov	17.33	3.90
Dec	7.33	2.75
Jan	0.00	0.00
Feb	0.00	0.00
Mar	3.30	0.00
r		0.926**
Remarks		S

Correlation between mean population of *H. theivora* and its damage (% infestation)

The infestation of *H. theivora* in April was only 10.00 per cent and the damage was gradually increased up to July'2012 with 26.70 % infestation. During this period, the mean temperature and relative humidity was 28.5^{0}C and 82.5 %, respectively. The correlation studies (**Table 131**) showed a highly significant positive relationship in respect of per cent infestation (r = 0.808) of *H. theivora* related to population number of the pest. It indicated that the infestation of *H. theivora* would be increased with the increase of the population of the pests.

Table 131: Correlation between mean population of *H. theivora* and its damage (%t infestation)

Month, 2012	Mean population of TMB/ 3 shoot	% infestation
April	4.67	10.00 (18.43)
May	5.67	13.40 (21.47)
June	11.67	18.30 (25.32)
July	14.0	26.70 (31.11)
Aug	13.33	20.30 (26.77)
Sep	25.00	23.40 (28.92)
Oct	18.67	15.80 (23.42)
Nov	17.33	12.50 (20.70)
Dec	7.33	10.80 (19.18)
Jan	0.00	0.00 (0.00)
Feb	0.00	0.00 (0.00)
Mar	3.30	3.30 (10.46)
r		0.808**
Remarks		S

3. Natural enemies associated with cashew tea mosquito bug (OUAT)

No-Report

2.14. Mealybugs

1. Survey for mealy bugs and its natural enemies on horticultural crops – papaya, hibiscus, tapioca, brinjal, tomato, okra (AAU-J)

The main objectives of the survey were to assess the population of mealy bugs and its damage on different host plants and to collect and identify the parasitoids and predators in different season of the year.

Regular surveys were initiated in different districts (Kamrup, Jorhat, Golaghat, and Dibrugarh) of Assam to monitor the occurance of mealy bugs and their natural enemies on horticultural crops- like papaya, hibiscus, Guava, citrus, brinjal, tomato and okra during June 2012 to February, 2013.

As the papaya crop is not cultivated commercially in large areas, the homesteads gardens (10 numbers homestead garden in each district) were surveyed in different districts to ascertain the infestation of papaya mealy bugs, *Paracoccus marginatus* on papaya. But no incidence of papaya mealy bugs was observed in surveyed areas from June to July '2012. Similarly, in case of other host plants, like hibiscus, okra, citrus and Guava were found to be free from mealy bug infestation. However, a very minor infestation of mealy bugs was observed in citrus and guava leaves during the month of September and October'2012.

Papaya mealy bugs on papaya fruits and leaves was first detected in Kamrup district during mid of July'2012 in homestead garden nearby Guwahati. The mealy bug collected was identified as Papaya mealy bug, *Paracoccus marginatus*. Subsequently, the invasive pests was also observed in Dibrugarh and Jorhat districts during September' 2012.In different homestead garden of Kamrup district the infestation of papaya mealy bugs varied from 20 -60 %. and in Dibrugarh and Jorhat it was 0 -30 %. The incidence was observed in alarming situation during August and September, 2012 in Kamrup district. No incidence of mealy bugs was observed in Golaghat district.

The mealy bug collected from Kamrup, Dibrugarh and Jorhat was kept in cages for 10 days in the laboratory for emergence of parasitoids if any. Some spiders (unidentified) and *Chrysoperla* spp. were found to be associated in the sample collected from Dibrugarh district. A few unidentified parasitoids were also emerged from the sample collected from Jorhat district. The mealy bug and its parasitoids have been submitted to NBAII, Bangalore for identification.

Brinjal, and tomato crop were found to be free from infestation of any species of mealy bug during the survey period.

An awareness training programme on papaya mealy bug was organized by Director of Horticulture & FP , Assam , Khanapara for officers and farmers on 07.08.2012. Later on another awareness programme was also organized in Jorhat under DAO (Agri), Joraht on 13.08.2012. In the awareness programme, a threadbare discussion was held on IPM measures to keep the invasive pests under check including timely spraying of insecticides. Moreover

the importation of parasitoids from USA through NBAII (ICAR), Bangalore was also discussed under bio control session to manage the pests by bio agents like *Acerophagus papayae*

The investigation of mealy bugs will be continued in 2013 -14.

2. Survey and record of incidence of papaya mealy bug and its natural enemies on papaya and other alternate hosts (OUAT)

Report of Papaya Mealy bug

Papaya plants in and around Bhubaneswar were found heavily infested with mealy bug *Paracoccus marginatus* during May,2011 and subsequently report of its occurrence came from various districts of Odisha. There are very less farmers of Odisha who are doing papaya cultivation in large areas, but, almost all household in villages and even in urban areas have papaya in their backyards. This pest was also recorded from Guava, Okra, Brinjal, Hibiscus, Teak and American silk cotton in and around Bhubaneswar.

Spalgis epius was found to be feeding on this mealy bug everywhere. Among other predators, *Cheilemenes sexmaculata, Scymnus coccivora* and one green lace wing larva was found predating on this pest.

The first consignment of *Acerophagus papayae* was obtained from NBAII in August 2011 and was released in OUAT and neighboring areas. The population of mealy bug seemed to be reduced but not significantly. The second batch of *Acerophagus papayae* was released by the Director, NBAII on 5.8.2011 in some infested areas in Bhubaneswar. By September, the infested plants recovered. Heavy rainfall in September also reduced the population of the mealy bugs. The third consignment of the parasitoid was released in some infested plants during the visit of Dr.A.N.Shylesha in January,2012.The parasitoid is being multiplied on sprouted potatoes and has been supplied to farmers in and around Bhubaneswar.It was also recovered from the released sites and redistributed to other areas.

3. Mass production of *Spalgis epius* (IIHR)

Three types of net cages as mentioned below were evaluated as oviposition cage

I. 6 ft length x 3ft height with lantana twigs and pumpkins as resting and oviposition sites,

II. 10ft ht x 3ft width x 5ft length pumpkins infested with mealy bugs, lantana twigs and polyanthia branches as resting sites

III. Glass house of 20ft ht.x 15 ft.length x10 ft. width with guava plants, pumpkins infested with mealy bugs and polyanthia as resting sites

Among these three types of cages and different hosts, about three to four newly hatched larvae were recorded on custard apple fruits after a week that confirms egg laying.

In glass house, the adults fly up and remain on rooftop and sides and where these adults were predated by spiders within hours of release.

2.15. Termites

1. Testing the bioefficacy of entomopathogenic fungi in suppression of termite incidence in sugarcane (ANGRAU)

Status: This trial is being taken up in collaboration with Agrl. Res. Station, Anakapalle, E.Godavari Dt. and is in progress.

2. Testing of bio-efficacy of entomopathogenic fungi for suppression of Termite incidence in maize (MPUAT)

Treatments

Soil application of following:-

1. *Beauveria bassiana* @5x10^{13} spores/ha.
2. *Beauveria bassiana* @5x10^{13} spores/ha FYM enriched.
3. *Metarrhizium anisopliae* @5x10^{13} spores/ha.
4. *Metarrhizium anisopliae* @5x10^{13} spores/ha FYM enriched
5. *Paecilomyces fumosoroseus* @5x10^{13} spores/ha
6. *Paecilomyces fumosoroseus* @5x10^{13} spores/ha FYM enriched
7. Seed Treatments with Chlorpyriphos 20Ec @ 4ml/kg seed (Reco. Check)
8. Untreated Control

Results: Experiment conducted at farmers field during 2012-13 in termite infested maize field revels that the treatments comprises soil application of FYM enriched *Metarrhizium anisopliae* @ 5x10^{13} spores/ha, effectively increased maize germination up to 95% and resulted in least plant mortality 4.6% (at 90 day after sowing) and yielded 39.42 q/ha, it was followed by soil application of *Metarrhizium anisopliae* @ 5x10^{13} spores/ha 93% (germination), and 6.2 (plant mortality at 90 day after sowing) and yielded 37.62 q/ha respectively (**Table 132**).

Table 132. Bio-efficacy of entomopathogenic fungi for suppression of termite incidence in maize

S.No	Treatments	Mean germination (%)	Plant mortality at 90 days (%)	Yield (q/ha)
1	*Beauveria bassiana* @5x10^{13} spores/ha	92	11.2	32.52
2	*B. bassiana* @5x10^{13} spores/ha FYM enriched	94	8.2	34.92
3	*Metarhizium anisopliae* @5x10^{13} spores/ha	93	6.2	37.62
4	*M. anisopliae* @5x10^{13} spores/ha FYM enriched	95	4.6	39.40
5	*Paecilomyces fumosoroseus* @5x10^{13} spores/ha	94	10.2	35.8
6	*P. fumosoroseus* @5x10^{13} spores/ha FYM enriched	95	8.5	36
7	Chlorpyriphos 20 Ec@ 4ml/kg seed treatment (Reco. Check)	98	2.8	41.66

8	Untreated Control	76	21.8	30.82

2.16. Biological Suppression of Polyhouse crop pests

1. Evaluation of anthocorid predator, *Blaptosthetus pallescens* against spider mites of carnation/rose in poly houses (ANGRAU)

Status: The trial is in progress

2. Evaluation of biocontrol agents against sap sucking insect pests of carnation in polyhouses (ANGRAU)

Status: The trial is in progress

3. Evaluation of Biological Control Agents against Mites in Carnation under protected condition (TNAU)

Treatment details

1. Release of predatory mite, *Amblyseius* sp @ 5 mites/ plant
2. Release of predatory mite, *Amblyseius* sp @ 10 mites/ plant
3. *Beauveria bassiana* 10^8 CFU/ml
4. Release of coccinellid beetle, *Stethorus pauperculus*
5. Standard acaricide, Abamectin 0.3 ml / l
6. Untreated check

Design: RBD
Plot size : 4x5m
Replications : 4
Number of sprays/ release : 2 at 10 days interval
Variety : Domingo
Location : Elkhil Farms, Ooty
Date of planting : 06.08.2012

Observations

1. Recorded mite population from 10 randomly selected plants before treatment
2. Recorded mite population from 10 randomly selected plants 7 days after treatment
3. Yield

Among biocontrol agents, release of coccinellid beetle, *Stethorus pauperculus* and predatory mite, *Amblyseius* sp @ 10 and 5 mites/ plant were effective in reducing two spotted spider mite, *Tetranychus urticae* which were on par, followed by *Beauveria bassiana* 10^8 CFU/ ml spray. However, two sprays of the standard acaricide, abamectin 1.9 EC @ 0.3 ml/ litre reduced the mite population (1.3 / 10 plants) significantly over all other treatments evaluated. The untreated check recorded the highest mite population of 78 / 10 plants 7 days after second treatment (**Table 133**).

The highest yield of 2465 numbers of flush/ plot were recorded in abamectin treated plot followed by *Stethorus*, *Amblyseius* sp*, Beauveria bassiana* biocontrol plots. Untreated check recorded the lowest yield of 1540 kg.

Table 133. Evaluation of Biological Control Agents against Mites in Carnation under protected Condition

Treatments		Spider mites/10 plants (3 sq.cm. area / plant)			Yield during I flush Number of stalks/ plot
		Pre treatment	7 days after first treatment	7 days after second treatment	
(i)	Release of predatory mite, *Amblyseius* sp @ 5 mites/ plant	74.7	34.3[b]	27.3[b]	2155[b]
(ii)	Release of predatory mite, *Amblyseius* sp @ 10 mites/ plant	69.3	27.3[b]	22.7[b]	2180[b]
(iii)	*Beauveria bassiana* 10^8 CFU/ml	72.0	48.0[c]	42.3[c]	1975[c]
(iv)	Release of coccinellid beetle, *Stethorus pauperculus*	76.7	29.3[b]	21.3[b]	2195[b]
(v)	Abamectin 0.3 ml / l	67.0	2.3[a]	1.3[a]	2465[a]
(vi)	Untreated check	69.7	74.3[d]	78.0[d]	1540[d]

4. Evaluation of predatory mite, *Neoseiulus longispinosus* against phytophagus mite in carnation under polyhouse condition (YSPUHF, SKUAST)

YSPUHF

An experiment was conducted to evaluate predatory mite, *Neoseiulus longispinosus* against *Teyranychus urticae* on carnation under polyhouse conditions. *N. longispinosus* was evaluated at predator: prey ratio of 1:30, 1:20 and 1:10 and compared with Neem Baan (1500 ppm; 3ml/l) and fenazaquin (0.0025%). Untreated control was also maintained for comparison. In total 3 releases of predatory mite (at each predator: prey ratio) at 7 days interval were made during June, 2012. Similarly three sprays each of Neem Baan (3ml/l) and fenazaquin(0.0025%) at 7 days interval were made. Each treatment was replicated 4 times in a randomized block design. Data on mite population was recorded before spray/release and 7days after final release/spray. Since the pre treatment mite population in different plots varied significantly, the final data on mite population was converted to per cent reduction in mite population over pretreatment count, which was further converted to per cent reduction over control after applying abbott's correction. Results of the experiment (**Table 134**) indicated that

profenophos (0.05%) was the most effective treatment resulting in 87.5 per cent reduction of mite population over control, which was, however, statistically on par with three releases of *N. longispinosus* at 1:10 predator: prey ratio where the corresponding reduction was 73.8 per cent. Other biocontrol agents like, Neem Baan (3ml/L), and *N. longispinosus* at predator: prey ratio of 1:20 and 1:30 resulted in 62.3, 69 and 62 per cent reduction of mite polulation over control, respectively. All these treatments were statistically on par with each other and also with *N. longispinosus* at 1:10 predator: prey ratio.

Table 134: Evaluation of predatory mite, *Neoseiulus longispinosus* against phytophagus mite in carnation under polyhouse condition.

Sr. no.	Treatment	Reduction(%) in mite population over control
1	*N. longispinosus* (1:30)	62.0 (51.9) [b]
2	*N. longispinosus* (1:20)	69.0(56.2) [b]
3	*N. longispinosus* (1:10)	73.8(59.3) [ab]
4	Neem Baan (1500 ppm;3ml/L)	62.3(52.2) [b]
5	Profenophos (0.5%)	87.5(69.2) [a]
	CD(p=0.05)	12.5
	CV (%)	17.4

Figures in parentheses are arc sine transformed values

SKUAST

This experiment could not be done during 2012.

5. Biological suppression of thrips on capsicum in polyhouse (IIHR)

The effectiveness of biological control agents (Entomopathogens and predator *B.pallescens,* botanicals, and chemicals were carried out against *S. dorsalis* on capsicum F1 hybrid, Indra. Spraying of the entomo-pathogens at the above dosage was carried out with spotting upward curling of terminal leaves that recorded about 1-2 thrips / tap. Pinching of the terminal shoots at weekly intervals was carried out for 4 times to sustain the crop for a longer period in all treatments including control.

Rating of terminal leaf damage from 0-5 was followed in addition to recording thrips per plant population. Spraying was initiated with recording of 1.0 rating in all treatments. Results indicated no increase in the rating of thrips in all treatments while in control it recorded 2.6 (ranged from 1.0 to 5.0 rating) (**Table 135**).

Table.135. Comparative field efficacy of biological control agents in management of thrips on capsicum

Treatments	% reduction over control	Rating
M.anisopliae @ 1x10^7 spores/ml (plant oil)	83.7	1.1
M.anisopliae@ 1x10^7 spores/ml (mineral oil	76.5	1.2
B.bassiana @1x10^7 spores/ml + adjuvant	85.2	1.2
B.bassiana @1x10^7 spores/ml)+ adjuvant	86.2	1.0
Predator *B.pallescens* @ 2/plant	84.2	1.2
Neem soap 10 g/L	85.2	1.1
Spinosad @0.3ml/L	87.2	1.2
Neem oil 2ml/L	83.2	1.0
Control		2.6

6. Biological management of root knot nematode infesting tomato, gerbera, carnation in poly houses (ANGRAU, MPKV, and SKUAST)

ANGRAU

Status: The trial is in progress

MPKV

The trial is laid out in Hi-Tech Floriculture Project, College of Agriculture, Pune on already planted gerbera var. Mellowdisc. The plot size was 1.5 x 4 m and the plant spacing was maintained 60 x 45 cm. The treatments consisted soil application with fungal pathogens, *Paecilomyces lilacinus* and *Arthobotrys oligospora* each @ 20 kg formulated dust/ha, standard chemical check carbofuran 3G @ 1.0 kg a.i./ha and untreated control. Soil 200 cc and root 5 g samples were drawn on 10/2/2013 from each treatment plots before treatment application to record initial population of root-knot nematodes. The application of fungal pathogens and chemical pesticide were provided given on 11/2/2013. The crop was irrigated with drip system. Similarly, the soil and root samples will be drawn from each treatment plots three months after application to assess the final nematode count. The trial is in progress.

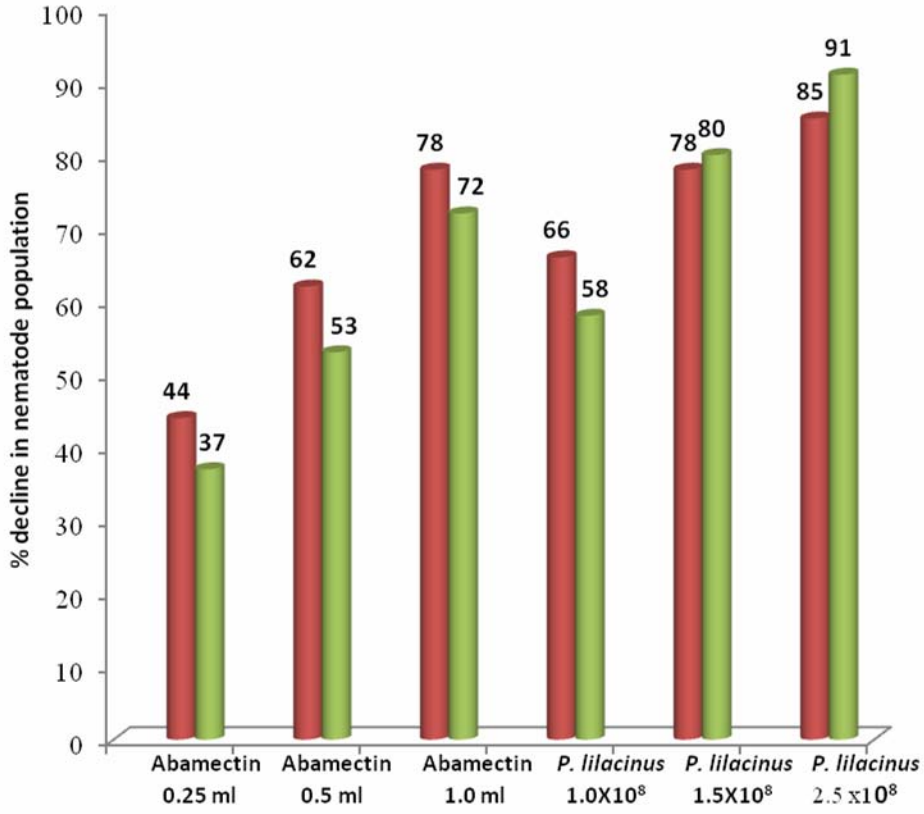
SKUAST

A pot trial was conducted to evaluate the effect of fungal bio control agent *Paecilomyces lilacinus* and chemical, abamectin against root-knot nematode *Meloidogyne hapla* infesting tomato cv. Shalimar 1. *P. lilacinus (*procured from IMTECH, Chandigarh) was applied at three different doses i.e. 1.0, 1.5 and 2.0 x 10^8 spores/ liter of water, whereas Abamectin 1.8 EC was applied @ 0.25, 0.5 and 1.0 ml/ liter of water for root dip treatment of

tomato seedlings 15 minutes before transplantation. A total of 42 clay pots (15 cm diameter and height) were filled with steam sterilized soil amended with compost (3:1). 100 ml of nematode suspension, each containing second stage juveniles (J_2) of *M. hapla* was mixed in the top soil of the pot one day before sowing so that juveniles could distribute uniformly in the soil. One untreated control was also used in the experiment. Each treatment was replicated six times and one plant was maintained in each pot. After 45 days of transplantation, plants from three pots were randomly selected for recording galls and egg mass production on root system. Uprooting was done very carefully to prevent damage to the root system. Root-knot Index was recorded on 1-5 scale i.e. 1 = no galling, 2 = 1-10 galls, 3 = 11-30 galls, 4 = 31-100 galls and 5 = more than 100 galls/ root system. For the observation of root population of *M. hapla*, one gm root was taken by weight from each plant and egg masses were isolated from it. Egg masses was then kept for hatching at room temperature and the second stage juveniles (J_2) of *M. hapla* thus collected were kept in a beaker and counted under stereoscopic microscope with the help of hand tally counter. At harvest, soil samples were drawn from the rhizosphere of tomato plants for recording the final population of *M. hapla* (J_2/kg soil). Yield parameter was recorded by weighing the fruit of one plant at each harvest separately and the sum of all the harvests from one plant was the total produce of one plant. This was finally calculated on g/plant basis.

A significant reduction in soil population of nematodes was observed in treated seedlings as compared to untreated. Highest reduction ($P \leq 0.05$) observed in soil population of nematodes was 85% in *P. lilacinus* (2.0×10^8 spores/ lit of water) followed by Abamectin (1.0 ml/ lit of water) where it was 78.0%. At the same dose of *P. lilacinus* and Abamectin, suppression in the root population of nematodes were also highest i.e. 91.0 and 72%, respectively (**Fig. 4**). The root-knot index of *P. lilacinus* @ 2.0×10^8 spores/ lit of water was 1.1 as compared to 3.8 in untreated control. An yield increase of 38-84% ($P \leq 0.05$) was recorded at different doses (1.0, 1.5 and 2.0×10^8 spores/ lit of water) of *P. lilacinus* whereas in case of Abamectin (0.25, 0.5 and 1.0 ml/ liter of water) it varied from 11-60% as compared to untreated control. In the present experiment it can be concluded that root dip treatment of tomato seedlings with *P. lilacinus* (2.0×10^8 spores/ lit of water) is more efficacious than Abamectin (1.0 ml/lit of water) in suppressing the population of root-knot nematode *M. hapla* in soil as well as in plant roots and increasing the crop yield to a significant level.

Figure 4. Effect of seedling root dip treatment on the soil and root population of *Meloidogyne hapla* (J_2) in tomato, in Kashmir, during 2012.



2.17. Storage Pests

1. Evaluation of anthocorid predators against storage pests in rice (AAU-J)

Evaluation of anthocorids (*Blaptostethus pallescens* and *Xylocoris flavipes*) against storage pests of rice, *Corcyra cephalonica* was conducted in the Biological control laboratory, Deptt. of Entomology, Assam Agricultural university, Jorhat. One kilogram of untreated rice was taken in plastic jars of two-kilogram capacity for each treatment and the jars were closed with lids. Each container was infested with 100 eggs of *Corcyra* during September 2012. Altogether there were seven treatments including control with four replications.

Treatments:

T1: Release of 10 *Blaptostethus pallescens* nymphs
T2: Release of 20 *Blaptostethus pallescens* nymphs
T3: Release of 30 *Blaptostethus pallescens* nymphs
T4: Release of 10 *Xylocoris flavipes* nymphs
T5: Release of 20 *Xylocoris flavipes* nymphs
T6: Release of 30 *Xylocoris flavipes* nymphs
T7: Infested grains with *Corcyra* eggs without release of anthocorids

Methodology: Seven day old nymphs of the anthocorids, *Blaptostethus pallescens* and *Xylocoris flavipes* were released @ 10, 20 and 30 nymphs per container. The nucleus culture of both the species of anthocorids were obtained from NBAII, Bangalore. Observations on number of *Corcyra* moths emerged from each container and the number of anthocorids (nymphs/adult) in the bins were recorded after a month from the release of the predators.

Result: The results indicated that (**Table 136**) the inoculative release of *Xylocoris flavipes* @ 30 nymphs per kg of stored rice (18.00 moths/ container) was significantly superior to all other treatments in reducing the emergence of *Corcyra* moths. However, *B pallescens*,@ 30 nymphs/container and *X. flavipes* @ 10 nymphs / container were on par with each other where 32.5 and 36.0 moths emerged respectively from these treatments. On an average, the moth emergence in untreated control was 59.25. Maximum number of living nymphs was recorded from the treatment of *X. flavipes* @ 30 nymphs/ container (12.50) followed by *X. flavipes* @ 20 nymphs/ container (7.75), where as negligible number of living nymphs was observed in different treatments of *B. pallescens.* It was concluded from the experiment that *Xylocoris flavipes* was better than *Blaptostethus pallescens* in controlling *Corcyra* moth infestation in stored rice in the laboratory conditions.

Table136. Effect of anthocorid predators against storage pests of rice

Treatments	Mean no. of corcyra mothemergence (Mean of 4 replication)	Mean no. of living anthocorids (nymphs) (Mean of 4 replication)
Blaptostethus pallescens @ 10 nymphs	55.75[a]	0
Blaptostethus pallescens @ 20 nymphs	41.25[b]	0.75
Blaptostethus pallescens @ 30 nymphs	32.5[c]	1.25
Xylocoris flavipes @ 10 nymphs	36.0[c]	4.50
Xylocoris flavipes @ 20 nymphs	26.75[d]	7.75
Xylocoris flavipes @ 30 nymphs	18.00[e]	12.50
Untreated	59.25[a]	0
CD at 5%	8.75	NS

2.18. Weeds

1. Release and establishment of *Cecidocharus connexa* in Jagdalpur area of Chhattisgarh (DWSR)

Chromolaena odorata, a problematic weed of Western Ghats, Karnataka and Tamil Nadu was not found in Baster area of Chhattisgarh about a decade back. However, in a short span, it has invaded large area of forest, community and waste land in and around Jagdalpur. It was observed that weed is spreading fast on road side leading from Jagdalpur to Raipur.

To manage this weed by biological methods, about 3000 galls infested with gall fly (*Cecidocharus connexa*) collected from Bengaluru were released in the Jagdalpur area during November 2011. Survey done during December 2012 did not reveal the establishment of bioagents at the released sites. The reason of failure in establishment of bioagent in the released area may be due to the fire occurred during May 2012 at the released site. This fire might have killed all the developing bioagents in the area. Therefore, again during December 2012, about 1500 infested galls were collected from Bengaluru and released in the three different sites of Jagdalpur area. The observations about the gall formation and establishment of the bioagent will be taken during July-August 2013.

2. Natural enemies' complex in different weeds (DWSR)

DWSR- No Report

2.19. Enabling large scale adoption of proven bio control technologies

1. Rice- AAU-J, KAU, OUAT

AAU-J (Adat model has to be replicated)

Large scale adoption of proven bio control based IPM package in rice was carried out in the farmer's field at village Pirakota of Jorhat district. The total area under rice cultivation was 50 ha. The variety was 'Ranjit' and the crop was transplanted in the first week of August'2012.

The IPM package as per technical programme was evaluated in comparison with farmer's practice (chemical control) where chlorpyrifos 20 EC @ 0.02 % was applied. Four rounds of chemical sprays were made at 15 days interval in the farmer's practice.

The IPM package consisted root dip treatment with *Pseudomonas fluorescens* @ 2 % solution, application of *Beauveria bassiana* @ 10^{13} spores/ha against sucking pests, erection of bird perches @ 10 no /ha, three releases of *T. chilonis* @ 1, 00,000 laks /ha at weekly interval starting from 35 DAT against *Scirpophaga* spp. and *Cnaphalocrocis* spp, spray of Botanicals (Pestoneem @ 3ml/lit) against sucking pests and *Pseudomonus* @ 10g/lit against foliar diseases, respectively. Diseases incidence was negligible during the cropping seasons. Population of skippers, hairy caterpillar and case worm was negligible. Statistical analysis was carried out using't' test.

Results

No significant difference was observed in the population of *Nephotettx sp* /hill in IPM plot as well as farmers' practice. However, the *Nephotettx spp* /hill were lower in IPM package after 65 days after transplanting (**Table 137**). The incidence of dead heart (2.75 %), WEH (3.00 %) and damaged leaves due to *Cnaphalocrocis* sp (2.78%) was significantly high in farmers' practice where as they were 1.41, 1.48 and 1.37 per cent in IPM plot after 65 DAT, respectively. Grain yield of 3364kg/ha was registered in IPM package which was significantly superior to farmers' practice with 3160 kg/ha (**Table 138**). In IPM package the activity of natural enemies like predatory spiders and coccinellids was more in comparison to farmers' practice. However, higher number of spider population (1.40 /sq.m) was recorded in IPM plots as against farmers' practice. But both the treatments were on par with each other (**Table 139**).The investigation revealed that IPM package was superior in respect of low occurrence of pests and thus increasing the crop yield.

Table 137. Observation on incidence on Green leaf hopper (GLH)/hill

Treatments	Precount (*Nephotettx sp.*/hill)	Post count	Post count
		45DAT (*Nephotettx sp* /hill)	65 DAT (*Nephotettx sp* /hill)
IPM package	4.57	2.81	1.40
Farmers' practice	4.50	2.67	1.70
't' value	0.14	0.40	1.40
Remarks	NS	NS	NS

Table 138. Observation on incidence on Dead heart, White ear head (WEH), Leaf folder damaged leaf (LFDL) and yield of rice

Treatments	Dead heart (%)		WEH (%)	LFDL (%)		Grain yield (Kg/ha)
	45 DAT	65 DAT		45 DAT	65 DAT	
IPM package	3.53(10.00)	1.41(5.26)	1.48(5.41)	3.13(9.66)	1.37(5.03)	3364
Farmers' practice	3.20(9.82)	2.75(9.52)	3.00(10.23)	3.24(9.84)	2.78(9.57)	3160
't' value	0.116	2.35	2.24	-0.115	2.37	3.25
Remarks	NS	S	S*	NS	S*	S*

*S: Significant at 5% level

Table 139. Observation on spider population/m^2 in rice

Treatments	Precount (spider/ m^2)	Post count	Post count
		45DAT (spider/ m^2)	65 DAT (spider/ m^2)
IPM package	1.20	1.40	0.09
Farmers' practice	1.00	0.08	0.8
't' value	0.61	1.64	-0.32
Remarks	NS	NS	NS

KAU (Adat model)

Location: Thrissur
Season: November 2012 – March 2013
Area: 100 ha
Variety: Jaya, Uma

The practices followed in IPM

- Seed treatment with *Pseudomonas* @ 10g/kg of seeds
- *Trichogramma japonicum* @ 1 lakh/ha was released from 20 days after transplanting and 40 days after sowing. Five releases were made at 10 days interval.
- Sprayed *Pseudomomas* @ 2% against foliar diseases.
- In some plots neem oil was sprayed at tillering stage against sucking pests.
- Sprayed neem oil 0.5% against rice bugs.

The practices followed in conventional farming

- Seed treatment with *Pseudomonas* @ 10g/kg of seeds
- Flubendamide @ 50 ml/ha against rice stem borer and leaf folder
- Fipronil 1.5l/ha against sucking pests and rice bugs

Observations were recorded from the two farming areas. Pest incidence was low in all the locations. There was no significant difference in grain weight between the IPM plot and the chemical plot.

	IPM	Conventional	t value	Significance
Grain yield/ ha	6970 kg	7354 kg	0.758	NS

In addition to that, in an area of 2770 ha of paddy biocontrol technologies were followed for the management of rice pests. Other districts where IPM practised for pest management in rice were Palakkad, Malappuram, Kozhikode, Kannur, Kasaragode, Ernakulam, Alappuzha, Kollam, Kottayam, Thiruvananthapuram, Idukki and Wayanad.

OUAT (Large scale adoption of proven bio control technologies)

1. Theme area of research : Demonstration of bio control technology in large areas for control of insect pests of rice
2. Background information: There are proven bio control technologies for effective control of insect pests of rice which has been demonstrated in various parts of the country. In Kerala, the Adat Vally project has drawn the attention of bio control activists for control of rice pests.
3. Location : Bauligarh(Block: Banarpal; Angul District)
4. Date of start of the project : Kharif,2011-12
5. Likely date of completion of the project : Kharif,2013 – 14
6. Area covered: 100 Acres
7. BIPM adopted

- Seed treatment with *Pseudomonas* @ 8g/kg of seeds/seedling.
- Spray of *Beauveria bassiana* 10^{13} spores/ha against sucking pests.
- Bird perches erected @10/ha.
- Release of *Trichogramma japonicum* @ 1 lakh/ha when either the leaf folder or stem borer occurrence is noticed. Releases initiated as soon as the moth activity is seen. Six releases made at weekly intervals.
- Spray of *Bt* @2kg/ha, 2sprays given at 15 day interval
- Spray of *Pseudomonas fluorescens* @ 1.5 kg/ha against foliar diseases.
- Spray of Neemazol @ 2.5 lit./ha twice at 45 and 60DAT

Farmers' practice
Six to eight rounds of spray with insecticides like Monocrotophos, Chlorpyriphos, Rynaxypyr, Imidacloprid, Acetamiprid etc.

Results: The dead heart, white ear, leaf folder and case worm incidence in BIPM demonstration plots were recorded as 4.6,7.3,4.9 and 3.9 % respectively where as, their population in non-IPM farmers' plots were 13.6,16.9,11.2 and 5.4 %. Population of other pests like Hairy caterpillar, green laef hopper (GLH) and brown plant hopper (BPH) were less in IPM plots (1.2, 2.3 and2.1/hill respectively) as compared to non-IPM plots where these pests recorded as 1.5,7.9 and 6.3/hill. The spider and predatory mired bug population were 1.1 and 0.9 /hill in IPM fields as compared to 0.3 and 0.4/hill in non-IPM fields. Subsequently lower pest population resulted in higher yield in IPM plots recording 43.9q/ha as against 28.5q/ha in non-IPM plots due to more pest load. The IPM farmers got an additional benefit of Rs 20,790.00/ha over the non-IPM farmers (**Table 140**).

Table 140: Demonstration of bio control technology in large areas for control of insect pests of rice

Treatments	Dead Heart (%)	White Ear (%)	Leaf Folder (%)	Case Worm (%)	Hairy Caterpillar No./Hill	GLH No./Hill	BPH No./ Hill	Spiders No/ Hill	Mirids No./ Hill	Yield (Q/Ha)	BIPM Farmers' benefit over Non-adopters
BIPM	4.6	7.3	4.9	3.9	1.2	2.3	2.1	1.1	0.9	43.9	Rs 20,790/ha
Farmers' Practice	13.6	16.9	11.2	5.4	1.5	7.9	6.3	0.3	0.4	28.5	

2. Sugarcane

i. Large scale demonstration of biocontrol for suppression of plassey borer, *Chilo tumidicostalis* using *Trichogramma chilonis* (AAU-J, ANGRAU)

AAU-J

Large scale demonstration of *Trichogramma chilonis* against the plassey borer, *Chilo tumidicostalis* was carried out in the farmer's field located at Khanikor gaon in Golaghat district covering an area of 50 ha during 2012 -13. It was compared with Farmer's practice (Chemical control).The farmers' practice plot was taken at Sugarcane Research Station, Buralikson. The sugarcane variety 'Dhansiri' was planted in all the locations in the second week of April, 2012. In farmers' practice four rounds of profenofos 50 EC @ 0.05% was sprayed at 15 days interval.

A total of eleven releases of *T. chilonis* @ 50,000/ha/release at 10 days interval from mid July to November first week, 2012 was made. Observations on mean percent egg parasitism and infested canes due to ***Chilo tumidicostalis*** attack before and after treatment were recorded. Statistical analysis was done using't' test .

Results

The data presented in the table 141 shows that the per cent incidence of *C. tumidicostalis* in chemical control plot was 14.71 compared to 12.08 per cent in parasitoid released plot and had no any significant difference in between the treatments, which resulted in only 18.00 per cent reduction in damage. However, the mean per cent parasitism of eggs of *C. tumidicostalis* in parasitoid released plot was 24.4 with a significant difference from that of chemical control where it was only 7.1 (**Fig 5**). The cane yield attributed in parasitoid released and chemical plot was 73.2 t/ha and 71.39 t /ha, respectively. No significant difference was observed in respect of cane yield in both the treatments (**Table 141**). A net return of Rs.3720 was only achieved in cane yield of IPM plot compared to chemical control plot (**Table 142**).

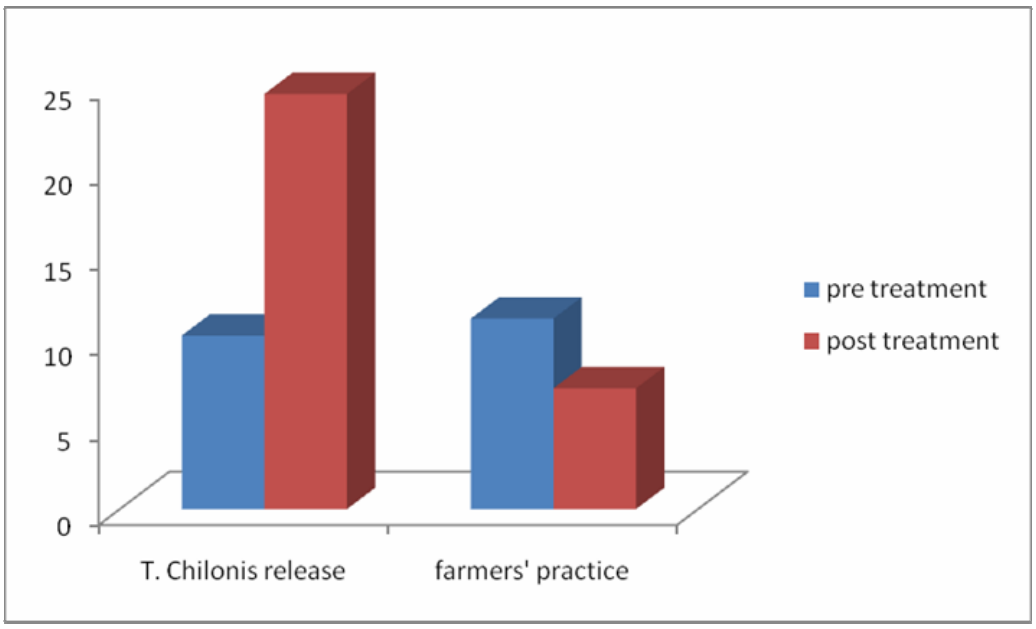


Fig 5. Percent egg parasitization by *T. chilonis* in sugarcane

Table 141: Evaluation of *Trichogramma chilonis* against *Chilo tumidicostalis*

	Pre count		Post count			Yield q/ha
Treatments	% infested cane	% egg parasitization	% infested cane	% reduction over fermer's practice	% Egg parasitization	
T. chilonis released plot @ 50000/ha	11.10 (19.17)	10.20 (18.59)	12.08(20.88)	17.87	24.40(29.56)	73.25
Farmer's practice (Chemical control)	12.17 (20.23)	11.20 (19.47)	14.71(22.10)	--	7.1 (15.26)	71.39
T' value	-0.658	-1.147	-2.094		13.68	0.879
Remarks	NS	NS	NS		S*	NS

S* = Significant at 5 % value
Figures in parenthesis are angular transformed values

Table 142: Cost benefit ratio

Treatment	Yield (Kg /ha)	Additional yield over chemical control	Value of yield/ ha (Rs/ha)	Cost of bio control/ chemical treatment (Rs /ha)	Net return (Rs/ ha)
Trichogramma chilonis released plot@ 50,000/ha/release	73250	1860 --	146500 142780	962.5 2164	3720 ----
Chemical control	71390			2164	

- Cost of sugarcane @Rs. 200.00 q/ha

ANGRAU

No Report

ii. Demonstration of temperature tolerant strain (TTS) of *Trichogramma chilonis* against early shoot borer (ESB) in *Suru* planting of sugarcane (MPKV, PAU)

MPKV

Demonstration on effectiveness of *T. chilonis* TTS against ESB in sugarcane was conducted on the farm of Agronomy, College of Agriculture, Pune. Planting of sugarcane cv. Co 265 @ 25,000 setts/ha was done on 23/01/2012 over 1.0 ha with at 90 x 30 cm plant spacing. Nucleus culture of the parasitoid was obtained from the NBAII, Bangalore and mass cultured in the Biocontrol laboratory. The treatments comprised eight releases of *T. chilonis* TTS @ 50,000 adults/ha at weekly interval, farmers' practice- three sprays of chlorpyriphos 0.05% and untreated control. A control plot maintained at 200 m distance from parasitoid released plot. Each treatment plot divided into 10 subplots as replicates. Release of parasitoids started from 22/3/2012. The pre-release observations on infestation of ESB (% dead hearts) and number of tillers per clump were recorded at 15 spots in each subplot. Similarly, post counts of dead hearts and number of tillers at each spot were

recorded at 15 days interval from initiation of parasitoids' release up to 4 months old crop. Yield was recorded on per plot basis and converted in to MT per ha.

Data on per cent dead hearts and number of tillers per clump transformed to arc sin and √x+0.5 values respectively, before statistical analysis. The results in **Table 143** indicated that eight releases of *T. chilonis* TTS @ 50,000 parasitoids/ha at weekly interval starting from 45 days after emergence of shoots found significantly superior to untreated control in reducing the ESB infestation (6.7% dead hearts) and increased number of tillers (10.9 tillers/clump) as well as cane yield (144.9 MT/ha). It was, however, statistically comparable with chemical control.

Table 143. Efficacy of of *T. chilonis* TTS against ESB on Sugarcane

Treatment	Dead hearts (%)		No. of tillers/clump		Yield (MT/ha)
	Pre-count	Post count	Pre-count	Post count	
T1: *T. chilonis* @ 50,000parasitoids/ha	9.8 [a]	6.7 [a]	8.3 [a]	10.9 [a]	144.9 [a]
T2: Farmers practice-chlorpyriphos 0.05%	10.0 [a]	7.5 [a]	8.6 [a]	10.3 [a]	144.0 [a]
T3: Untreated control	10.0 [a]	15.8 [b]	8.5 [a]	7.2 [b]	132.2 [b]
CD (p = 0.05)	NS	2.07	NS	0.41	5.60

PAU

(a) Demonstration conducted by PAU alone: Demonstrations on use of temperature tolerant strain (tts) of *T. chilonis* developed by NBAII was conducted at village Paddi Khalsa (Distt. Jalandhar). It was compared with chemical control and untreated control. *T. chilonis* was released 8 times, during mid April to June end, at 10 days interval @ 50,000 per ha. In chemical control, cartap hydrochloride (Padan 4G) was applied @ 25 kg/ha, after 45 days of planting. The plot size 20 ha for temperature tolerant strain and 0.4 ha each for chemical control and untreated control at each location. Each plot was sub-divided into 8 parts to record the observations.

The data presented in **Table 144** revealed that the mean incidence of early shoot borer in control (15.8%) were significantly higher than temperature tolerant strain of *T. chilonis* (6.6%) and chemical control (6.2%). The mean incidence in temperature tolerant strain of *T. chilonis* was on par with chemical control. Thus percent incidence reduction in release fields and chemical control over untreated control was 58.2 and 60.7 respectively. The mean yield in chemical control (765.8q/ha) and temperature tolerant strain of *T. chilonis* (756.8 q/ha) was on par but yield in these two was significantly higher than control (690.6 q/ha). The cost benefit ratio in temperature tolerant strain of *T. chilonis* (1:20.6) was higher than chemical control (1: 10.7).It can be concluded that 8 releases of temperature tolerant strain of *T. chilonis* @50,000per ha were on a par with chemical control for the management of early shoot borer *C. infuscatellus*, and reduced the incidence by 58.2 per cent over untreated control.

(b): In Collaboration with sugar mills: Large scale demonstration of effectiveness of *T. chilonis* (tts) against against early shoot borer, *Chilo infuscatellus* over an area of 1000 acres was carried out in collaboration with two sugar mills of the state i.e. Doaba Co-operative Sugar Mills Ltd. Nawanshahar and Morinda Co- operative Sugar Mills Ltd. Morinda (Table 2). The egg parasitoid, *T. chilonis* was released from during mid April to June end, at 10 days interval @ 50,000 per ha.

The incidence of *C. infuscatellus* at Nawanshahar and Morinda in release fields was 11.4 and 9.3 per cent respectively (**Table 145**). The corresponding figures in control fields were 27.7 and 23.2 per cent. The reduction in damage over control in the field of these two mills was 58.8 and 59.9 percent, respectively. Hence the mean reduction was 59.3per cent. It can be concluded that in large-scale demonstration, eight releases of *T. chilonis* (tts) @ 50,000 per ha at 10 days internal during mid April to June end reduced the incidence of early shoot borer by 59.3 per cent.

Table 144. Demonstration of *T. chilonis* (Temperature tolerant strain) against early shoot borer, *Chilo infuscatellus* at village Paddi Khalsa (Distt. Jalandhar) during 2012

Treatments	Incidence of *C. infuscatellus* (%)	Per cent reduction over control	Yield (q/ha)	Cost benefit ratio*
***T. chilonis* (Temperature tolerant strain)**	6.6[a]	58.2	756.8 [a]	20.6
Chemical control (Padan @25kg/ha)	6.2[a]	60.7	765.8 [a]	10.7
Control	15.8[b]	-	690.6 [b]	-

Note: 8 releases of *T. chilonis* were made @50,000/ha at 10 days interval during April to end June; Padan 4G@ 25kg/ha was applied after 45 days of planting.
*Cost of insecticide: Rs 70/kg, Trichocard: Rs 40/card, Sugarcane price: Rs 250/q

Table 145: Demonstration of *T. chilonis* (Temp. tolerant strain) against early shoot borer, *C. infuscatellus* in two sugar mills of Punjab during 2012

Mill area	Area covered (acres)	Incidence of *C. infuscatellus*		
		IPM*	Non Adopted	Reduction (%) over control
Doaba Co-op Sugar Mills Ltd, Nawanshahar	500	11.4	27.7	58.8
Morinda Co-op sugar Mills Ltd, Morinda	500	9.3	23.2	59.9
Total/ Mean	**1000**	**10.4**	**25.5**	**59.3**

Note: Eight releases of *T. chilonis* were made @ 50,000/ha at 10 days interval during April to end June

iii. Use of *Trichogramma chilonis* for the suppression of stalk borer, *Chilo auricilius* in collaboration with sugar mills (PAU)

Large scale demonstration of effectiveness of *T. chilonis* against stalk borer over an area of 3500 acres was carried out in collaboration with two sugar mills of the state i.e. Doaba Co- operative Sugar Mills Ltd. Nawanshahar and Morinda Co- operative Sugar Mills Ltd. Morinda (**Table 146**). The egg parasitoid, *T. chilonis* was released from July to October 10 days interval @ 50,000/ha. The incidence of *C. auricilius* at Nawanshahar and Morinda in IPM fields was 7.2 and 3.1 percent, respectively. The corresponding figures in control fields were 19.8 and 6.3 per cent. The reduction in damage over control in these

two mills was 63.6 and 49.8 percent, respectively. Hence the mean reduction was 56.7 per cent.

It can be concluded that in large-scale demonstration, 12 releases of *T. chilonis* @ 50,000 per ha at 10 days internal during July to October reduced the incidence of stalk borer by 56.7 per cent.

Table 146: Large-scale demonstration of biocontrol based IPM against stalk borer, *Chilo auricilius*, on sugarcane in two sugarcane mills in Punjab during 2012-13

Mill area	Area covered (acres)	Incidence of *C. auricilius*		
		IPM*	Non Adopted	Reduction (%) over control
Doaba Co-op Sugar Mills Ltd, Nawanshahar	1500	7.2	19.8	63.6
Morinda Co-op sugar Mills Ltd, Morinda	2000	3.1	6.3	49.8
Total/ Mean	**3500**	**5.1**	**13.0**	**56.7**

***** Twelve releases of *T. chilonis* @ 50,000 per ha at 10 days interval during July to October.

iv. Demonstration on the use of *Trichogramma japonicum* for the suppression of top borer, *Scirpophaga excerptalis* (PAU)

Large-scale demonstrations of effectiveness of *T. japonicum* against top borer, *S. excerptalis* were carried out at village Rawalpindi (Distt Jalandhar) in 20 ha area. It was compared with chemical control and untreated control. The parasitoid, *T. japonicum* was released 8 times at 10 days interval from April to June @ 50,000 per ha. In chemical control, phorate (Thimet 10G) @ 25kg/ha was applied during last week of June. The incidence of top borer and yield was recorded from six locations in each treatment. The egg masses of *S. excerptalis* were collected to record percent parasitization.

The data presented in **Table 147** revealed that the incidence of top borer in control (15.9%) was significantly higher than releases and chemical control. The incidence recorded in chemical control (5.8%) was at par with *T. japonicum* releases fields (6.0%). The reduction in incidence over control was 62.3 and 63.5 per cent in release fields and chemical control, respectively. The mean parasitism of eggs of *S. excerptalis* in release field was 47.2 per cent as compared to 1.9 percent in chemical control and 3.0 per cent in control. The yield in control (732.8 q/ha) was significantly lower than release fields (792.0 q/ha) and chemical control (804.0 q/ha), the latter two were at par with each other. The cost benefit ratio in *T .japonicum* (18.5) was higher than chemical control (10.1). It can be concluded that eight releases of *T. japonicum* at 10 days interval during April to June @ 50,000 per ha proved as effective as chemical control for the control of top borer.

Table 147: Large scale demonstration of *Trichogramma japonicum* against *Scirpophaga excerptalis* at village Rawalpindi (Distt Jalandhar) in Punjab during 2012

Treatments	Incidence of *Scirpophaga excerptalis* (%)	Per cent reduction over control	Per cent parasitism	Yield (q/ha)	Cost: Benefit ratio*
***T. japonicum* @50,000/ha**	6.0 [a]	62.3	47.2	792.0 [a]	18.5
Phorate 10G @30kg/ha	5.8 [a]	63.5	1.9	804.0 [a]	10.1
Control	15.9 [b]		3.0	732.8 [b]	-

Note: 8 releases of *T. japonicum* were made @50,000/ha at 10 days interval during April to end June; Phorate 10G@ 25kg/ha was applied in end June.
*Cost of insecticide: Rs 70/kg, Trichocard: Rs 40/card, Sugarcane price: Rs 250/q

v. Large-scale Demonstration on the use of *T.chilonis* against early shoot borer and internode borer of Sugarcane in Farmers' field (OUAT, ANGRAU)

OUAT

1. Project title **:** Large-scale Demonstration on the use of *T.chilonis* against early shoot borer and internode borer of Sugarcane in Farmers' field
2. Theme area of research : Demonstration of *T.chilonis* against early shoot borer and internode borer of Sugarcane in Farmers' field
3. Background information: Trichogramma chilonis has been a success in controlling tissue borers of sugarcane in several parts of the country. The effectiveness of temperature tolerant strain has been demonstrated.
4. Investigator : Dr.B.K.Mishra, Professor,Entomology
5. Location : Rambhadeipur(Badachana),Dalabhamapur(Nimapara),Pohal(Adaspur)
6. Date of start of the project : Rabi,2011-12
7. Likely date of completion of the project : Rabi,2013 – 14
8. Period for which report is submitted. Rabi,2011-12

Village: Madhibramhapur; **Block** : Nimapara; **District**: Puri; **Area**: 50 Acres

Results: The crop was planted in the month of November-December.First release of *T.chilonis* was done on 5th December after taking pre-release ESB infestation which ranged from 15.9 to 17.2 %. Release of *T.chilonis* for ESB continued till 4th week of February. Observation on incidence of ESB was taken each week starting from 2nd week of December till the 4th week of February. The incidence of ESB ranged from 5.5 to 24.7%, the lowest being in *T.chilonis* released plots. Parasitoid release resulted in significant reduction of ESB population as compared to pesticide application which resulted in 16.9% ESB incidence. The control plots had 24.7% ESB incidence. Similarly, internode borer incidence was also least in parasitoid released plots (11.84%) as compared to 20.65% in farmers practice and 39.8 % in untreated control. As regards to Top Shoot Borer, the incidence before release of parasitoid was 4.0 to 5.7%. The pest incidence was least in parasitoid treatment (2.8%) followed by 3.9 % in pesticide applied plots and 10.4% in control. The yield was highest (128.7 t/ha) in parasitoid released plots whereas,it was 104.3 t/ha in farmers practice and 81.2 t/ha in untreated control (**Table 148**).

Table 148: Demonstration on the use of *T.chilonis* against early shoot borer and internode borer of Sugarcane in Farmers' field

Treatments	Early shoot borer (%)		Internode borer(%)		Top Shoot Borer(%)#		Yield (t/ha)
	Pre release	Post release**	Pre release	Post release***	Pre Release	Post Release	
1. Release of *T.chilonis* after 45 DAG @ 50,000/ha at weekly intervals. Total of 10-12 releases will be made	15.9 (4.05)	5.5 (2.45)	5.4 (2.43)	11.84 (20.09)	4.2 (2.17)	2.8 (1.82)	128.7
2. Farmers' practice* of pesticide application.	17.2 (4.21)	12.9 (3.66)	6.9 (2.72)	20.65 (27.06)	4.0 (2.12)	3.9 (2.10)	104.3
3. Untreated control	16.4 (4.11)	24.7 (5.02)	7.1 (2.76)	39.80 (39.11)	5.7 (2.39)	10.4 (3.30)	81.2
C.D (p=0.05)	NS	(0.94)	(0.24)	(4.37)	(NS)	(0.18)	16.52

Figures in parentheses are square root transformations for ESB and Top Shoot Borer and arc sin√ X for Internode Borer (Post release)

*Application of Phorate,Carbofuran or Imidacloprid granules at varying doses during earthing up and spraying of Rynaxypyr, Monocrotophos, Profenophos

** Mean of ten observations, *** Mean of ten observations, #Mean of five observations

ANGRAU

Treatments

1. Release of of*Trichogrammachilonis* on 45th day after crop germination @ 50000/- ha at weekly interval. Total of 8-10 releases to be made depending upon pest situation + erection of Woto T pheromone traps @ 8 per Acre for both ESB & IB
2. Farmers practice of the region against early shoot borer and internode borer to be followed
3. Untreated control

Area of Demonstration: 40 ha to be taken up in collaboration with sugar mills in AP

Observations

1. Divide the area into 8 equal sized blocks to serve as 8 replicates
2. Record pre-release infestation in all the 8 blocks.
3. Post release observation on infestation/dead hearts to be recorded at fortnightly intervals after initiation of releases and observations to be recorded up to 4 months old crop. Infestation/dead hearts to be recorded at least at 15 spots in each block.

4. Record number of tillers on each observation day at each spot. The tillers are to be counted at 15 spots in each block.
5. Record yield at harvest in each block.

Results: This trial is being taken up in collaboration with sugarcane research stations at Rudrur, Nizamabaddt and Vuyyuru, Krishna dt.

3. Maize

i. Demonstration of biological control of maize stem borer, C*hilo partellus* using *Trichogramma chilonis* (PAU)

PAU

The demonstration of biological control of maize stem borer, C*hilo partellus* was given at village Chaggran in Hoshiarpur district on 20 ha area. The sowing of maize hybrid PMH 2 was done on 28th of June; 2012. The demonstration area was divided into three blocks representing three treatments each having three replications. A buffer zone of three meter was maintained for each treatment. The treatments were release of *Trichogramma chilonis@* 1, 00,000 parasitoids/ha at 12 days after germination (Biocontrol package), farmers practice and untreated control. The eggs of *Corcyra cephalonica* parasitized by *T. chilonis* were glued to tricho cards. The required number of tricho cards depending upon the dose per hectare were cut into smaller pieces and attached to the underside of maize leaves between 10 - 15 days old maize crop and at different places in each plot. For recovery of *T. chilonis,* five egg clusters (having 40 eggs per cluster) of *C. partellus* were attached to the central whorl of the maize plants at different places in the field, one day after release of the parasitoids and were collected 24 hour later and brought to biocontrol laboratory to observe for adult parasitoid emergence. The recovery was also observed in the untreated control and farmers practice treatments to observe for natural parasitization or any dispersal of the parasitoids. Observations on leaf injury and dead hearts were recorded at 30 and 45 days after sowing and yield was recorded at harvest. The data was recorded from 100 plants selected at random from each plot.

The results of the demonstration at farmers field shows significantly lower leaf injury in plots with release of *Trichogramma chilonis* @ 1,00,000 parasitoids/ha on 12 days old crop (7.6 %) as compare to the untreated control (28.3 %) (**Table 149**). However, it was at par (6.2 %) in farmer's practice of two sprays of fenvalerate 20 EC and deltamethrin 2.8 EC on 10 & 15 days old crop. Dead heart formation caused by maize stem borer was minimum (2.9 %) in plots which receive farmers practices followed by single release of *T. chilonis* (4.3 %) on 12 days old crop but significantly lower than untreated check (14.8 %). The parasitization rate of *C. partellus* eggs was significantly higher in releases of parasitoid (31.7 %) in comparison to untreated check (9.2%). The minimum parasitization (2.7%) was observed in chemical control. The yield was significantly higher in releases of parasitoid (46.7 q ha^{-1}) in comparison to untreated check (39.1 q ha^{-1}) but comparable to farmer's practices (49.8 q ha^{-1}). Overall results shows that biological control of maize stem borer, *C. partellus* using *T. chilonis* brings much better results in comparison to control treatments and comparable to farmers practices. The net return over control in Biocontrol package was Rs 8934/- as compared to 11840 in farmer practice (**Table 150**).

Table 149: Effect of *T. chilonis* releases on incidence of *C. partellus* and yield in *Kharif* maize during 2012

Treatments	Leaf injury (%)	Dead hearts (%)	Parasitization (%)	Yield (q ha^{-1})
Biocontrol package	7.6[a]	4.3[a]	31.7[a]	46.7[a]
Farmers Practice	6.2[a]	2.9[a]	2.7[c]	49.8[a]
Untreated control	28.3[b]	14.8[b]	9.2[b]	39.1[b]
CV	10.8	6.6	10.1	4.1

Table 150: Cost Benefit analysis (2012)

Treatments	Yield (kg/ha)	Additional yield over control (kg/ha)	Value of yield/ha (Rs)	Cost of treatment (Rs/ha)	Net return over control (Rs/ha)
Biocontrol package	4667	757	9084	150	8934
Farmer's practice	4980	1070	12840	1000	11840
Untreated control	3910	-	-	--	-

*Rs 12/kg of seeds

4. Coconut

i. Large area field validation of integrated biocontrol technology against *Oryctes rhinoceros* (CPCRI)

Large area field management of *O. rhinoceros* was conducted in two wards of Devikulangara Panchayat (Alappuzha dist., Kerala) comprising an area of 100 ha. In the area average land area under coconut cultivation is 52.8% and 54.5% of farmers were having holding size of <40 cents. Training programmes and group meetings were organized in respective wards and treatment of breeding sites of Rhinocerus beetle was done with farmers' participation. Rhinoceros beetle incidence was 37.5, 82.4 and 81.1% in young, juvenile and adult palms respectively. Potential breeding sites of Rhinoceros beetle recorded include dead palms (27.9%), cow dung pits (14.7%) and compost tanks (4.4%). Post treatment observations after one year showed 43-47% reduction in leaf damage and 60-80% reduction in site occupancy by the pest (**Table 151 & 152**). This programme is being scaled up in 4 panchayaths of Alappuzha district covering an area of 1500 ha under the new CDB funded project.

Table 151. Rhinoceros beetle incidence at Devikunagara (Alappuzha dist., Kerala)

Palms infested (%) with RB at Devikulangara			
Category of palms	Pre treatment 2011-12	Post treatment 2012-13	Reduction in pest incidence
Juvenile (< 3yrs)	32.8	23.4	28.6
Young pre-bearing palms (4-10 yrs)	82.6	70.6	14.5
Adult palms (>10 yrs)	84	70	16.6

Table 152. Leaf damage (%) by rhinoceros beetle at Devikulangara (Alappuzha dist., Kerala)

Category of palms	Pre treatment 2011-12	Post treatment 2012-13	*t* value	Reduction in leaf damage (%)
Juvenile (< 3yrs) (n= 128)	10.21	5.36	8.25**	47.5
Young pre-bearing (4-10 yrs) (n= 80)	20.63	11.78	3.72**	42.8
Adult (>10 yrs) (n=130)	17.39	9.11	13.46**	47.6
Total palms	16.04	8.55	14.32**	46.6

3. Functioning of the co-ordinated project

3.1. Staff position

Sl. No.	Name	Designation	Joining date	Date of leaving
National Bureau of Agriculturally Important Insects, Bangalore				
1	Dr. N. K. Krishna Kumar	Director	30.06.2011	09.08.2012
2	Dr. B. S. Bhumannavar	Director (Acting)	09.08.2012	31.03.2013
3	Dr. N. Bakthavatsalam	Principal Scientist	01.10.1994	Continuing
4	Dr. Prashanth Mohanraj	Principal Scientist	07.04.2001	Continuing
5	Dr. B. Ramanujam	Principal Scientist	11.12.2000	Continuing
6	Dr. (Ms.) K. Veenakumari	Principal Scientist	07.04.2001	Continuing
7	Dr. (Ms.) J. Poorani	Principal Scientist	01.08.1996	Continuing
8	Dr. (Ms) Chandish R. Ballal	Principal Scientist	06.02.1985	Continuing
9	Dr. M. Nagesh	Principal Scientist	29.01.2001	Continuing
10	Dr. A. N. Shylesha	Principal Scientist	04.08.2007	Continuing
11	Dr. S. K. Jalali	Principal Scientist	06.02.1985	Continuing
12	Dr. T. Venkatesan	Principal Scientist	29.10.1994	Continuing
13	Dr. P. Sreerama Kumar	Principal Scientist	31.07.1995	Continuing
14	Dr. K. S. Murthy	Principal Scientist	04.04.2001	Continuing
15	Dr. Sunil Joshi	Principal Scientist	04.11.1994	Continuing
16	Dr. R. Rangeshwaran	Principal Scientist	05.03.1997	Continuing
17	Dr. T. M. Shivaling Swamy	Principal Scientist	2009	Continuing
18	Dr. G. Siva Kumar	Senior Scientist	2009	Continuing
19	Dr. Mohan	Senior Scientist	01.06.2012	Continuing
20	Dr. Mahesh Yandigeri	Senior Scientist	04.06.2012	Continuing
21	Ms. M. Pratheepa	Scientist SS	23.09.1999	Continuing
22	Dr. (Ms.) Deepa Bhagat	Scientist SS	30.03.2007	Continuing
23	Dr. Gandhi Gracy	Scientist	2009	Continuing
24	Dr. Ankitha Gupta	Scientist	2010	Continuing
25	Mr. K.J. David	Scientist	28.12.2011	Continuing
26	Mrs. S. Salini	Scientist	28.12.2011	Continuing
27	Dr. Jagdesh Patil	Scientist	2012	Continuing
Central Tobacco Research Institute, Rajahmundry				
1.	Sri. S. Gunneswara Rao	Scientist SG (Ent.)	16-2-1993	Continuing
Central Plantation Crops Research Institute, Regional Station, Kayangulam				
1	Dr. (Ms.) Chandrika Mohan	Principal Scientist (Ent.)	01.04.1996	Continuing
Indian Agricultural Research Institute, New Delhi				
1	Dr. B. Paul	Senior Scientist (Ent.)	2012	
Indian Institute of Sugarcane Research, Lucknow				
1	Dr. Arun Baitha	Senior Scientist (Ent.)	01.10.2006	Continuing
Indian Institute of Horticultural Research, Bangalore				
1.	Dr. A. Krishnamoorthy	Princ. Scientist (Ent.)	1977	Continuing
2	Dr. P. N. Ganga Visalakshy	Senior Scientist (Ent.)	1987	Continuing
Anand Agricultural University, Anand				
1	Dr. D. M. Korat	Principal Res. Scientist	01.10.2006	Continuing
2	Dr. (Mrs.) Harsha. N. Shelat	Asst. Res. Sci. (Micro)	01.03.2013	Continuing

3	Sh. N. B. Patel	Asst. Res. Sci.(Ent.)	2011	Continuing
Acharya N. G. Ranga Agricultural University, Hyderabad				
1	Dr. S. J. Rahman	Prin. Scientist & Head	19.02.2007	Continuing
2	Smt. G.Anitha	Scientist (Ent.)	06.01.2009	Continuing
Assam Agricultural University, Jorhat				
1	Dr. D. K.Saikia	Principal Scientist (Ent.)	23.03.2001	Continuing
2.	Dr. (Mrs) Anjumoni Devi	Junior Scientist (Ent.)	20.12.2012	Continuing
Dr. Y.S. Parmar University of Horticulture and Forestry, Solan				
1	Dr Usha Chauhan	Senior Entomologist	June, 2009	Continuing
2	Dr. P. L. Sharma	Entomologist	16.05.2008	Continuing
Gobind Ballabh Pant University of Agriculture and Technology, Pantnagar				
1	Dr. J. Kumar	Dean	2008	Continuing
2	Dr. Anand Kumar Tewari	Snr. Sci. (Pl. Pathology)	2012	Continuing
Kerala Agricultural University, Thrissur				
1.	Dr. K. R. Lyla	Professor (Ent.)	23-11-95	Continuing
2.	Smt. C.V. Vidya	Asst. Prof. (Ent.)	2011	Continuing
Mahatma Phule Krishi Vidyapeeth, Pune				
1	Dr. D. S. Pokharkar	Entomologist	10/4/1996	Continuing
2	Dr. R. V. Nakat	Asstt. Entomologist	21/8/2007	Continuing
Punjab Agricultural University, Ludhiana				
1.	Dr Neelam Joshi	Microbiologist	8.5.1997	Continuing
2.	Dr Naveen Aggarwal	Entomologist	2.7.2008	Continuing
3.	Dr Rabinder Kaur	Asstt. Entomologist	20.12.2004	Continuing
4.	Sh. Sudhendu Sharma	Asstt. Entomologist	1.1.2009	Continuing
Sher-e-Kashmir University of Agricultural Science & Technology, Srinagar				
1.	Dr. M. Jamal Ahmad	Assoc. Professor	Nov., 2007	Continuing
2	Dr. G.M. Lone	Asst. Prof. Ent.	Feb. 2012	Continuing
Tamil Nadu Agricultural University, Coimbatore				
1.	Dr. P. Karuppuchamy	Professor (Ent.)	02.07.2007	Continuing
2.	Dr. M. Kalyanasundaram	Professor (Ent.)	16.05.2007	Continuing
Jawaharlal Nehru Agricultural University, Jabalpur				
1	Dr. S.B. Das	Senior Scientist (Ent.)	2007	Continuing
Maharana Pratap University of Agriculture & Technology, Bhubaneshwar				
1	Dr. B. S. Rana	Assoc. Professor (Ent.)	2007	Continuing
Central Agricultural University, Pasighat				
1	Dr. K. Mamocha Singh	Assoc. Professor (Ent.)	2007	Continuing
Orissa University of Agriculture & Technology, Bhubaneshwar				
1	Dr. B. K. Mishra	Entomologist	2007	Continuing

3.2. Budget for AICRP on Biocontrol 2012-13 (Rupees in Lakhs)

National Bureau of Agriculturally Important Insects (NBAII), Bangalore

Head	Plan	Non-Plan	Total
Pay & Allowances	261.69	-	261.69
TA	13.46	-	13.46
Other charges including Equipment	36.23	-	36.23
TSP	-	-	-
HRD	-	-	-
Pension	-	-	-
Loan	-	-	-
Total	**311.38**	**-**	**311.38**

AAU-Anand

Item of Expenditure	ICAR Share (75 %)	State Share (25 %)	Total Amount (Rs)
Pay and allowances	40.86	13.62	54.48
Rec. Contingencies	2.86	0.95	3.81
T.A	1.00	0.33	1.33
TOTAL	**44.73**	**14.91**	**59.64**

AAU-Jorhat

Head	Budget allotted (Lakhs)	Expenditure (Rs)	ICAR (75%)	State 25%
Pay and allowances	31.00	a).16,06,167.00 b). 12,53,653.00 28,59,820.00	21,44,865.00	71,495.00
TA	1.00	63,465.00	47,598.00	15,866.00
Recurring Contingencies	2.80	3,50,000.00	2,80,000.00	70,000.00

KAU-Thrissur

Item	Budget (Rs. in lakhs)	Expenditure (Rs.)
Pay & allowances	20.72	2879823
TA	1.00	73556
Contingencies	2.78	**209697**
Total	**24.50**	**3163076**

PAU-Ludhiana

Sub Head	Revised Estimate 2012-13	Remittance up to March, 2013	Expenditure up to 31st March, 2013
Pay and Allowances	37,49,000	37,49,000	42,65,470
6th CPC Arrears	9,19,126	-	8,83,985
Travelling Allowances	1,00,000	1,00,000	48,055
RC	2,75,000	2,75,000	2,74,680
Total	**50,43,126**	**41,24,000**	**54,72,190**

TNAU-Coimbatore

Head	Amount sanctioned	Total expenditure
Estt. Charge	27.013	35.733
TA	1.00	0.623
RC	1.828	2.418
Non recurring	-	-
Works	-	-
Total	**29.841**	**38.774**

Expenditure ICAR share 75% = 29.080 State share 25% = 9.694

3.3. Problems encountered during the year

AAU-Jorhat

1. Recruitment of a laboratory attendant is very essential for the mass production of bio agents.
2. A separate fund for POL is essential for the local as well as outside tours
3. Replacement of old vehicle: a new vehicle may please be provided for conducting different survey programmes , demonstration trials etc. in different agroclimatic zone of Assam

CPCRI-Kayangulam: Shortage of manpower for executing the work.

KAU-Thrissur: The post of Technical Assistant is vacant.

SKUAST-Kashmir: Availability of grants at the end of financial year (2012-13) restricted the field work. Moreover, late allotment of some survey based experiments i.e. during the 2nd week of July' 2012, could not be done as per programme, which however will be conducted during current year, 2013.

4. General

4. 1. Meteorological data (2012-13)

AAU-Jorhat

Month, 2012-13	Temperature (^{0}C)			RH% (mean)	No. Of rainy days	Total rainfall (mm)	BSSH
	Max.	Min.	Mean				
April-12	27.3	19.1	23.2	82.5	24.0	931.8	4.5
May -12	32.4	22.1	27.2	77.5	14.0	137.7	6.2
June-12	30.0	25.4	27.7	84.0	20.0	215.9	2.9
July-12	31.4	25.6	28.5	82.5	26.0	401.3	4.6
August-12	32.6	25.7	29.1	83.0	23.0	307.8	4.7
September-12	30.5	24.4	27.4	87.5	22.0	234.8	2.8
October-12	29.7	20.9	25.3	76.5	12.0	80.6	7.8
November-12	27.7	15.0	21.3	76.5	0.0	0.0	7.9
December-12	23.0	11.1	17.0	79.0	3.0	6.8	7.9
January-13	23.3	8.3	15.8	72.0	1.0	0.5	60.9
February-13	27.7	12.1	19.9	69.5	1.0	9.3	64.6
March-13	27.7	14.9	21.3	71.5	5.0	36.7	5.2

KAU-Thrissur

Month	Temperature ^{O}C		RH (%)	Rainfall (mm)
	Min.	Max.		
April 2012	24.5	34.3	73	207
May	24.9	33	77	198.5
June	23.6	29.3	89	799.6
July	22.5	29.1	88	588.2
August	22.9	29.4	87	713
September	23.10	30	85	435.2
October	23.5	31.1	78	193
November	22.9	31.4	68	240
December	21.9	31.9	62	2.4
January 2011	22.3	34.1	52	0.0
February	23.3	34.7	57	84.4
March	24.4	35.4	64	14.6

MPKV-Pune

Met. week	T_{max} ^{0}C	T_{min} ^{0}C	RH-I (%)	RH-II (%)	Rain (mm)	Rainy days	BSS (hrs)
1	31.7	13.9	94.4	32.4	0.0	0	8.2
2	28.0	7.5	95.6	26.3	0.0	0	9.6
3	28.4	8.4	96.9	30.7	0.0	0	9.6
4	29.8	12.4	94.9	35.0	0.0	0	8.2
5	29.8	11.5	91.3	34.1	0.0	0	9.2

6	30.6	10.2	89.1	25.1	0.0	0	9.0
7	32.4	11.4	90.4	22.1	0.0	0	9.8
8	34.7	13.6	85.0	19.6	0.0	0	8.2
9	34.1	11.7	84.9	17.3	0.0	0	10.0
10	33.1	11.5	78.6	19.3	0.0	0	9.7
11	35.6	13.9	69.1	17.0	0.0	0	9.2
12	38.0	15.5	66.3	15.6	0.0	0	8.3
13	38.0	18.1	67.9	17.4	0.0	0	8.0
14	38.2	19.9	62.0	17.6	0.0	0	8.4
15	38.4	21.0	65.7	18.4	0.0	0	8.1
16	37.6	20.9	63.4	24.4	7.0	2	7.8
17	37.9	20.2	47.3	15.6	0.0	0	10.2
18	37.3	20.3	57.0	22.9	0.0	0	10.8
19	37.0	23.6	67.9	27.7	0.0	0	10.1
20	38.0	21.1	60.9	18.4	0.0	0	11.3
21	37.9	21.4	69.4	24.6	0.0	0	10.8
22	35.8	23.6	69.7	34.1	0.0	0	10.5
23	33.8	24.9	73.4	55.9	12.0	2	6.3
24	33.5	23.1	76.0	52.3	2.1	1	7.1
25	31.8	23.7	74.1	54.4	13.0	1	7.4
26	31.8	23.2	81.1	55.4	7.4	1	5.6
27	30.7	23.0	85.4	68.9	15.9	3	3.3
28	30.5	22.7	81.1	60.4	2.1	1	4.6
29	29.3	22.8	85.9	72.6	22.3	4	2.8
30	28.0	23.0	84.7	76.7	10.0	1	1.3
31	26.6	21.8	87.0	86.3	129.1	7	1.1
32	27.7	22.1	88.4	79.7	36.6	4	2.4
33	28.4	21.6	85.6	70.0	13.6	2	6.7
34	29.0	21.6	85.3	64.3	8.7	1	6.0
35	28.8	22.3	89.3	77.9	58.7	3	3.7
36	27.3	22.0	90.9	86.1	23.6	3	2.4
37	27.4	21.0	88.7	73.9	11.6	1	2.9
38	29.5	20.6	86.0	60.7	1.4	1	4.9
39	30.8	20.1	89.0	59.6	1.1	1	7.4
40	30.5	21.4	94.6	69.6	120.2	5	3.8
41	31.9	19.8	87.7	39.6	0.0	0	7.7
42	31.7	16.9	85.9	36.3	0.1	1	8.4
43	30.5	19.8	84.0	52.3	24.2	2	4.0
44	30.0	16.5	89.4	42.1	1.2	1	6.6
45	32.1	16.2	88.0	35.6	0.0	0	9.0
46	30.2	13.4	89.7	32.7	0.0	0	8.9
47	30.0	12.3	91.4	36.4	0.0	0	8.8
48	31.6	14.3	91.7	36.7	0.0	0	8.0
49	31.2	16.1	89.1	40.9	0.0	0	8.5
50	31.6	12.8	92.7	33.4	0.0	0	9.1
51	29.7	11.7	92.1	33.9	0.0	0	7.8
52	29.5	10.7	95.3	36.3	0.0	0	8.6
1	32.0	15.1	93.3	27.1	0.0	0	8.9
2	30.1	10.4	94.7	32.3	0.0	0	8.6
3	31.3	11.5	92.6	32.0	0.0	0	8.0

4	31.1	11.4	94.0	27.4	0.0	0	8.5
5	31.7	14.7	82.3	33.3	0.0	0	7.0
6	31.4	14.7	89.9	35.6	0.0	0	8.0
7	32.4	11.4	90.4	22.1	0.0	0	9.8
8	33.5	12.6	84.7	22.1	0.0	0	9.9
9	29.9	10.8	70.8	12.6	0.0	0	8.5

PAU-Ludhiana

Month	**Temp.(^{0}C)**		**RH (%)**		**Total Rainfall (mm)**	**Sunshine (hrs.)**
	Max.	**Min.**	**Morning**	**Evening**		
April, 2012	31.8	15.3	84	36	0.0	7.6
May, 2012	33.8	18.1	75	32	38.6	8.5
June, 2012	43.7	25.9	43	19	0.0	10.9
July, 2012	40.6	27.2	37	32	3.5	8.9
August, 2012	35.7	27.9	76	58	76.9	6.6
September, 2012	33.2	26.6	87	73	160.4	4.5
October, 2012	32.8	23.9	94	48	0.0	10.2
November, 2012	31.6	16.2	90	43	0.0	8.7
December, 2012	26.6	10.5	91	40	0.0	6.6
January, 2013	19.4	7.4	92	58	17.4	5.2
February, 2013	17.0	5.1	94	60	8.2	5.3
March, 2013	27.6	13.2	94	50	35.6	9.2

CTRI- Rajahmundry

Month	**Temp. °C**		**% RH**		**Rainfall (mm)**	**No. rainy days**
	Max	**Min**	**Max**	**Min**		
Aug	31.1	25.3	91	76	337	11
Sept	32.5	25.3	91	74	322	13
Oct	32.9	24.0	91	72	110	4
Nov	30.3	20.3	94	67	332	4
Dec	31.8	18.8	93	47	0.0	0
Jan	31.4	17.9	92	50	9.5	1
Feb	31.7	17.1	93	56	17.0	1
Mar	30.0	18.7	54	32	0.0	0

SKUAST-Srinagar

Date	**Max. Temp.**	**Min. Temp**	**Avg. Temp.**	**Rainfall**	**Max. RH (%)**	**Min. RH (%)**	**Avg. RH (%)**	**Sun Shine (hrs.)**
1-15 Jan	2.84	-3.42	-0.29	2.0	94.8	80.2	87.5	1.03
16-31 Jan	5.7	-3.1	1.3	2.3	93.7	78.8	86.3	2.5
1-15 Feb	7.9	-0.8	3.5	3.8	92	67.3	28.9	3.4
16-29Feb	9.3	0.7	10.8	1.5	90.2	65.5	77.9	2.6
1-15 March	12.5	1.4	6.9	2.1	85.2	49.6	67.4	4.2
16-31March	18.6	5.4	15.8	0.3	74.9	39.3	57.1	3.6

1-15Apr	18.7	6.2	12.4	5.1	81.0	55.9	68.5	5.5
16-30Apr	19.9	7.7	16.8	3.5	85.0	51.7	68.4	4.7
1-15 May	22.5	7.8	15.1	1	80.7	57.1	68.9	6.7
16-31 May	23.3	9.5	18.2	1.92	82.1	56.0	70.1	6.9
1-15 June	26.1	10.9	18.5	0.8	77.6	53.3	65.5	6.2
16-30 June	29.3	14.1	22.1	0.12	76.8	44.7	60.8	9.1
1-15 July	30.6	16.6	23.6	1.3	79.2	52	65.6	6.8
16-31 July	31.9	15.6	23.6	0.7	81.8	45.3	63.5	8.9
1-15 Aug	28.4	17.5	22.9	3.7	84.4	57.6	71.0	4.6
16-30 Aug	31.7	18.0	24.4	0.2	80.6	50	65.3	7.1
1-15 Sep	26.6	16.9	21.7	7.6	90.4	67.2	78.8	4.44
16-31 Sep	25.9	10.1	19.6	0.82	89.2	61.1	75.2	7.2
1-15 Oct	23.6	5.7	14.6	0	85.4	45.6	65.5	6.88
16-31 Oct	18.1	2.9	10.5	0.5	89.0	61.0	75.0	5.9
1-15 Nov	19.2	-0.43	9.4	0	84.8	55.5	70.2	6.9
16-30 Nov	13.3	0.5	6.9	0.8	80.7	52	66.3	3.2
1-15 Dec	8.2	-0.8	3.6	2.4	89.0	71.6	29.0	1.7
16-31 Dec	8.1	-0.5	10.3	0.4	88.6	74.5	29.3	2.3

Meteorological data of Kargil for year 2012 : Not available

TNAU-Coimbatore: All the experiments were conducted in the farmer's field in various locations

4.2. Visitors

AAU-Anand

Visitors	**Total**
VIPs	2
1. Dr. Dolly kumar, Associate Professor, Dept. of Zoology, Faculty of Science, M.S.University, Baroda (Gujarat)	
2. Project coordinator of AICRP on Biocontrol, Bangalore	
Govt. officers	23
Farmers	545
Students	255
Total	**825**

AAU-Jorhat

1. QRT team – Dr. G.K. Veeresh, Dr. B. S. Bhumannavar, Dr. N. Raghunathan and Dr. Basudev Rao, visited Biological control laboratory,Department of Entomology, AAU, Jorhat on 15th June , 2012
2. Team of students and teachers from different districts of Kamrup, Morigaon, Dibrugarh visited the bio control laboratory under Gyan Jyoti Programme of School children organized by Govt. of Assam, Department of Elementary Education on 17.08.2012, 14.09.2012, and 18.03.2013
3. A group of farmers under NGO (Sadbhavana) visited the bio control laboratory on 07.11.12

ANGRAU-Hyderabad

1. Director of Pesticide Formulation Technology Centre, Dr. S. K. Raza and Principal Scientist, Dr. Patanjali visited the scheme on 23 August, 2012.
2. Dr. V. K. Yadav, PPA, KrishiBhavan, New Delhi, visited the scheme on 16 October, 2012.
3. Scientists of Michigan State University visited the scheme
4. Dr.Sreedhar, Head (Plant Protection), CTRI Rajahmundry visited the scheme on 28 November, 2012.
5. Dr. Tripathi,Project Co-ordinator – AINP on Rodentology visited the scheme on 8 March, 2013.
6. Dr. K. S Varaprasad, Project Director, Directorate of Oilseed Research, visited the scheme on March 20, 2013 along with Dr. J S Benthur, Head – Entomology,Directorate of Rice Research.

MPKV-Pune

1. Dr. G. P. Gupta, National Consultant (PP), NPSM, DAC, GOI, New Delhi and former Head, Division of Entomology, IARI, New Delhi visited this Biocontrol Lab. on 10/5/2012.
2. Dr. M. Mani, Emeritus Scientist (Entomology), IIHR, Bangalore visited the laboratory on 12/6/2012 and 05/10/2012; observed mass production of bioagents and visited papaya orchards for PMB incidence on research farm and farmers' fields.
3. Dr. A. G. Chandele, Head, Dept. of Entomology, MPKV, Rahuri visited the lab. on 18/5/2012, 25/6/2012, 13/7/2012, 20-21/7/2012, 17/8/2012, 03/9/2012, 15/10/2012; observed mass production unit of bioagents, microbial agents and took review of research programme as well as status of papaya mealy bug and its parasitoid *A. papayae* in western Maharashtra.
4. The QRT and other delegates visited the lab. and field trials on July 20-21, 2012.
   i.Dr. G. K. Veeresh, Chairman of QRT and Ex. Vice Chancellor, UAS, Bangalore,
   i. Dr. B. S. Bhumannavar, Member Secretary of QRT,
   ii. Dr. N. K. Krishna Kumar, The Director, NBAII, Bangalore,
   iii. Dr. V. Vasudeva Rao, Project Co-ordinator, AINP on Ornithology, Hyderabad,
   iv. Dr. N. Srinivas, Network Co-ordinator, AINP on Acarology, UAS, Bangalore,
   v. Dr. T. A. More, Hon. Vice Chancellor, MPKV, Rahuri,
   vi. Dr. D. M. Korat, Principal Scientist, AICRP on Biocontrol, AAU, Anand,
   viii. Dr. J. J. Jani, Microbiologist, AICRP on Biocontrol, AAU, Anand,
   ix. Dr. B. M. Parasharya, Sr. Scientist, AINP on Ornithology, AAU, Anand,
   x. Dr. A. Shukla, Acarologist, AINP on Acarology, NAU, Navasari,
   xi. Dr. A. R. Karale, Associate Dean, College of Agriculture, Pune, and
   xii. Dr. S. B. Gurav, Associate Director of Research, NARP (PZ), Pune
   Dr. D. S. Pokharkar, Entomologist of the project presented the report of research work and other activities carried out during 2007 to 2012 at the centre.

1. Dr. Sandipa Kanitkar, Managing Director, Kanboysis Pvt. Ltd. Pune visited the laboratory on 15/10/2012.

2. Dr. Subrato Sarkar, Research Advisor, M/S. Ajay Biotech Ltd., Pune visited the Biocontrol lab. on 15/10/2012.
3. Monitoring Team: Dr. A. N. Deshpande, Chairman & Head, Dept. of Soil Science and Agril. Chemistry, Dr. K. J. Kamble, Dy. Director of Research (IV) & Member, MPKV, Rahuri, and Dr. S. B. Gurav, Associate Director of Research, NARP (PZ), Pune & Member Secretary visited this centre on October 17-18, 2012 and took review of progress of research work and facilities available at the centre. The team visited Biocontrol lab. and observed different cultures bioagents, mass production unit and field trials on the research farm of the college.
4. Dutch-Expert Team, Greenport Holland International, Netherland of Dr. Jouke Campen, Mr. Prakash, Mr. Udayanarayan Bhat and Mr. Karst Weening visited the centre on 20/11/2012 and discussed research and extension activities of the project.
5. Dr. G. B. Khandagale, Director of Research, Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra visited the lab. on 10/01/2013 and discussed research activities particularly work on mealy bugs and microbial agents.
6. Dr. S. V. Sarode, Director of Research, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola visited the lab. on 10/01/2013 and impressed with research activities, observed mass production unit of bioagents and remarked as one of the best Biocontrol lab. in Maharashtra.
7. Mr. Peter Davies, Professor of Plant Physiology, Cornell University, USA and 30 foreign students from the University visited the lab. on 11/01/2013 and observed various cultures of bioagents and discussed research and extension activities.
8. Eight Agril. Officers and 7 progressive growers from Madhya Pradesh visited the lab. on 22/02/2013 and Shri. A. S. Dhane delivered the lecture on use of bioagents and biopesticides in crop pests management.
9. Dr. O. P. Veda, Professor & Head, Dept. of Entomology, JNKVV, Jabalpur, MP visited the lab. on 18/03/2013 and observed the mass culturing of bioagents, their host insects and discussed the research activities of the centre.

SKUAST-Kashmir

1. Dr. N.K. Krishna Kumar, Director, NBAII, Bangalore
2. Dr. M.N. Azim. Head, Department of Zoology, University of Kashmir

TNAU –Coimbatore

1. At regular intervals, students are hosted to the Laboratory from all over the country in partial fulfillment of their curricular aspects regarding biological control.
2. On 17-04-2012 Dr.J.P.Michaud, Scientist from Kansas State University, USA visited the biocontrol Laboratory and delivered a lecture on “coccinellid beetles for Biological control” on 18-04-2012.
3. On July 10, 2012 Dr.Kusumakar Sharma, ADG(HR) ICAR visited the Biocontrol Lab and interacted with the scientists
4. On 17.10.12 Dr A.R Prasad, Pheromone Research Laboratory, IICT, Hyderabad visited the Bio-control Laboratory.
5. On 21.2.2013 Dr. Harish C Sharma, Principal Scientist, ICRISAT visited the Bio-control Laboratory.

CTRI-Rajhamundry

1. Mr.P.S.K.Prasad Plant Protection Officer CIPMC Govt.of .India Hyderabad on 5.03.13

PAU-Ludhiana

S. N.	Name	Date of visit
1.	Pakistan delegation from University of Faisalabad, Pakistan	November 30, 2012
2.	B. Sc Agri students from the Baba Farid College, Bathinda	March 30, 2013

4.3. Miscellaneous Information

i. Awards/ Honours /Recognition:

CPCRI-Kayangulam

Received by **Chandrika Mohan**, Principal Scientist (Agrl. Entomology)

1. Conferred the **Fellows of Association for Advancement of Pest Management in Horticultural Ecosystem (**FAAPMHE), IIHR, Bengaluru in recognition of the contributions in the field of Plant Protection and Horticulture.

2. Bestowed upon with **Dr. C S Venkata Ram Memorial Award** for the second best original research paper entitled "Field Validation of Biological Suppression of Coconut Black Headed Caterpillar, *Opisina arenosella* Walker using larval parasitoids *Goniozus nephantidis* and *Bracon brevicornis*" presented at PLACROSYM XX, 2012 held at Coimbatore during December 12-15, 2012

3. **Awarded consolation price for the best poster presentation** of the research paper entitled "Coconut water as a promising culture media for *Hirsutella thompsonii* Fisher, a pathogen of coconut mite" presented at the 4th international conference on Insect science held during 14-17 February 2013 at Bangalore

IIHR-Bangalore

1) Dr. P.N. Ganga Visalakshy, Principal Scientist, Division of Entomology and Nematology was honored with Fellow of AAPMHE
2) Dr. P.N. Ganga Visalakshy, Principal Scientist, Division of Entomology and Nematology were awarded Dr.Sithanandam award for her contributions in the field of biological control.
3) Organizing secretary of IV National Sym. On Plant protection in Horticultural crops _ Emerging Challenges and sustainable Pest manage. organized by AAPMHE, Dvn. of Entomology and Nematology, IIHR.
4) Dr. A. Krishnamoorthy, Principal Scientist, Division of Entomology and Nematology was honored with Fellow of AAPMHE
5) Dr. A. Krishnamoorthy, Principal Scientist continued as Chief Editor, Journal of Horticultural Sciences.
6) Dr. A. Krishnamoorthy acted as referee for The Indian Journal of Agricultural Sciencesand Journal of Biological Control
7) Dr. A. Krishnamoorthy acted as President for Association for Pest Management in Horticultural Crop Ecosystems (AAPMHE)
8) Dr. A. Krishnamoorthy acted as Vice-President of the Society for Biocontrol Advancement. for the year 2010-13
9) **Dr. A. Krishnamoorthy** acted as a member of Institute Management committee of NBAII, Bangalore
10) **Dr. A. Krishnamoorthy** was nominated as External Expert of ITMC member of NBAII, Bangalore.

SKUAST-Kashmir

Dr. Jamal Ahmad

- Acted as external examiner of Mr. Parveez Ahmad Bhat (Zoology Department (Entomology), University of Kashmir, Srinagar) on the "Management of Elm Bark Beetle, *Scolytus kashmirensis* Schedl. infesting Elm trees (*Ulmus* spp.) in Kashmir"
- Acted as guide of Mr. Saran Rajan (M.Sc. (Ag.) for his M. Sc. Dissertation entitled comparative toxicity of some pesticides against *Trichogramma cacoeciae* and *Trichogramma embryophagum*.
- Acted as co guide for the M. phil. thesis of Ms. Iram Khursheed who obtained her degree in M. phil (Zoology: Entomology), University of Kashmir, Srinagar), on the topic entitled, Taxonomical studies on faunistic composition of Chalcidoidea (Hymenoptera : Chalcidoidea) of Kashmir valley.
- Acted as co guide of Mr. Abbas Shah (M.Sc. (Ag.) for his dissertation on "Bio diversity, biology and predation of coccinellids in horticulture ecosystem".
- Acted as member of P.G. studies during 2012-13.

TNAU-Coimbatore

The research work on biological control of papaya mealy bug and the action taken by TNAU for the successful management was appreciated by Director General,ICAR during the national meeting on the celebration of success of papaya mealy bug biocontrol on 19.10.2012.

ii. Education and Training

AAU-Anand

P.G. Teaching

The Scientists working under the AICRP on Biological Control are also engaged in Post Graduate teaching and as well as acting as guide. Following courses are taught to the P.G. students.

Sr. No.	Name of Teacher	Course No.	Credits	PG Students	
				M. Sc.	Ph. D.
1	Dr. D.M. Mehta	ENT-507	1+1	2	1
		ENT-514	1+1		
		ENT-602	1+1		
		ENT-612	2+0		
2	Dr. J. J. Jani*	Micro 508	2 +1	3	3
		Micro 510	2 +1		
		Micro 503	2 +1		
		Micro 601	2 +1		
		Micro 603	2 +0		
3	Prof. Mrs. H N Shelat	**UG** Ag.Micro 8.2	1+3	6	0
		PG Ag.Micro 502	3+1		
		Ag. Micro 511	1+1		

		Ag. Micro 508	2+1		
		Ag. Micro 512	2+0		
		Ag. Micro 506	2+1		
		Ag. Micro 504	2+1		
		Ag. Micro 602	2+0		
		Ag. Micro 603	2+0		
		Ag. Micro 604	2+0		
		Ag. Micro 501	2+1		
		Ag. Micro 505	2+1		
		Ag. Micro 591	1+0		
		Ag. Micro 599 research	20		
4	Dr.P.H.Godhani	**UG** ENT 4.2	2 + 1		
		UG ENT 3.1	2 + 1		
		SST 511	1+1		

***Note: On sad demise of Dr J J Jani (6th Feb 2013), Microbiology courses and students transferred and distributed amonsst to Dr R V Vyas and Prof Ms. H N shelat**

Advisory and Extension Services

1. Technical guidance on "Biological control" was provided to the farmers, extension officers, students and other visitors visited Biocontrol Research Laboratory.
2. Technical guidance regarding Biological Control of crop pests was provided through lectures to the extension officers and farmers in various training programs organized by Directorate of Extension Education, AAU, Anand, State Department of Agriculture, Govt. of Gujarat and NGOs.
3. Participated and arranged exhibition during Krushi mela, farmer's meeting and other special occasions as per the directives received from Directorate of Extension Education, AAU, Anand and Extension education Institute.

Extension activities:

Following talks were delivered to farmers /extension workers by Dr. D. M. Mehta in training programmes organized by various agencies.

Sr. No.	Date	Topic	Trainee	Training organized by
1.	07-08-2013	Role of biocontrol agents in IPM	Officers of Department of Agriculture (Gujarat state)	Extension Education institute, Anand
2.	05-04-2013	Biological control of Crop pest	Technical Staff	ATMA, Directorate and Sameti, Gandhinagar

Following talks were delivered to farmers /extension workers by Dr. P. H. Godhani in training programmes organized by various agencies.

Sr. No.	Date	Topic	Trainee	Training organized by
1.	10-12-12	Biological control of Crop pest	Students of BRS College	Dept. of Ento., BACA, Anand

2.	27-12-12	Biological control of Crop pest	Farmers	Dept. of Ento., BACA, Anand
3.	28-12-12	Integrated pest management of Sesamum and Soyabean	Farmers	Dept. of Ento., BACA, Anand
4.	01-07-12	Biological control of Crop pest	Farmers	ATIC, AAU, Anand
5.	01-07-12	Introduction of Plant protection and biological control	Farmers	ATIC, AAU, Anand
6.	29-01-13	Biological control of Crop pest	Farmers	Dept. of Ento., BACA, Anand
7.	30-01-13	Integrated pest management of Sesamum and Soyabean	Farmers	Dept. of Ento., BACA, Anand
8.	08-01-13	Biological control of insect pest and weeds	Farmers	Dept. of Ento., BACA, Anand
9.	03-03-13	Role of biocontrol agents in IPM	Farmers	Dept. of Ento., BACA, Anand
10.	15-03-13	Biological control of Crop pest	Farmers	Dept. of Ento., BACA, Anand

Details of Khedut Shibirs arranged during 2012-13

Sr. No.	Date	Village & Taluka	No. of farmers attended
1	06-11-2012	Sherpura, Ta. Mehshana	45

AAU-Jorhat

1. Dr.D.K.Saikia, principal Scientist conducted advance course of Biological Control to P.G.Studies (ENT 507)
2. One M.Sc (Agri) students are being carried out P.G. research work under the guidance of Dr. D.K.Saikia,
3. Dr. D.K.Saikia is guiding a Ph.d student and title of the programme is " Evaluation of local varieties of Assam against yellow stem borer (*Scirpophaga incertulas*) and leaf folder (*Cnaphalocrosis medinalis*) and ecology of their trichogrammatid egg parasitoids.
4. Dr. D.K.Saikia , Principal Scientist act as a course leader for Experiential learning programme (Bio-control agents and bio-pesticide) offered to B.Sc. (Agri) students
5. Dr. D.K.Saikia , Principal Scientist act as a Lead Scientist in Technology Mission (MM1) for IPM on Vegetables
6. Dr.D.K.Saikia act as a Co- investigator in the Biopesticides programme under DBT –AAU, Centre
7. Dr.D.K.Saikia attended XXI Biological worker's group meeting held at Acharya N.G Ranga University of Agriculture, Hyderabad on 22nd and 23rd May,2012.
8. Dr. Anjumoni Devee, Jr. scientist, act as a course instructor in different UG and PG courses like Ent213, Ent 223, Ent 313, ent 504, Ent 508, Ent 519, Ent 607 and Ent 612.
9. Dr. Anjumoni Devee, Jr. scientist, act as a course instructor for Experiential learning programme (Apiculture and Pesticides and plant protection equipments) offered to B.Sc. (Agri) students
10. Under the guidance of Dr. Anjumoni Devee, One M.Sc (Agri) student is being carried out P.G. research work

11. Dr. Anjumoni Devee, Jr. scientist, attended Workshop on ' Data Analysis using SPSS' organized by ISI, Kolkata, held at B.N.College of Agriculture, Biswanath Chariali, Assam, from 11th -15th march, 2013
12. Dr. Anjumoni Devee, Jr. scientist,attended regional workshop on 'Protection of Plant Varieties and Farmers' Rights', organized by IPR cell, AAU, Jorhat, from 24th -26th march, 2013

Training obtained

13. Dr. Anjumoni Devee, Jr. scientist, obtained Training on ' Taxonomy of insects and mites', organized by Dept. of Entomology, USA Bangalore, from 25th july to 14th Aug. 2012

Training Imparted

1. **Training on IPM with special reference to use of bioagent/ biopesticides in vegetables*(Kharif & Rabi*) rice and sugarcane**

Programme	**Place**	**Resource person**	**Date**
Remmedy of papaya mealy bug	Directorate of Horticulture, Guwahati, Khanapara	Dr. D.K.Saikia	07.08.2012
Attack of mealy bug in Horticultural crops and its remedial measure	Supervisory Training centre, Jorhat	Dr.D.K.Saikia	13.08.2012
Insect pests management in poly house horticultural crops	Extension Education Institute, AAU, Jorhat	Dr. D.K. Saikia	15.12.2012
Farmers' Scientist interaction	RARA, Titabor and SRS, Buralikson	Dr. D.K.Saikia	4.10.2012 & 6.11.2012
Intregated pest management of fruit and vegetable crops	Dist. Agricultre office, Jorhat	Dr. D.K.Saikia	24.09.2012
Biopesticides and Biofertilizer Production technology	AAU- DBT Centre, AAU, Jorhat	Dr.D.K.Saikia	25 08.2012 to31.8.2012
Use of Trichogramma as biopesticides in pest management	Conference Hall, DEE, AAU, Jorhat	Dr.D.K.Saikia	05.09.12
Bio natural management of pest in organic farming	Confrence Hall, Director of Research, AAU, Jorhat	Dr. D.K.Saikia	22.12.2012

Television Programme

Dr.D.K.Saikia attended live programme on production technique of Trichogramma and its uses, broadcasted by Doordorshan, Guwahati on 19.03.2012.

Bio-agents maintained in Biocontrol Laboratory, AAU, Jorhat

i. *Trichogramma japonicum*
ii. *T. chilonis*
iii. *T. brassicae*
iv. *T. mwanzai*
v. *T. pieridis*
vi. *Chrysoperla zastrowi sillemi*
vii. *Xylocoris flavipes*
viii. *Blaptostethus pallescens*

The biocontrol agents produced in the laboratory are being utilized for teaching and training of farmers, extension workers, entrepreneurs and also students of P.G. Research. Cultures of parasitoids have been supplied to different regional research stations of AAU, KVKs and Agricultural officers, Govt. of Assam for their field demonstration.

ANGRAU-Hyderabad

B.Sc. (Ag.), M.Sc.(Ag.) and Ph.D. students of College of Agriculture, Rajendranagar, Hyderabad were trained in different methodologies in rearing of different natural enemies and culturing & field use of microbial formulations.

CPCRI-Kayangulam

Trainings conducted for Farmers /students / NGOs

1. Imparted on campus training on "*M. ansiopliae* multiplication technique*"* to officials of Gandhi Smaraka Seva Kendra, Alappuzha on 18/4/12
2. One day training programme on " Farm level production of *Oryctes rhinoceros virus*" was conducted for a group of farmers of Edava Grama panchayath on 8/8/12
3. One day on campus training programme on "IPM of rhinoceros beetle and red palm weevil with special emphasis on biocontrol and pheromone taps" was conducted for selected farmers of Munroe Island of Kundra Block, Kollam on 28/12/12.

Conducted training programme on "Multiplication and utilization of *Metarhizium anisopliae*" to technical staff of Deejay Consultancy Services, Bangalore 1/3/2013.

TOT programmes for Agricultural Officers and farmers.

1. Participated as resource person and handled class on Integrated Pest and Disease Management of coconut in the ATMA farmer's training programme on 28/05/2012 at Chingoli Krishi Bhavan.
2. Handled a training session on IPM and IDM of coconut for Agricultural Officers of Pathanamthitta district held at FTC, Pandalam on 04/07/2012.
3. Functioned as a resource person for the training on Pest / disease management in coconut for Agricultural Officers of Alappuzha district conducted at Nedumudi, on July 25, 2012.
4. Conducted awareness campaign and method demonstration on biocontrol strategies for the management of *Opisina arenosella* for farmers at Thiruvananthapuram on 26/07/2012.

5. Participated in the CPS leader's seminar and handled a training session on IPM of coconut on 04/08/2012 at Bharanikkavu.
6. Handled a training session on IPM and IDM of coconut for Agricultural assistants held at RATTC, Vytilla on 20/10/2012.
7. Functioned as a resource person for the training on Pest / disease management in coconut for Assistant Directors/Agricultural officers of Trichur and Ernakulam districts conducted at RATTC, Vytilla on 15/11/2012.
8. Handled training sessions on IPM of coconut to two batches *Friends of Coconut Tree* organized by KVK Alappuzha on 19/9/12 and 20/11/2012

IIHR-Bangalore

Training

1. A special International training programme was conducted for the Scientists on BIOCONTROL TECHNIQUES sponsored by Royal Government of Bhutan from 1st to 16 May at IIHR, Bangalore and NBAII, Bangalore. I have given lectures for five days on various aspects of biological control both in basic and as well as applied aspects with special reference to horticultural crops. Four scientists from Bhutan were there to learn techniques involved in Biological control of pests of horticultural crops.
2. Professional Attachment Training was given to Dr. Prasanna Kumar. Scientist, IARI from 13 Nov.2102 – 12 Feb 2013

SKUAST-Kashmir, Trainings imparted

Dr. Jamal Ahmad

1. Attended ATIC duties fortnightly. Interacted with farmers related to insect problems and their management.
2. Provided the information to Director of Extension Education, SKUAST-K, Srinagar, on the non chemical practices for the Management of Codling moth at Laddakh
3. Demonstrated on – the- spot use of apple burlapping, for trapping and killing of overwintering codling moth, at Bagh-e Khomini, Hardass and Chanigund of district Kargil (17.6.2011 to 19.6. 2011).
4. Demonstrated on –the- spot use and benefits of pheromone traps for mass destruction of codling moth, at Kargil (Kharrol, Chanigund, Mangmore) and Leh (Khalsi and Nirula) from 9.8.2011 to 13.8.2011.
5. Demonstrated on –the- spot significance of debarking of apple trees for destruction of overwintering codling moth, at Kargil (Hardass, Mangmore and Mingy)on 10.8.2011. and Leh (Nirula and Khalsi) on 13.8.2011.
6. Imparted information to orchardists regarding disposal of codling moth infested fruits to reduce codling moth population in above mentioned orchards from 9.8.2011 to 13.8.2011.
7. Demonstrated on – the- spot use of *Trichogramma* spp. against the management of Diamond Back moth, *Plutella* xylostell attacking *Brassica* spp., among the farmers at Sumbul and Zuzina of the district of Ganderbal during the months of May-July' 2012.

Establishment of Mass Production Unit

The culture of following bio agents (obtained from NBAII, Bangalore) including parasitoids and predator, along with their actual/ fictitious hosts, was maintained for the

purpose of mass production, teaching and training to P.G.students, farmers, FCLAs, extension workers etc.

Trichogramma embryophagum (from PDBC)

1. *Trichogramma brassicae* (from PDBC)
2. *Trichogramma chlionis* (from PDBC)
3. *Trichogramma cacoeciae* (from PDBC)
4. *Blaptostethus pallescens* (from PDBC)
5. *Xylocoris flavipes* (from PDBC)
6. *Bracon hebetor* (Local strain)
7. *Coccinella septempunctata* (Local strain)
8. *Coccinella undecimpunctata* (Local strain)
9. *Chrysoperla* sp. (Local strain)
10. *Quadraspidiotus perniciosus* (Local strain)
11. *Corcyra cephalonica* (Local strain)
12. *Sitotroga cerealella* (from PDBC)

The culture of bio agents however could not be maintained during harsh winter condition, as well as unavoidable circumstances in the valley.

GBPUAT-Panthnagar

Farmers' training programme: Time to time demonstration and training programmes were conducted at farmer's field as well as on university campus. A total of 990 farmers trained through 14 trainings on various crops viz. wheat, rice, tomato, pulses and vegetables for successful application of biocontrol technologies under organic farming/IDM. During large scale field demonstrations 12 quintal of bioagent (PBAT-3) was distributed among farmers**.**

KAU-Thrissur

Training obtained: Smt. C.V. Vidya, Asst. Professor attended 21 days training on New Frontiers in Integrated Pest Management in rice and rice based cropping systems from September 13 to October 3, 2012 at Directorate of Rice Research, Hyderabad.

Trainings imparted:

Sl. No	Date of training	Place	Beneficiaries
1	12/07/2012	ARS, Mannuthy	Field Associates of Kole land crop Security Intelligence Training
2	27/07/2012	Krishibhavan, Vilvattom	Training to farmers under ATMA
3	14/08/2012	Krishibhavan, Ollur	Training to farmers under ATMA
4	22/10/2012	Krishibhavan, Kodumbu	Training to farmers under Farmers Field School
5	28/11/2012	Krishibhavan, Thalikulam	Training to farmers under ATMA
6	22/01/2013	RATTC, Malampuzha	Training to Agrl. Assistants
7	30/01/2013	RATTC, Malampuzha	Training to Agrl. Assistants
8	08/02/2013	Krishbhavan, Cherpu	Training to farmers under Farmers Field School

MPKV-Pune

1. Dr. D. S. Pokharkar conducted PG course ENT. 507, Biological Control of Crop Pests and Weeds. He conducted Semester End Practical Examination of the PG course on 24/7/2012.
2. Shri. N. D. Tamboli conducted Final Practical Examination of Agril. Diploma School during April 23-30, 2012.
3. Shri. N. D. Tamboli worked as Supervisor for Final Theory Exam. of Agril. Diploma School at Sadhana Vidyalaya, Hadapsar, Pune during May 3-8, 2012.
4. Dr. D. S. Pokharkar worked as Senior Supervisor for Semester End Theory Exam. of I semester (New/Old) of UG courses at College of Agriculture, Ambi, Dist. Pune during December 3-15, 2012.

Extension development activities / Training Imparted:

1. Dr. D. S. Pokharkar delivered lecture on Mass production and quality parameter of biopesticides and Dr. R. V. Nakat attended lab. visit of the 25 Extension workers and Biopesticides Manufacturers of the state on 9/4/2012.
2. Dr. D. S. Pokharkar delivered lecture on 'IPM and role of bioagents in crop pest management' to extension workers (20) from RAMETI, Dept. of Agriculture, Pune on 26/6/2012 and attended lab. visit.
3. Dr. D. S. Pokharkar delivered lecture on 'Biological control of insect pests and mites in grapes' to 25 trainees at Grape Growers Association, Manjari, Pune on 01/7/2012.
4. Dr. D. S. Pokharkar delivered lecture on 'Use of Bioagents and biopsticides in crop pest management' to Agril. Officers (8) from State Dept. and farmers (7) from Madhya Pradesh on 21/9/2011.
5. Staff of the project conducted "Experiential Learning Programme" on 'Production and Handling of Bioagents' registered for VIII semester of UG cours.
6. The bioagents arranged in the State level farmers exhibition,"**KISAN-2012**" at Moshi, Pune during December 12-16, 2012.
7. The bioagents arranged in National level farmers' exhibition '**AGROWON AGRI. EXPO-2012'** at College of Agriculture, Pune on December 1-5, 2012.
8. Demonstration on *M. anisopliae* and *N. rileyi* against *S. litura* on lucerne conducted on farmers' fields at Digras and Pimpri Avghad, Dist Ahmednagar.
9. Demonstration on effectiveness of *Nomuraea rileyi* against *S. litura* on potato carried out over 50 acres on farmers' field at Peth, Dist. Pune on 17/9/2012.
10. Demonstration on effectiveness of *M. anisopliae* against safflower aphids carried out over 60 acres on farmers' fields in Solapur district on 27/11/2012.
11. Demonstration on effectiveness of *M. anisopliae* against mango hoppers carried out over 25 acres on farmers' fields in Mulshi, Dist. Pune on 22/2/2013.

Radio Talk:

1. Dr. R. V. Nakat gave radio talk on 'Management of African Giant snail' on AIR, Pune and broadcasted on 01/6/2012 at 7:15 pm in *Amchi Mati Amchi Manase* programme.
2. Dr. D. S. Pokharkar delivered radio talk on 'Biological control of potato tuber moth' on AIR, Pune on 26/6/2012 and broadcasted on 4/7/2012 at 7:15 pm in *Amchi Mati Amchi Manase* programme.
3. Shri. N. D. Tamboli gave radio talk on 'Integrated pest management of soybean' on AIR, Pune and broadcasted on 25/06/2012 at 7:15 pm in *Amchi Mati Amchi Manase* programme.

4. Shri. A. S. Dhane delivered radio talk on 'Integrated pest management of *Kharif* crops' on AIR, Pune and broadcasted on 30/6/2012 at 7:15 pm in *Amchi Mati Amchi Manase* programme.
5. Shri. A. S. Dhane delivered radio talk on '*Chrysoperla*: an important bioagent in pest management' on AIR, Pune and broadcasted on 14/8/2012 at 7:15 pm in *Amchi Mati Amchi Manase* programme.
6. Dr. D. S. Pokharkar gave radio talk on 'Use of entomopathogenic virus in biological control of insect pests' on AIR, Pune on 13/8/2012 and broadcasted on 20/8/2012 at 7:15 pm in *Amchi Mati Amchi Manase* programme.

MPUAT-Udaipur

In year 2012-13, 50 under graduate, 32 M.Sc. and 2 Ph.D student were trained on "bio- agent their production and use.

PAU-Ludhiana

P. G. teaching

S. N.	Title	Date	Event	Number of lectures
Dr Naveen Aggarwal:				
1	In Insect pest management in direct seeded rice	25. 06. 12	Training on direct seeded rice/basmati organized by directorate of extension education at Farmer's service centre	1
2	Insect pest management in Maize	27. 06. 12	Workshop on plant protection measures in major *kharif* crops Organized by PAMETI, Ludhiana	1
3	Insect pest management in Rabi crops	27.9.2012	District level camp organized by Dept of Agriculture, Mohali	1
4	Different useful and harmful insects	15.10.2012	Three month training course for Field Functionaries of PAU Ludhiana	1
5	Mass production of Biocontrol agents	26.12.2012	Educational Visit of students of Secondary Education	1
6	Insect pest management in Spring Maize	10.1.2013	28 ıg of trainers on plant protection measures in major Rabi crops from 10-13 January, 2013	1
7	Insect pest management in Kharif crops	23.3.2013	District level camp organized by Dept of Agriculture, Barnala	1
8	Natural enemies of cotton insect pests	26.3.2013	Training of Scouts in Better Production of Cotton for economic growth, farm livelihoods and ecosystem health in Malwa region of Punjab organized by Dept. of	1

			Entomology, PAU, Ludhiana	
9	Monitoring of insect pests & their natural enemies in cotton	26.3.2013	Training of Scouts in Better Production of Cotton for economic growth, farm livelihoods and ecosystem health in Malwa region of Punjab organized by Dept. of Entomology, PAU, Ludhiana	1
10	Natural enemies of cotton insect pests	2.4.2013	Training of Scouts in Better Production of Cotton for economic growth, farm livelihoods and ecosystem health in Malwa region of Punjab organized by Dept. of Entomology, PAU, Ludhiana	1
Total Lectures				**10**

Materials developed:

Name of Centre	**Name of Biocontrol agents produced during 2012-13**	**Monthly production capacity in brief**	**Total annual production (2012-13) in brief**
PAU, Ludhiana	i) *Trichogramma chilonis*	670 cards	8,000 cards
	ii) *T. japonicum*	580 cards	7000 cards
	iii) *T. pretiosum*	50 cards	400 cards
	iv) *Chrysoperla carnea*	3000 grubs/adults	36,000 grubs/adults

Activities of Biocontrol Group at PAU Centre

The biocontrol unit at PAU is also performing all other duties assigned to them from time to time. In the year 2012 we organized an exhibition on behalf of NBAII, Bangalore in the 7th KVK's Conference, 2012 held from November 20 - 22, 2012 at PAU, Ludhiana.

The biocontrol unit has also started an Experiential learning (EL) for hands – on – training (ELP- 401- Specialized Experiential Learning Programme Activity – I) for B. Sc. (Agri.) final year students during the 2nd semester (0 + 12 credit hrs) of current academic year 2012 - 13 which has been sponsored by ICAR, New Delhi. In this programme we are giving training on the mass production of important parasitoids and predators for use in important field crops for developing entrepreneurship skills in the students.

TNAU-Coimbatore

Training imparted

Regular hands on trainings were offered for extension functionaries, farmers and entrepreneurs on biocontrol aspects.

Sl.No.	**Date**	**Title of the Training**	**Beneficiary / Participants**
1	12-12-12	Quality control parameters for Bio-pesticides during zonal meet	35 Department officials

2	07-11-12	Biocontrol methods for Entrepreneur Development organized by CARDS of TNAU	75 members from self help group of Karur District
3	27.11.2012	Use of biocontrol agents in Horticultural crops	75 members of Zonal workshop attended
4	28-12-12	Biological Control in vegetable crops conducted by department of Agriculture - ATMA	50 Farmers from Sulur block
5	05-01-2013	Role of Biocontrol agents for food security – CAFT programme	Twenty scientists from all over the country
6	24-01-13	Enhancing the effectiveness of Natural enemies	Six scientists from National semi arid resources Research Institute Uganda
7	31-01-2013	Biological control for Horticultural crops organized by AV. Thomas group of companies	80 Tribal farmers attended
8	06-02-2013	Entomopathogens for safe pest management	60 extension officials from Coimbatore district attended
9	12.02.2013	Biological control of pests of Horticultural crops	80 extension officials of Zonal workshop attended
10	14-02-2013	Non-chemical methods of pest management for major Floriculture crops organized by KVK of Ooty.	100 farmers attended
11	12-03-03	Recent advances in Biocontrol Research organized by KVK Gandhigram	30 Staff members from Gandhigram rural University
12	28-03-13	Papaya mealy bug management	55 staff members from all KVK's of TNAU

iii. Participation of Scientists in conference, meetings, seminars, workshops, symposia, training extension etc. In India and abroad

ANGRAU-Hyderabad

1. Dr. S J Rahman delivered a lecture on "Role of Biological Control in Integrated Pest Management of various crops" at NIPHM, Rajendranagar on June 24, 2012.
2. Dr. S. J. Rahman delivered a lecture on "Biological Control" as a tool for "Cost reduction technologies for sustainable agriculture" for ADAs at SAMETI, Malakpet on 27 August, 2012.
3. Dr. S J Rahman delivered a lecture on "Bio control as an important component of IPM" to Dept officers on September 11, 2012 at SAMETI, Malakpet.

CPCRI-Kayangulam

Dr. Chandrika Mohan attended the following programmes:

1. Attended the "XXIth AICRP workshop on Biocontrol of crop pests and weeds" held at Acharya N.G. Ranga University of Agriculture, Hyderabad on 22nd and 23rd May, 2012 and presented the work on Biocontrol of coconut pests.
2. Participated in the National meeting "Brainstorming session on Plant Protection of Spices and Plantation Crops" held at Spices Board, Kochi during June 20, 2012.

3. Attended the QRT meeting on AICRP on Biocontrol of crop pests and weeds at NBAII, Bangalore during June 26-27, 2012 and presented the achievements of biocontrol of coconut pests for the period 2007-12.
4. Attended "XXIth Annual Group meeting on AICRP on Palms" held at Agricultural College and Research Institute, Madurai during July 11-13, 2012 and functioned as Co-chairman of the Technical Session on Pest Management.
5. Attended the seminar on " Twenty-five years of research on Breeding for Resistance/ Tolerance to Coconut Root (Wilt) disease" held at CPCRI, Regional Station, Kayamkulam on August 24, 2012.
6. Attended the "Group meeting on new approaches for management of *Phytophthora* diseases in plantation crops" held at CPCRI, Kasaragod on 29-10-2012.
7. Participated in the "Flagship programme envisioning workshop on phytoplasmal disease management" held at CPCRI, Kasaragod on 09-11-2012.
8. Attended the "Brain storming session on Phytoplasma disease management in coconut and arecanut" held at Kayamkulam on 08-12-2012.
9. Attended "Meeting for operationalizing Schedule V of PQ order and harmonizing with new Policy on Seed Development, Govt. of India" held at NCIPM, New Delhi on 10-12-2012.
10. Attended the "Plantation Crops Symposium - PLACROSYM XX" held at Coimbatore, during December 12-15, 2012 and presented a research paper entitled "Field Validation of Biological Suppression of Coconut Black Headed Caterpillar, *Opisina arenosella* Walker using larval parasitoids *Goniozus nephantidis* and *Bracon brevicornis*". Co-ordinated the technical session on Pest Management as Co-chairman of the session.
11. Attended the "Fourth International Congress on Insect Science on New Horizons in Insect Science" held at UAS, Bengaluru & Hotel Holiday Palms during February 14-16, 2013 and presented a research paper entitled "Coconut water as a promising culture media for *Hirsutella thompsonii* Fisher, a pathogen of coconut mite"

IIHR-Bangalore

1. **Ganga Visalakshy.PN** Attended IV National Sym. on Plant protection in horticultural crops: Emerging challenges and sustainalbenaible pest manage. 25-28 April, 2012
2. **Ganga Visalakshy.PN** Attended International congress on insect science (ICIS, 2013) conducted by UAS, Bangalore and society of Insect science in Feb.2013at Bangalore.
3. **Krishnamoorthy** Attended IV National Sym. on Plant protection in horticultural crops: Emerging challenges and sustainable pest manage. 25-28 April, 2012

KAU-Thrissur

1. Dr. K. R. Lyla, Professor and Smt. Vidya C.V., Asst. Professor attended XXI Biocontrol Workers Group Meeting held on 22-23rd May, 2012 at ANGRAU, Hyderabad.
2. Dr. K.R. Lyla attended Biennial conference of Indian Society of Weed Science on "Weed Threat to Agriculture, Biodiversity and Environment", April 19-20, 2012, Kerala Agricultural University.
3. Dr. K.R. Lyla attended National level meeting on success story of papaya mealybug held on 20th October 2012 at NBAII, Bangalore

MPKV-Pune

1. D. S. Pokharkar, R.V. Nakat and N. D. Tamboli attended 'Research Review Committee Meeting in Plant Protection- Agril. Entomology and

Nematology' held at MPKV, Rahuri on 12/04/2012 and presented the report of the centre.

2. D. S. Pokharkar and R.V. Nakat attended 'XXI Biocontrol Workers Group Meeting on Biological control of crop pests and weeds' ANGRAU, Hyderabad on May 22-23, 2012 and presented the report on Biological suppression of vegetable crop pests and storage pests.
3. QRT meeting of AICRP on Biological control of crop pests and weeds was held on July 20-21, 2012 at this centre and all staff of this project attended the meeting. Dr. D. S. Pokharkar presented the research work carried out during 2007 to 2012.
4. Meeting of Monitoring was held on 17/10/2012 and the team reviewed research work, facilities and constraints of the project in conducting trials. All staff attended the meeting and Dr. D. S. Pokharkar presented the report.
5. Dr. D. S. Pokharkar attended the 69th Board of Studies Meeting in Agril. Entomology on 4/01/2013 at Department of Entomology, MPKV, Rahuri and discussed Ph. D. synopsis and academic performance of the department.
6. Dr. D. S. Pokharkar attended the Research Programme Planning Meeting in Agril. Entomology on 21/2/2.013 at the Directorate of Research, MPKV, Rahuri and presented the proposed technical programme for 2013-2014.

PAU-Ludhiana

1. Dr Naveen Aggarwal and Dr. Neelam Joshi participated in National Seminar on Biotechnological Approaches in Pest management held from 4.5.2012 to 5.5.2012 at PAU, Ludhiana.
2. Dr Naveen Aggarwal, Dr Rabinder Kaur and Dr. Neelam Joshi participated in XXI Biocontrol Workshop group meeting held on 22.5.2012 & 23.5.2012 at ANGRU, Hyderabad.
3. Dr Naveen Aggarwal,Dr. Neelam Joshi & Dr Rabinder Kaur participated in Research and Extension Specialists Workshop for *Rabi* crops August 22-23, 2012 at PAU, Ludhiana.
4. Dr Naveen Aggarwal Dr Neelam Joshi and Dr Rabinder Kaur participated in *Kisan Mela* at PAU, Ludhiana on Sep[illegible] 21-22, 2012.
5. Dr Naveen Aggarwal, Dr. Neelam Jo[illegible] Dr Rabinder Kaur participated in 7th KVK Conference, 2012 held from November 20-22, 2012 at PAU, Ludhiana.
6. Dr Naveen Aggarwal, Dr. Neelam Joshi & Dr Rabinder Kaur participated in "International Conference on Sustainable Agriculture for Food and Livelihood Security" held on November 27-29, 2012 at PAU, Ludhiana.
7. Dr Naveen Aggarwal participated in One Day Brain Storming Workshop for promoting Extra-mural Research in Punjab state on January 28, 2013 at PAU, Ludhiana organized jointly by PAU, Ludhiana in collaboration with Punjab State Council for Science and Technology, Chandigarh
8. Dr Naveen Aggarwal & Dr Rabinder Kaur participated in International Conference on Insect Science held at UAS, GKVK, Bangalore from February 14-17, 2013.

SKUAST-Kashmir

Dr. Jamal Ahmad

1. Attended XXI Bio control workers Group Meeting(22-23rd May' 2012) at ANGRAU, Hyderabad and presented research findings on "Poly house crop pests, storage pests & weed bio control"

2. Visited Maharashtra Organic Farming Federation, Pune from 5-12th September' 2012, and attended meetings with organic farmers at district Pune, Nashik, Jalgaon and Malegaon etc.
3. Attended 29th and 30th Meetings of Faculty of P.G. studies at DEE, SKUAST-K, Shalimar campus, Srinagar.
4. Attended National Seminar on Science for shaping the future of India : Faunal diversity, challenges and opportunities (19-21st November' 2012)organized by the Department of Zoology, University of Kashmir and Presented paper on the "Diversity of chalcids in Kashmir".
5. Attended one day meeting with the Director of horticulture, Jammu & Kashmir ON 9th October' 2012, organized by the Directorate of Research, SKUAST-K. Shalimar campus, Srinagar.
6. Attended Review meeting of AICRP on 14th September' 2012, and presented salient achievements to the Vice Chancellor and Director Research, SKUAST-K. Shalimar campus, Srinagar

TNAU-Coimbatore

1. Dr.P.Karuppuchamy attended ICAR-CAFT Directors' Meet on "Systematic Approaches in Training on 11-13th July 2012 at TNAU, Coimbatore.
2. Dr.P.Karuppuchamy attended and presented report for ICAR-QRT on Biological control at NBAII, Bangalore on 26 & 27.6 2012
3. Dr.P.Karuppuchamy and Dr.M.Kalyanasundaram attended National meeting on Suceess of papaya mealy bug management at NBAII on 19.10 2012.

iv.List of publications

1. Research Papers

AAU-Anand

1. Godhani, P. H.; Patel, B. H. and Korat, D.M. (2012). Evaluation of bio-intensive pest management (BIPM) module for the suppression of insect pests infesting *Bt* cotton. *GAU Res. J*., 37(1): 42-45.
2. Patel, B. H.; Godhani, P. H.; Patel, R. M.; Patel, H. M .; Patel, B. K. and Korat, D.M. (2012). Impact of habitat manipulation on insect pests infecting *Bt*. Cotton and their natural enemies. *Karnataka J. Agric. Sci.,* 25(3): 336-339.

AAU-Jorhat

1. Dr. Anjumoni Devee and Dr. AALH Baruah, (2012): Bio- efficacy of imidacloprid and bifenthrin against *Lipaphis erysimi* (Kalt.) on *Brassica rapa* L. subsp. *oleifera* (toria), *Indian Journal of Agricultural Sciences*, 82 (10), 845-851

CPCRI-Kayangulam

1. Rajan, P., **Chandrika Mohan**, Chalapathi Rao, N.B.V. and Thomas, G.V. (2012) Scenario of coconut eriophyid mite infestation in Andhra Pradesh. *Indian Coconut Journal* **55**(2): 25-31.
2. Josephrajkumar, A., Rajan, P., **Chandrika Mohan** and Thomas, R.J. (2012) New distributional record of buff coconut mealybug (*Nipaecoccus nipae*) in Kerala, India. *Phytoparasitica* **40**: 533–535 (DOI: 10.1007/s12600-012-0260-2.)
3. Rajan, P., Nair, C.P.R., Josephrajkumar, A. and **Chandrika Mohan** (2012) Another invasive pest, coconut leaf beetle, *Brontispa longissima* (Gestro), an

imminent biosecurity threat at the doorsteps of India. *J. Plantn. Crops* **40**(2): 140-143.
4. Sivakumar T., Chandrika Mohan and Babu, M. 2013. Incidence and management of the leaf hopper, *Busoniomimus manjunathi*, on Malabar Tamarind, *Garcinia cambogia*. *African Journal of Agricultural Research*. 8(1): 145-147

GBPUAT-Panthnagar

1. Rawat, L., Singh, Y., Shukla, N and Kumar, J. 2013. Salinity tolerant *Trichoderma harzianum* reinforces NaCl tolerance and reduces population dynamics of *Fusarium oxysporum* f.sp. *ciceri* in chickpea (*Cicer arietinum* L.) under salt stress conditions. *Archives of Phytopathology and Plant Protection*.
2. Shukla, N., Awasthi, R.P., Rawat, L., and Kumar, J. 2012. Biochemical and physiological response of ric (*Oryza sativa* L.) as influenced by *Trichoderma harzianum* under drought stress. *Plant Physiology and Biochemistry,* 54 : 78-88.
3. Rawat, L., Singh, Y., Shukla, N. and Kumar, J. 2012. Seed biopriming with salinity tolerant isolates of *Trichoderma harzianum* alleviates salt stress in rice (*Oryza sativa* L.): growth, physiological and biochemical characteristics. *Journal of Plant Pathology,* 94 (2): 353-365.
4. Negi, D.S., Kumar, J., Gupta, R.K. and Shah, B. 2013. Integrated organic management of powdery mildew disease in vegetable pea caused by *Erisiphe poligoni*. *Journal of Ecofriendly Agriculture,* 8: 89-91.
5. Rawat, L., Y. Singh and Kumar, J. 2012. Improvement in nutritional status of *Trichoderma* colonized FYM . *Internat. J. Plant Protec.* 5(1):154-156.
6. Rawat, L., Y. Singh and Kumar, J. (2012). Management of sclerotium root rot in lentil and Fusarium wilt in chickpea using *Trichoderma* isolates. *Internat. J. Agric. Sci*.8(2): 416-422.
7. Rawat, A., Rawat, L., Negi, Y. and Kumar, J. 2012. Effect of population density of *Rhizoctonia solani* on biocontrol ability of *Trichoderma harzianum* in Frenchbean. *VEGETOS,* 25 (1): 117-124.
8. Saxena, Deepika; Tewari, A. K. and Awasthi, R. P. 2012. Cultural, morphological and molecular characterization of *T. harzianum* PBT 23**.** *Pantnagar Journal of Research*, **10** (1): 35-39.

IIHR-Bangalore

1. Krishnamoorthy**, A**. 2012. Exploitation of egg parasitoids for control of potential pests in vegetable ecosystems in India. *Comunicata Scientiae*, **3**: 1-15
2. Mani,M., Sunil Joshi, Kalyanasundram, M., Shivaraju,C., Krishnamoorthy**,A**., Asokan, R. AND Rebijith, K.B. 2012. A new invasive Jackbeardsley mealybug Pseudococcus jackbeardsleyi Gimpel and Miller on Papya in India. *Florida Entomologist* **96**(1): 242-245
3. Krishnamoorthy**, A.** AND P.N. Ganga Visalakshi, 2012. Thrips on Mango. *J. Hortl. Sci*., 7(1), 110-111
4. Mani, M. AND Krishnamoorthy**, A**. 2012. Determination of release time of the Australian Ladybird beetle, Cryptolaemus montrouzieri Mulsant for the suppression of the pink Hibiscus mealybug, Macconellicoccus hirsutus (Green) on grapes. *Pest management in Horticultural ecosystems* 18(1): 98-99

KAU-Thrissur

1. Lyla, K.R. Sinish, M.S. Vidya, C.V. and Manichellappan. 2012. Classical biocontrol of papaya mealybug, *Paracoccus marginatus* Williams and Granara de

Willink in Kerala using the parasitoid, *Acerophagus papayae* Noyes and Schauff (Hymenoptera: Encyrtidae). *J. of Biol. Control*, 26(4) 386-388.

MPKV-Pune

1. Pokharkar, D. S., R. V. Nakat, A. S. Dhane and N. D. Tamboli. 2013. Enhancement of natural enemies' population by habitat manipulation in rainfed cotton. *J. Agric. Res. Technol.*, 38(2): 271-276.
2. Pokharkar, D. S., R. V. Nakat, A. S. Dhane, N. D. Tamboli, S. B. Kharbade and A. G. Chandele. 2012. Current status of papaya mealy bug *Paracoccus marginatus* W. and G. in Maharashtra and its economic analysis on management with parasitoid *Acerophagus papayae* (N. and S.). Submitted for the *Golden Jubilee function of Biological control of Crop Pests* held on October 20, 2012 at NBAII, Bangalore.

3. Pokharkar, D. S. and D. S. Tirmare. 2013. Biointensive pest management of shoot and fruit borer, *Leucinodes orbonalis* Guenee (Lepidoptera: Pyralidae) in brinjal. *J. insect Sci.* (submitted).

OUAT-Bhubhaneshwar

1. Mishra,B.K.,Mishra Ipsita and Mandal,S.M.A.2012.Predatory potentiality of *Cryptolaemus montrouzieri* Mulsant on pink hibiscus mealy bug *Maconellicoccus hirsutus*(Green) and papaya mealy bug *Paracoccus marginatus* Williams and Granara De Willink. *Journal of Plant Protection and Environment* **9**(2):39 – 41
2. Mishra Ipsita, Mandal S.M.A and Mishra,B.K..2012.Biology and predatory potentiality of *Ischiodon scutellaris*(Fab.)on *Aphis craccivora* Koch. *Journal of Plant Protection and Environment* **9**(2):42 – 45
3. Mishra Ipsita, Mishra,B.K and Mandal S.M.A.2012.Ovicidal and larvicidal effect of some new insecticides and bio pesticides on *Chrysoperla carnea*(Stephens). *Journal of Plant Protection and Environment* **9**(2):46-48

PAU-Ludhiana

1. Neetan and Aggarwal N. (2013). Relative toxicity of some insecticides against *Chrysoperla zastrowi sillemi* (Esben – Petersen) under laboratory conditions. *J.Cotton Res. Dev*. 27 (1): 119-23
2. Aggarwal N. and Jindal J. (2012). Biological control of *Chilo partellus* (Swinhoe) using egg parasitoid T*richogramma chilonis* Ishii in summer sown maize. *Crop Improvement* Special Issue: 991 – 992
3. Jindal J, Aggarwal N, Singh G, Kumar M and Grewal M S. (2012). Effect of different methods of sowing on the incidence of shoot fly, *Atherigona naqvii* Steyskal in spring sown maize. *Crop Improvement* Special Issue: 929 - 930
4. Jindal V, Aggarwal N and Singh V. (2012). Evaluation of Bt cotton as an integral component of integrated pest management. *Indian J. Ecol.* 39(1): 118-122
5. Joshi N, Virk J.S and Sharma S (2012) Efficacy of HaNPV on larval population of lepidopteran pod borer complex infesting pigeon pea, *Cajanus cajan*. *J Insect Sci* 25 (2):197-198
6. Rabinder Kaur and J S Virk (2012). Evaluation of different plants for rearing of Eri silkworm, Samia *Cynthia ricini* under Punjab conditions. *Journal of Insect Science* 25 (3): 270-271
7. Sharma A and Joshi N (2012) Media composition influences growth parameters

of fungi and their LC_{50} against *Plutella xylostella* linn.*Crop Improvment*,PAU (special issue 881-882
8. Singh K, Singh G, Kaur R and Chandi A K (2012). Toxicity of Spinosad against diamondback moth, *Plutella xylostella* (Linnaeus) *Crop Improvement* (Special issue' 2012): 963-964

TNAU-Coimbatore

1. Jeyarani,S., N.Sathiah and P. Karuppuchamy. 2013. An *invitro* method of increasing UV tolerance in a strain of *Helicoverpa agrmigera* (Noctuidae:Lepidoptera) nucleopolyhedrovirus. Biocontrol Science and Technology 23(3) 305 – 316.
2. Divya,S., Kalayanasundaram,M. and P.Karuppuchamy. 2012 Efficacy of adult nutrition on longevity and parasitisation efficiency of *Acerophagus papaya*e Indian Journal of Biocontrol. 25(4): 316-319.
3. S.Jeyarani,N.Sathiah and P. Karuppuchamy. 2012. An *in vitro* enhancement of nucleopolyhedrovirus infection in *Helicoverpa armigera* (Hubner) by the granulovirus of *Spodoptera litura* Fabricius. *Journal of Biological Control*, 26(3): 234-239.
4. Kalyanasundaram, M., P.Thiyagarajan, M.Jawaharlal, P.Muthulakshmi and M.Ganga 2012.Effect of pesticides on management of blossom midge, *Contarinia maculipennis* Felt. (Cecidomyiidae: Diptera) in jasmine, *Jasminum sambac* (L.) Aiton.) *South Indian Hort*., 60: 169-172.
5. Mani,M.;Snil Joshi and M.Kalyanasundaram 2013 A new invasive jack Beardsley mealy bug *Pseudococcus jackbeardsleyi* (Hemiptera : Pseudococcidae) on papaya in India. *Florida Entomologist*.,96 (1) ; 242 -245.
6. Muthulakshmi P., M. Jawaharlal, P. Thiyagarajan, M. Kalyanasundaram and S.Senthilmurugan. 2012. Ecofriendly methods to manage Alternaria leaf blight (*Alternaria jasmini*) in jasmine, *Jasminum sambac* (L.) Aiton.) *South Indian Hort*., 60: 190-192.
7. Sakthivel,P., P.Karuppuchamy., M.Kalyanasundaram and T.Srinivasan. 2012. Toxicity of insecticides to papaya mealybug parasitoid, *Acerophagus papayae* (Noyes and Schauff) (Hymenoptera: Encyrtidae). *J. Biological Control*, 26(3):274-278.
8. Sakthivel,P., P.Karuppuchamy., M.Kalyanasundaram and T.Srinivasan. 2012. Host plants of invasive papaya mealybug *Paracoccus marginatus* (Williams and Granara de Willink) in Tamil Nadu. *Madras Agric. J*., 99(7-9):615-619.
9. Sakthivel,P., P.Karuppuchamy., M.Kalyanasundaram and T.Srinivasan. 2012. Potential native predatos, *Chrysoperla zastrowi sillemi* (Esben-Peterson) and *Cryptolaemus montrouzieri* (Mulsant) on *Paracoccus marginatus* (Williams and Granara de Willink). *Madras Agric. J*., 99(7-9):620-622.

YSPUHF-Solan

1. Sharma PL, and Ajay Sharma. 2012. Laboratory evaluation of a local isolate of *Nomuraea rileyi* (Farlow) Samson against *spodoptera litura (*fabricius) (Lepidoptera: Noctuidae). *Journal of Biopesticides* (in press).

2. Papers presented in symposia/seminar/workshops

AAU-Anand

Following paper was presented in the "**4th INTERNATIONAL CONFERENCE ON INSECT SCIENCE**, organised by Department of Entomology University of Agricultural Science, GKVK, Bangalore, Karnataka during February 14-17, 2013.

1. Jani, J.J.; Noushad, P. and Mehta, D.M. (2013). Metabolites of Pseudomonads: A new avenue of plant health management.
2. Pathak, L.; Noushad, P.; Patel, A.; Panpatte, D.; Khatri, K. and Jani, J.J. (2013). Insect resistance to *Bt.* Transgenic crops and its management.
3. Jani, J.J.; Korat, D.M.; Patel, N.B.; Darji, V.B. and Mehta D.M. (2013). Evaluation of microbial insecticides formulations against fruit borer of tomato.
4. Jani, J.J.; Korat, D.M.; Patel, N. B.; Dodia, J.F.; Patel, V.J. and Mehta D.M. (2013). Evaluation and demonstration of biocontrol based IPM module against pest complex of paddy.
5. Jani, J.J.; Korat; D.M.; Patel, N.B.; Patel, H.M.; Patel, Dodia, J.F. and Patel, V.J. (2013). Evaluation of some microbial insecticides against leaf defoliators infesting paddy.
6. Panpatte, D.; Noushad, P.; Pathak, L.; Patel, A.; Khatri, K.. and Jani, J.J. (2013). Nanomaterials – Future particles for environmental scientists
7. Patel, A.; Noushad, P.; Pathal, L.; Panpatte, P.; Khatri, K. and Jani, J.J. (2013). Molecular approaches for the improvement of *Bacillus thuringensis* against pests
8. Noushad, P.; Pathak, L.; Inamake, R.; Panpatte, D.; Patel, A. and Jani, J.J. (2013). Chitinase expressed as an inducible trait in Pseudomonas aeruginose.
9. Dhobi, C.B. and Mehta, D.M. (2013). Impact of food on efficacy of insecticides against *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae)
10. Choudhary, M.; Bharpoda, T.M. and Dhobi, C.B. (2013). Susceptibility of cowpea varieties to *Callosbruchus chinensis* Linnaeus under storage condition.
11. Patel, R.M.; Mehta, D.M. and Talati, J.G. (2013). Comparative biology of *Corcyra cephalonica* (Stainton) on sorghum with different amendments of nutrients
12. Korat, D.M.; Patel, H.M.; Patel, B.H. and Mehta D.M. (2013). Influence of crop habitat diversity on biodiversity of natural enemies of pigeonpea pests
13. Jani, J.J.; Korat, D.M.; Patel, N.B.; Patel, H.M.; Dodia, J.F. and Patel V.J. (2013). Evaluation of some microbial insecticides against leaf defoliators infesting paddy
14. Amin, R.; Khatri, K.; Panpatte, D.; Pathak, L.; Patel, A.; Noushad, P.; Shelat, H.; Jani, J.J. and Vyas, R. (2013). Optimization of fermentation parameters and in vitro efficacy of native *Bacillus thuringensis* isolates against *Spodoptera litura*
15. Inamke, R.; Panpatte, D.; Noushad, P.; Pathak, L.; Patel, A.; Khatri, K. and Jani, J.J. (2013). Insect conservation: a synthetic management approach
16. Ghetiya, L.V.; Mehta, D.M. and Jani, J.J. (2013). Population dynamics of *Helicoverpa armigera* (Hubner) in pigeonpea, *Cajanus cajan* (l.) millspaugh Gujarat
17. Ghetiya, L.V.; Mehta, D.M. and Jani, J.J. (2013). Efficacy of insecticides against pod borer, *Helicoverpa armigera* (Hubner) infesting pigeon pea (*Cajanus cajan* (l.) Millspaugh).
18. Jani, J. J.; Korat, D. M.; Patel, N.; Godhani, P. H. and Mehta, D. M. (2013). Impact evaluation of Cow-urine and Vermiwash on insect pests, their natural enemies and yield of Brinjal.

19. Mamta Devi Choudhary, T. M. Bharpoda and C. B. Dhobi (2013). Susceptibility of cowpea varieties to *callosobruchus chinensis* Linnaeus under storage condition.

CTRI-Rajhamundry

1. S.Gunneswra Rao, H.Ravi Shanker and U Sreedhar. Expert system for identification of natural enemies of tobacco pests. International conference on Plant Health Management for food security during November 28th to 30th 2012 at Hyderabad under poster session.
2. Gunneswara Rao,S and U.Sreedhar. Determination of economic injury level of tobacco capsule borer *Helicoverpa armigera* (Hubner). International Conference on Insect Science during February 14th to 17th 2013 at UAS Bangalore under poster session.

GBPUAT-Panthnagar

1. Roopali Sharma, Rashmi Tewari, B.C. Kabadwal, J.Kumar and R.K. Sharma. 2012.Role of biocontrol agents in management of compost pit in 7th Uttrakhand State Science and Technology Congress during 21-23 Nov. pp-17.
2. B.P. Bhadauria, Roopali Sharma, P.K.Singh and J.Kumar. 2012. Study of pathogenicity of a local isolate of *Beauveria bassiana* against *Spodoptera litura* (Fab.). 65th IPS National Symposium Indian Phytopathological Society National Symposium on Blending Conventional and Modern Plant Pathology for Sustainable Agriculture held on 4-6 December, p 124-125.
3. Bhupesh Chandra Kabadwal, Rashmi Tewari, Roopali Sharma and J.Kumar. 2012. A common minimum programme of pest/disease management for small farms in hills of Uttarakhand. 65th IPS National Symposium Indian Phytopathological Society National Symposium on Blending Conventional and Modern Plant Pathology for Sustainable Agriculture held on 4-6 December, pp. 47.
4. Kumar, J. and Puri, S.2012. Biological control of soilborne pathogens under green house conditions. *In: Proceedings of the 26th Training on "Diseases and management of crops under protected cultivation",* held at the Centre of Advanced Faculty Training in Plant Pathology, GBPUAT, Pantnagar, pp. 134-140.
5. Kumar, J. and Puri, S. 2012. Evaluation risks related to the release of biocontrol agenmts active against plant pathogens. *In: Proceedings of the 26th Training on "Diseases and management of crops under protected cultivation*", held at the Centre of Advanced Faculty Training in Plant Pathology, GBPUAT, Pantnagar, pp. 199-204.
6. Tewari, A.K. 2012. Biological control of foliar diseases under protected cultivation In: "Diseases and management of crops under protected cultivation". *In: Proceedings of the 26th Training on "Diseases and management of crops under protected cultivation"*, held at the Centre of Advanced Faculty Training in Plant Pathology, GBPUAT, Pantnagar, pp. 166-167.
7. Tewari, A.K. 2012. Commercial aspect of biological pest control in green houses *In: Proceedings of the 26th Training on "Diseases and management of crops under protected cultivation*", held at the Centre of Advanced Faculty Training in Plant Pathology, GBPUAT, Pantnagar, pp. 231-233.
8. Tewari, A.K. 2013. Influence of Environmental Parameters on *Trichoderma* Strains with Biocontrol Potential. *In: managing plant microbe interactions for the management of soil borne plant pathogens*. Jan.22- Feb.11 , p.129-130
9. Evaluation and Selection of promising *Trichoderma* isolates for the management

of soil borne plant pathogens. *In: managing plant microbe interactions for the management of soil borne plant pathogens*. Jan.22- Feb.11, p.102-105

10. Sharma, R, Puri, S and Erraya, 2013. Isolation, Identification and Quantification of Trichoderma. *In:Proceedings of the 27th Training Managing Plant Microbe Interactions for the Management of Soil-borne Plant Pathogen.* held at the Centre of Advanced Faculty Training in Plant Pathology, GBPUAT, Pantnagar, pp. 177-179.
11. Sharma, R., Puri, S and Tewari, R. 2013. Mechanism of Mycoparasitism and Antibiosis. *In: Managing Plant Microbe Interactions for the Management of Soil-borne Plant Pathogens* held at the Centre of Advanced Faculty Training in Plant Pathology, GBPUAT, Pantnagar, pp. 180-183.
12. Sharma, R and Bhadauria, B.P. 2013. Mass production and formulation technology of *Trichoderma*. *In: Managing Plant Microbe Interactions for the Management of Soil-borne Plant Pathogens* held at the Centre of Advanced Faculty Training in Plant Pathology, GBPUAT, Pantnagar, 184 p.
13. Kumar, J., Sharma, R., Puri, S and Arzoo, K. 2013. Identification of *Pseudomonas and Bacillus* Isolates using Biolog System. *In: Managing Plant Microbe Interactions for the Management of Soil-borne Plant Pathogen* held at the Centre of Advanced Faculty Training in Plant Pathology, GBPUAT, Pantnagar, pp. 185-187.

IIHR-Bangalore

1. Ganga Visalakshy.PN and Krishnamoorthy.A .2013 Comparative field efficacy of various entomopathogenic fungi against *thrips tabaci*: prospects for organic production of onion in India- ISHS Acta Horticulture 933: XXVIII International Horticultural Congress on Science and Horticulture for People (IHC2010): International Symposium on Organic Horticulture: Productivity and Sustainability.
2. Dr.Ganga Vislakshy, PN, Jayanth, KP. Ghosh.SK and Choudhary.M.2013Development of anatomical age grading technique for *Zygogramma. bicolorata* and its implications in biological control of invasive weed *Parthenium hystereophorus* in India –ICIS, 2013
3. Ganga Visalakshy.PN .2013 Factors influencing the abundance of *Dolichogenidae stantoni (*Asheamd), a potential natural enemy of *Diaphania indica* (*Saunders*) ICIS.
4. Ganga Visalakshy.PN and Krishnamoorthy.A .2013 Management of Thrips *tabaci* on onion – possible alternatives - IV National sym.on Plant protection in horticultural crops _Emerging challenges and sustainable pest manage. . 25-28 April, 2012

KAU-Thrissur

1. Joy, P.J. and Lyla, K.R. Successful biosuppression of *Salvinia molesta* using *Cyrtobagous salviniae* in Kerala. Biennial conference of Indian Society of Weed Science on "Weed Threat to Agriculture, Biodiversity and Environment", April 19-20, 2012, Kerala Agricultural University. p.5.

PAU-Ludhiana

1. Aggarwal N, Neetan and Kour G (2013). Integration between entomopathogenic nematodes and *Bacillus thuringiensis* as a novel approach for the biological control of Diamondback moth, *Plutella xylostella* (L.) In International Conference on Insect Science held from February 14-17, 2013 at UAS, GKVK, Bangalore p 42

2. Arora R, Suri K S, Kumar V, Chandi R S, Aggarwal N and Bhullar H S (2013). Bioefficacy of novel insecticides against the tobacco caterpillar, *Spodoptera litura* infesting cole crops in Punjab. In International Conference on Insect Science held from February 14-17, 2013 at UAS, GKVK, Bangalore p 120
3. Joshi N, Sharma N and Bhullar B.M (2013) Bioassay of fungal isolates against two spotted spider mite, *Tetranychus urticae* Koch. In proceedings of the International Conference on insect Science held on February 14th to 17th 2013 at University of Agricultural Sciences, GKVK, Bangalore .pp 116.
4. Malhan G S, Arora R Suri K S, Aggarwal N and Arora P K (2013). Farmer's knowledge, perceptions and management of insect pests of cole crops in Punjab. In International Conference on Insect Science held from February 14-17, 2013 at UAS, GKVK, Bangalore p 23
5. Saini M K, Aggarwal N and Kumar V. (2012). Impact of an integrated pest management programme in transgenic cotton in Punjab. In proceedings of the "National Seminar on Biotechnological Approaches in Pest management" held at Deptt. of Entomology, PAU, Ludhiana from 4 - 5th May, 2012. pp. 117. Singh K, Singh G, Kaur R and Chandi A K (2013). Influence of spinosad on the ovaries of diamondback moth, *Plutella xylostella* (Linnaeus). In International Conference on Insect Science held from February 14-17, 2013 at UAS, GKVK, Bangalore p112.
6. Singh S, Pandher S, Shera P S, Aggarwal N and Jindal V (2013). Changing insect pest scenario in Bt cotton era in Punjab). In International Conference on Insect Science held from February 14-17, 2013 at UAS, GKVK, Bangalore p 11.

TNAU-Coimbatore

1. E.I.Jonathan, P.Karuppuchamy, M.Kalyanasundaram, S.Suresh and C.A.Mahalingam.2010. Status of Papaya Mealybug in Tamil Nadu and its Management. Classical Biological Control of Papaya Mealybug (Paracoccus marginatus) in India. Proceedings of the National Consultation Meeting on Strategies for Deployment and Impact of the imported Parasitoids of Papaya Mealybug, 30th October 2010. Pg.No.24-33.
2. M.Kalyanasundaram, P.Karuppuchamy, S.Divya, P.Sakthivel, R.J.Rabindra and A.N.Shylesha. 2010. Impact of release of the imported parasitoid Acerophagus papaya on the management of Papaya Mealybug Paracoccus marginataus in Tamil Nadu. Classical Biological Control of Papaya Mealybug (Paracoccus marginatus) in India. Proceedings of the National Consultation Meeting on Strategies for Deployment and Impact of the imported Parasitoids of Papaya Mealybug, 30th October 2010. Pg.No.68-72.
3. Samiayyan,K. V.Sudha, V.Radha Krishnan, P.Karuppuchamy and E.I.Jonathan 2012. Spider Diversity in different Short Duration food Legumes Ecosystems of Tamil Nadu, India. Second International Symposium of Biopesticide and Eco-Toxicological Network (ISBiOPEN) – Abstracts 130-131.

YSPUHF-Solan

1. National symposium on Emerging Issues in Plant Health Management organized by Indian Phytopathlogical Society at UHF, Solan w.e.f. September 28-29, 2012 Paper of Sharma, PL and Ajay Sharma entitled " Efficacy of *Beauveria bassiana* (Balsamo) alone and in combination with endosulfan and deltamethrin against *Spodoptera litura* (Fabricius)" presented by PL Sharma, abstract book, p 94.
2. National symposium on Emerging Issues in Plant Health Management organized by Indian Phytopathlogical Society at UHF, Solan w.e.f. September 28-29, 2012 Paper of Nisha Devi, KC Sharma, PL Sharma, RS Chandel and Y Thakur entitled "

Laboratory Bioassy studies on some entomopathogenic fungi against greenhouse whitefly, *trialeurodes vaporariorum* westwood" presented by Nisha Devi, abstract book, pp 87-88.

3. National symposium on "Indian Agriculture: Present situation, challenges, remedies and road map" organized by CSK HPKV, Palampur w.e.f. August 4-5, 2012. Paper of Nisha Devi, KC Sharma, PL Sharma, RS Chandel and Y Thakur entitled " Bioefficacy of two pyrethroid insecticides and two entomopathogenic fungal formulations against greenhouse whitefly, *Trialeurodes vaporariorum* westwood" presented by Nisha Devi, abstract book, p 85.

CPCRI-Kayangulam

1. Chandrika Mohan, Josephrajkumar, A. and Rajan, P. (2012) Field Validation of Biological Suppression of Coconut Black Headed Caterpillar, *Opisina arenosella* Walker using larval parasitoids *Goniozus nephantidis* and *Bracon brevicornis*. Oral Presentation in *XX PLACROSYM-2012*, Coimbatore, December 12-15, 2012. Abstract of papers 107p.
2. Josephrajkumar, A. and Chandrika Mohan. 2012. Issues, challenges and future thrust of coconut entomology. In *Brainstorming session on Plant Protection of Spices and Plantation Crops*, June 20, 2012, CDB, Kochi
3. Chandrika Mohan, Radhika, M.K., Josephrajkumar, A. and Rajan, P. (2013) Coconut water as a promising culture media for *Hirsutella thompsonii* Fisher, a pathogen of coconut mite. *In Souvenir and Abstracts: New Horizons in Insect Science* (Eds.) A.K. Chakravarthy, C.T Ashok Kumar, Abraham Verghese, N.E. Thiagaraj, International Congress on Insect Science, February 14-17, 2013, Bengaluru,48p.
4. Josephrajkumar, A., Chandrika Mohan and Rajan, P. (2013) Evaluation of entomopathogenic nematodes against red palm weevil, *Rhynchophorus ferrugineus* (Olivier) and synergistic interaction with the neonicotinoid, imidacloprid. *In Souvenir and Abstracts: New Horizons in Insect Science* (Eds.) A.K. Chakravarthy, C.T Ashok Kumar, Abraham Verghese, N.E. Thiagaraj, International Congress on Insect Science, February 14-17, 2013, Bengaluru, 48-49p.

3. Book Chapter/Scientific Reviews

AAU-Anand

1. Janardan J. Jani and P. H. Godhani (2013) "**Fundamentals of microbial biocontrol and plant growth promotion practices".** Publisher: Biological Control Research Laboratory, AAU, Anand

AAU-Jorhat

1. Dr. Anjumoni Devee & Dr. U. Kotoky: Commercial nursery management of Horticultural crops (Assamese), Vol.I and Vol. II

PAU-Ludhiana

1. Virk J S, Sharma S and Joshi N (2012). Management approaches for sugarcane insect pests. In Dhawan A K, Singh B Arora R and Bhullar M (ed) "Advances in Agricultural Entomology" (Accepted)

CTRI-Rajhamundry

1. Gunneswara Rao,S and U.Sreedhar. 2013. Egg parasitoids in tobacco ecosystem . In Ed. Sitanantham.S *et a*l . Biological control of insect pests using egg parasitoids. Springer International.

4. Popular article/ Technical/Extension Bulletins

AAU-Anand

1. Patel, C.C.; Radadiya, B.V. and Godhani, P.H. (2012). Suryamukhi ane Kasumbini Jivato. Krushi Pakoma Sankalit Jivat Yvasthapan (Book), Department of Entomology, BACA, Anand Agricultural University, Anand-388 110, Gujarat.

AAU-Jorhat

1. Dr. Anjumoni Devee & Dr. U. Kotoky: Sustha sabal puli utpadanar sathik padakkhep, (Assamese), 12th Nov. Asamia Khabar, 2012.
2. Dr. Anjumoni Devee & Dr. U. Kotoky: Tamol- Narikalar puli utpadan, (Assamese), 29th oct. Asamia Khabar, 2012.
3. Dr. Anjumoni Devee & Gautam Handique: keetnasak drabya proyogar samayat loba loga sabadhanata, (Assamese), 10th May. Doinik Janambhumi, 2012.
4. Joibik krishit Trichogrammar bhumika by Dr. D.K.saikia
5. Sak- pachalirjoibik krishit keet-patanga niyantranar byabastha.by Dr. D.K.Saikia

MPKV-Pune

1. Tamboli, N. D., R. V. Nakat and A. S. Dhane. 2012. Integrated pest management. *Krishi Bhushan*, April, 2012, pp. 61-62.
2. Tamboli, N. D., D. S. Pokharkar and A. S. Dhane. 2012. Production technique of *Cryptolaemus montrouzieri* for the control of mealy bug. *Bhusawanardhan*, October 2012, pp. 13-14.
3. Tamboli, N. D. 2012. Biological control of sugarcane pyrilla. *Bhusawanardhan*, October 2012, pp. 31-32.
4. Pokharkar, D. S., S. B. Kharbade, S. S. Jadhav and A. S. Dhane. 2013. Occurrence of mealy bug on tomato. *Sakal AGROWON*, January 29, 2013. pp.11.

PAU-Ludhiana

1. Aggarwal N**,** Jindal J and Singh G. 2013. Manage insect pests of spring maize for higher yield *Prog Fmg*. 49 (1): 23-24**.**
2. Aggarwal N**,** Jindal J and Singh G. 2013. Bahar rut di makki nu kide makudiyan ton bachao *Changi Kheti* 48 (1): 8-10
3. Aggarwal N**,** Jindal J and Brar D S. 2012. Bahar rut di makki da jiyada jhar lain layi kide makudiyan di roktham de ahem nukte. *Modern Kheti* 28 (4): 32-33
4. Brar D S, Jindal J and Aggarwal N. 2012. Sauni di makki di fasl te hanikarak kidian di suchaji roktham *Modern Kheti* 28 (2): 32-34
5. Aggarwal N, Kaur R and Sharma S (2013). Experiential learning on mass production of biocontrol agents. pp 40

YSPUHF-Solan

1. Usha Chauhan,Harinder Gautam and YC Gupta.Carnation cultivation and its management under polyhouse conditions 60 pages(in press)
2. Usha Chauhan.Two spotted spider mite and its management 160 pages (In press)
3. Usha Chauhan. Indentification of various insect,mite pests and their natural enemies under polyhouse conditions.60 pages(In press).

CPCRI-Kayangulam

1. Rajan, P., Nair, C.P.R., Josephrajkumar, A. and Chandrika Mohan. (2012). *Nariyal Patha Fring* (*Brontispa longissima*) Hindi translation by Sreelatha, K. and Alka Gupta, *Technical folder*, CPCRI publication

2. Josephrajkumar, A., Chandrika Mohan, Rajan, P., Thomas, R.J., Chandramohanan, R. and Jacob, P.M. (2012) *Pest Management in Coconut Nursery*, CPCRI, Kasaragod, *Technical Bulletin No: 73*, p 16.

v. Technology Assesses and Transferred

AAU-Jorhat

1) Mass production procedure for Trichogrammatids have been demonstrated through training to the unemployed youth to develop entrepreneurship
2) Mass production of entomopathogen *Beauveria bassiana* is collaboration with Mycology section, Department of plant pathology, AAU, Jorhat
3) The Technology of growing mustard as trap crop and three releases of *T. brassicae* and *T. pieridis* @ 1,00,000/ha/week for management of *P. brassicae* and *P. xyllostella* has been assessed and validated in farmers field during 2011-2013
4) Eleven releases of *T. chilonis* could reduce the infestation of *Chilo tumudicostalis* and gave better yield in compared to chemical control. Parasitoid released plots showed high parasitization than chemical control plot. The Technology has been assessed and validated in farmers field during 2010-2013.
5) The Anthocorid bug *Xylocoris flavipes* showed better result than *Blaptostethus pallescens* to protect the stored rice grain from *Corcyra cephalonica* moths.

ANGRAU-Hyderabad

1. Sequential application of bio agents, Bt-Ha NPV-endo-Bt in pigeon pea against *Helicoverpa.*
2. Bio intensive management of pod borer complex through *Ha* NPV-NSKE alternation in pigeon pea.
3. Release technology of *T.chilonis* @ 1,50,000/ha/week through distribution @ 200 strips/ha in cotton.
4. BIPM module consisting of alternate methods for management *Helicoverpa* in cotton ecosystem.
5. Effective *Bt* formulations such Biobit&Dipel for managing DBM in cabbage.
6. Combination of *T.pretiosum*@ 50,000/ha-5 timesand NPV @250 LE/ha –3 times to manage *Helicovera* in tomato.
7. Application of NPV @ 250 LE/ha in pigeon pea – 4 rounds for *H.armigera*.
8. Dipel @ 0.5 kg/ha effective against castor semi looper.
9. Standardization of host distance for better parasitization by *T.chilonis*-1 meter (Optimum) 4 meter (Maximum).
10. *Bt* @ 1 kg/ha is very effective against *Adisuraatkinsoni*on Dolichosbean recording lesser pod damage and good yield.
11. Pigeonpea bordered with two rows of sorghum and intercropped with sunflower(9:1) gave better yields recording lesser population of pests due to higher biological control activity by natural enemy population compared to the sole crop.
12. The Anthocorid bug *Xylocorisflavipes*performed better than *Blaptostethuspallescens*in controlling the moth *Corcyra cephalonica* in stored rice grain. Lesser moths of Corcyra emerged from the bin where the grain was treated with *Xylocorisflavipes.*
13. Weekly sprays of *M.anisopliae* @ $1X10^9$after hopper infestation started in mango was effective in controlling the hopper on the inflorescence.
14. Predatory spiders in rice ecosystem were studied in kharif and rabi seasons. Nine genera of spiders were collected during the *kharif* seasons in Rajendranagar, while five genera

were collected in rabi.Species Diversity (Shannon Weiner Index)(H) was found to be 1.91 in *kharif* and 1.29 in rabi.*Oxyopes* sp. was found to be the most abundant genus followed by *Tetragnatha* sp. in kharif while the reverse was true in rabi.

CTRI-Rajhamundry

25,000 LE of *Sl NPV* was produced and distributed to tobacco farmers for the control of *S.litura*

KAU-Thrissur

1. Recommended *Acerophagus papayae* for the management of papaya mealybug
2. *Trichogramma japonicum* @ 1 lakh/ ha has been recommended for the management of rice leaf folder and stem borer

MPKV-Pune

1. Mass production of MPKV isolate of *Nomuraea rileyi* was undertaken on solid media (jawar + soybean) and demonstrated over 62 ha in soybean and potato fields against *S. litura* on the College research farm, Pune, Agril. School farm, Manjari, Agril. Research Station, Digraj and farmers' fields in Rajgurunagar area. There was 62% infectious condition in soybean and 70% in potato crop in larval population of the pest.

2. Mass production of *Metarhizium anisopliae* was carried out on solid media (rice + soybean) and demonstrated over 47 ha against mango hoppers in Pune region and 60 acres on safflower aphids at Solapur. It was found infectious to safflower aphids, wheat aphids and onion thrips on the College Research farm at Pune with >65% decline in the pests' population. Moreover, *M. anisopliae* was also supplied for the control of white grubs in sugarcane to farmers from Pune, Solapur, Sangli and Kolhapur region.

5. ACRONYMS

AAU-A	Anand Agricultural University, Anand
AAU-J	Assam Agricultural University, Jorhat
ANGRAU	Acharya N. G. Ranga Agricultural University
CPCRI	Central Plantation Crops Research Institute
CAU	Cental Agricultural University, Pasighat
DSR	Directorate of Soybean Research
GBPUAT	Gobind Ballabh Pant University of Agriculture and Technology
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
IIHR	Indian Institute of Horticultural Research
IISR	Indian Institute of Sugarcane Research
JNKVV	Jawaharlal Nehru Krishi Vishwa Vidyalaya
KAU	Kerala Agricultural University
MPKV	Mahatma Phule Krishi Vidyapeeth
MPUAT	Maharana Pratap University of Agriculture & Technology
NBAII	National Bureau of Agriculturally Important Insects
NCIPM	National Centre for Integrated Pests Management
OUAT	Orissa University of Agriculture & Technology
PAU	Punjab Agricultural University
SBI	Sugarcane Breeding Institute
SKUAST	Sher-e-Kashmir University of Agricultural Science & Technology, Srinagar
TNAU	Tamil Nadu Agricultural University
UAS-R	University of Agricultural Sciences Raichur
YSPUHF	Y.S. Parmar University of Horticultural and Forestry