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Proceedings of the XXIV Biocontrol Workers' Group Meeting and Technical Programme for 2015-16

2-3rd June, 2015
Tamil Nadu Agricultural University
Coimbatore

Compiled and Edited by

B. Ramanujam and Abraham Verghese

AICRP on Biological Control of Crop Pests

NATIONAL BUREAU OF AGRICULTURAL INSECT RESOURCES
P. B. No.2491, H. A. Farm Post, Bangalore 560024

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Bangalore
25 June, 2015

Abraham Verghese
Director
National Bureau of Agricultural Insect Resources
Bangalore

ANNUAL GROUP MEET OF ALL INDIA CO-ORDINATED RESEARCH PROJECT ON BIOLOGICAL CONTROL OF CROP PESTS

Venue: **Tamil Nadu Agriculture University, Coimbatore (Tamil Nadu)**
Date **: 2nd - 3rd June, 2015**

PROGRAMME: June 2, 2015 (Tuesday) 9.30 to 11.45 AM

0930-1030	**REGISTRATION**
1030-1130	**INAUGURATION**
Invocation	ICAR Song
Welcome	**Dr. M. Maheswaran** Director of Research, TNAU, Coimbatore
Project Co-ordinator's Report	**Dr. Abraham Verghese** Project Co-ordinator, AICRP-BC and Director, NBAIR, Bangalore
Release of AICRP Publications	**Ten publications (Folders/Pamphlets) from NBAIR & AICRP centres were released as given below** NBAIR: 1. Potential Anthocorid predators 2. NBAIR News Letter (March 2015 issue) AAU-A: 3. Pest management through bioagents (in Gujarati) AAU-J: 4. Use of Trichogramma against rice pests (in Assamese) 5. Organic Cultivation practices for Vegetable crops (in Assamese) KAU: 6. Biological Control in Crops- Farmer's guide (in Malayalam) MPKV: 7 Protection of Predators, Parasitoids & Pollinators (in Marathi & English) PAU: 8. Trichogramma- Mass production and utilization for biosuppression of insect pests (in English & Punjabi) TNAU: 9. Biological Control in Pest management (in Tamil) YSPUHF: 10. Seb ka Jer chedak Keet: Samasya evam Samadhan
Address by Director, CPPS, TNAU	**Dr. K. Ramaraju** Director, Centre for Plant Protection Studies, TNAU
Remarks of Chief Guest: ADG (PP &B)ICAR	**Dr. P. K. Chakrabarty,** ADG (PP & B), ICAR, New Delhi
Presidential Address: VC, TNAU	**Dr. K. Ramasamy**, Vice Chancellor, TNAU, Coimbatore
Vote of thanks	**Dr. B. Ramanujam**, Principal Scientist & I/C PC Cell, AICRP-BC, NBAIR
1130-1145	**TEA**

PRESENTATION OF PROGRESS REPORTS	
June 2, 2015; 1145-1230 hrs	**SESSION I: BASIC RESEARCH ON BIOCONTROL AT NBAIR AND BIOLOGICAL CONTROL OF PLANT DISEASES AT AICRP CENTRES**
Chairman Co-Chairman	Dr. K. Ramaraju, Director, CPPS, TNAU, Coimbatore Dr. Alice, HOD, Plant Pathology, TNAU
Rapporteurs	Dr. T.Venkatesan, NBAIR, Bangalore Dr Jagadeesh Patil, NBAIR, Bangalore
Speakers	
Biodiversity, Biosystematics, Molecular Characterization and Biocontrol potential of newer natural enemies (NBAIR)	Dr. Prashanth Mohnaraj, NBAIR, Bangalore
Biological Control of Plant diseases using antagonists	Dr. A.K. Tiwari, GBPUAT, Pantnagar
June 2, 2015; 1230-1330 hrs	**SESSION II: BIOLOGICAL SUPPRESSION OF PESTS OF SUGARCANE, COTTON, RICE, MAIZE AND SORGHUM**
Chairman Co-Chairman	Dr. C.A. Viraktamath, Chairman, RAC, NBAIR Dr. G. Gajendran, Dean, AC&RI, STAMIN campus, Kudumiyanmalai, TNAU
Rapporteurs	Dr. S. M. Galande, MPKV, Pune Dr. P.S. Shera, PAU, Ludhiana
Speakers	
Sugarcane & Cotton	Dr. K. S. Sangha, PAU, Ludhiana
Rice, Maize & Sorghum	Dr. Madhu Subramanian, KAU, Trissur
1330-1400 hrs	**LUNCH**
June 2, 2015; 1400-1530 hrs	**SESSION III: BIOLOGICAL SUPPRESSION OF PESTS OF PULSES, OILSEEDS AND COCONUT**
Chairman Co-Chairman	Dr. A. Krishnamoorthy, PS, IIHR, Bangalore Dr. S.K. Jalali, HOD, NBAIR, Bangalore
Rapporteurs	Dr. Arun Kumar Hosmani, UAS-Raichur Dr. Madhu Subramanian, KAU, Thrissur
Speakers	
Pulses & Oilseeds	Dr. S. J. Rahman, PJSTAU, Hyderabad
Coconut	Dr. Chandrika Mohan, CPCRI, Kayangulam
1530-1545	**TEA**
June 2, 2015 (Tuesday) 1545-1800 hrs	**SESSION IV: BIOLOGICAL SUPPRESSION OF PESTS OF FRUIT AND VEGETABLE CROPS, POLYHOUSE CROP PESTS, STORAGE PESTS AND WEEDS**
Chairman Co-Chairman	Dr. K. Samiayyan, Dean, AC&RI, Eachankottai, TNAU Dr. Chandish R Ballal, HOD, NBAIR, Bangalore
Rapporteurs	Dr . Dr. Jaydeep Halder, IIVR, Varanasi Dr. M. Visalakshi, ANGRAU, Anakapalle

Speakers	
Tropical and Temperate Fruits, Mealybugs & Tea Mosquito Bug	Dr. Jamal Ahmad, SKUAST, Srinagar
Vegetables	Dr. R. V. Nakat, MPKV, Pune
Polyhouse Crop Pests, Storage pests & Weed Biocontrol	Dr. P. N. Ganga Visalakashi, IIHR, Bangalore
June 3, 2015 (Wednesday) **0915-0945 hrs**	**SESSION V: TRIBAL SUB PLAN PROGRAMME**
Chairman Co-Chairman	Chairman: Dr. Abraham Verghese, Director, NBAIR, Bangalore Co-Chairman: Dr. B. Ramanujam, NBAIR, Bangalore
	Presentation on achievements of Tribal Sub Plan programme of 11 centres of AICRP-BC Dr. Usha Chauhan, YSPUHF, Solan
0945-1130 hrs	**Session VI: INSTITUTE–INDUSTRY PARTNERSHIP**
Chairman Co-Chairmen	Dr. R. J. Rabindra, Former Director NBAII Dr. N. Ragupathi, Director, Student Welfare, TNAU, Coimbatore
Rapporteurs	Dr. N. Bakthavastalam, NBAIR, Bangalore Dr. T. Venkatesan, NBAIR, Bangalore
	Speakers from Private Industry
1130-1145 hrs	**TEA**
1145-1330 hrs	**SESSION VI (Plenary): Presentation of Recommendations and Finalization of Technical Programme for the year 2015-16**
Panel of Experts	Dr. Abraham Verghese, Director, NBAIR, Bangalore Dr. R. J. Rabindra, Former Director, NBAII Dr. Chandish Ballal, HOD, NBAIR Dr. S.K. Jalali, HOD, NBAIR Dr. B. Ramanujam, I/C PC Cell NBAIR, Bangalore
Rapporteurs	Dr. B. Ramanujam, NBAIR, Bangalore
Speakers	Presentations of Recommendations & Plan of Work by Chairmen of different technical sessions. Remarks by Panel of Experts
1330-1400 hrs.	**LUNCH**
1400-1700 hrs	**Continuation of SESSION VI (Plenary): Presentation of Recommendations and Finalization of Technical Programme for the year 2015-16**
Vote of Thanks	Dr. Chandish Ballal, HOD NBAIR, Bangalore

INAUGURAL SESSION

The **XXIV Biocontrol Workers' Group Meeting** was conducted under the aegis of the Indian Council of Agricultural Research, New Delhi at Tamil Nadu Agricultural University, Coimbatore on 2nd and 3rd June, 2015. Delegates and invitees from ICAR Institutes, Agricultural Universities and representatives of private commercial production units attended the Inaugural Session. The programme was as follows:

Welcome Address:	**Dr. M. Maheswaran** Director of Research, TNAU, Coimbatore
Project Co-ordinator's Report:	**Dr. Abraham Verghese** Project Co-ordinator AICRP on Biological Control
Remarks of Chief Guest:	**Dr. P. K. Chakrabarty,** ADG (PP&B), ICAR, New Delhi
Address by Director, CPPS, TNAU:	**Dr. K. Ramaraju** Director, Centre for Plant Protection Studies, TNAU
Presidential Address: VC, TNAU:	**Dr. K. Ramasamy,** Vice Chancellor, TNAU, Coimbatore
Vote of Thanks :	**Dr. B. Ramanujam** AICRP PC Cell I/C, NBAIR, Bangalore

Dr. K. Ramasamy, Vice Chancellor TNAU inaugurated the workshop. In his presidential address, he suggested that the basic research has to be strengthened in all fields of agricultural sciences especially in biological control so that breakthroughs in pest management can be achieved and sustainability in agricultures is maintained. Studies on improving the plant immunity against biotic stresses through biotechnological interventions should be strengthened so that cost of plant protection is minimized. In his address, **Dr. P.K. Chakrabarty,** Assistant Director General (PP&B), ICAR emphasized that more successful biocontrol technologies should be developed so that the area under BIPM can be increased to a greater extent and the harmful effects of chemical pesticides are minimized. ADG stressed the importance of publications of the data generated in AICRPs and bringing out good crop-wise manuals on BIPM/ Biocontrol technologies. He suggested strengthening of biocontrol studies in protected cultivation and also on plant diseases. **Dr. K. Ramaraju** Director, Centre for Plant Protection studies, TNAU gave brief account the work carried out at on biological control at TANU. **Dr. Abraham Verghese**, Director, NBAIR presented a summarized report of 2014-15 and along with **Dr. C.A. Viraktamath** Chairman RAC, NBAIR, reviewed the

progress of research on biological control of insect pests and plant diseases of various crops using parasites, predators, pathogens and antagonists. **Dr. B. Ramanujam**, AICRP PC Cell I/C reviewed the progress of Tribal Sub Plan programme in ten centers. Dr. R. J. Rabindra, former Director, Dr. M. Maheswaran, Director of Research, Dr. G. Gajendran, Dean, TNAU, Dr. Samiayyan, Dean, TNAU, Dr. N. Raghupathi, Director, TNAU and nearly 80 scientists of AICRP on Biocontrol and NBAIR and representatives from Biocontrol Industry participated in the workshop. The recommendations and the technical Programme for 2015-16 were finalized on the occasion.

SALIENT FINDINGS DURING 2014-15

Abraham Verghese
Director, NBAIR, Bangalore

1. Introduction

The technical programme for the year 2014-15 was formulated during the workshop of the XXIII Biocontrol Workers's Group Meeting on 27-28 June, 2014 at OUAT, Bhubaneswar and was implemented by the twenty five centers of AICRP (14 SAUs and 11 ICAR Institutes), completing most of the mandated experiments on several field and horticultural crops. A large number of experiments and demonstrations were conducted in different centers across the country during 2014-15 and the results of these experiments as well as demonstrations are presented in this document.

1. Mandate of AICRP on Biological control of crop pests

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

- Demonstration of usefulness of biocontrol in IPM in farmers' fields.

2. Objectives

i. Development of effective biocontrol agents for use in biological suppression of crop pests and diseases.
ii. Evaluation of various methods of biological control in multi-location field trials.
iii. Development of biointensive integrated pest management strategies for cotton, rice, sugarcane, pulses, oilseeds, potato, coconut and a few selected fruits and vegetable crops.
iv. Demonstration of biocontrol agents and biopesticides as a component of IPM in farmers' fields

3. Setup

With a view to fulfil the mandate effectively and efficiently, the Bureau is functioning in close coordination with the following State Agricultural Universities and ICAR Institutes.

State Agricultural University–based centers

1.	Anand Agricultural University	Anand
2.	Assam Agricultural University	Jorhat
3.	Dr. Y.S. Parmar University of Horticulture and Forestry	Solan
4.	Gobind Ballabh Pant University of Agriculture and Technology	Pantnagar
5.	Kerala Agricultural University	Thrissur
6.	Mahatma Phule Krishi Vidyapeeth	Pune
7.	Pandit Jayashankar Telangana State Agricultural University	Hyderabad

8.	Punjab Agricultural University	Ludhiana
9.	Sher-e-Kashmir University of Agricultural Science & Technology	Srinagar
10.	Tamil Nadu Agricultural University	Coimbatore
11.	Central Agricultural University	Pasighat
12.	Maharana Pratap University of Agriculture & Technology	Udaipur
13.	Orissa University of Agriculture & Technology	Bhubaneshwar
14.	University of Agricultural science (Raichur)	Raichur

ICAR Institute–based centres

1.	Central Institute of Subtropical Horticulture	Lucknow
2.	Central Plantation Crops Research Institute	Kayangulam
3.	Central Tobacco Research Institute	Rajahmundry
4.	Indian Institute of Rice Research	Hyderabad
5.	Directorate of Seed Research	Mau
6.	Indian Institute of Millet Research	Hyderabad
7.	Directorate of Soybean Research	Indore
8.	Directorate of Weed Science Research	Jabalpur
9.	Indian Agricultural Research Institute	New Delhi
10.	Indian Institute of Horticultural Research	Bangalore
11.	Indian Institute of Sugarcane Research	Lucknow
12.	Indian Institute of Vegetable research	Varanasi
13.	National Centre for Integrated Pest Management	New Delhi

4.0 Executive Summary

4.1 Basic Research at NBAIR

The National Bureau of Agricultural Insect Resources (NBAIR) backs up the AICRP (BC) with basic and applied research. In addition, NBAIR has been strongly supporting identification and supply of nucleus cultures of bioagents. It also functions as the repository of all insect fauna collected under biodiversity programmes.

1.Taxonomic studies on parasites & predators of insect pests

2. Biodiversity of economically important Indian Microgastrinae (Braconidae)

3. Biodiversity of oophagous parasitoids with special reference to Scelionidae (Hymenoptera)

4. Biosystematics of Trichogrammatoidea (Hymenoptera)

5. Biodiversity of aphids, coccids and their natural enemies

6. Molecular characterization and DNA barcoding of agriculturally important parasitoids and predators

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

8. Introduction and studies on natural enemies of some new exotic insect pests and weeds

9. Biosystematics and diversity of entomopathogenic nematodes in India.

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

11. Exploitation of *Beauveria bassiana* for management of stem borer (*Chilo partellus*) in maize and sorghum through endophytic establishment

4.2 Biological suppression of crop pests and diseases

The co-coordinating centers of the AICRP on Biological Control of Crop Pests validate the various techniques for the bio-intensive management of pests and diseases of sugarcane, cotton, rice, maize, sorghum, pulses, oilseeds, coconut, fruit and vegetable crops, polyhouse crops, mealy bugs, storage pests and weeds.

5. Profile of experiments and demonstrations carried out during 2014-15

Crop/Insect	Experiments	Large Scale Demonstrations
Biodiversity of biocontrol agents	2	0
Antagonists of crop disease management	4	2
Sugarcane	1	4
Cotton	3	0
Rice	2	4
Maize	1	1
Sorghum	1	0
Pulses	2	0
Oilseeds	7	0
Coconut	4	1
Tropical Fruits	8	0
Temperate Fruits	4	0
Vegetables	18	1
Tea mosquito bug	1	0
Mealybugs	1	0
Polyhouse crops	9	0
Storage pests	1	0
Weeds	1	0
TSP	-	10
Total	**70**	**23**

6. Publications: During the year 2014-15, a total of 247 Research papers/symposium papers/reviews/technical bulletins, etc. were published by the different centres as given below.

Centre	Journal Papers	Papers in Symposia/Seminars	Tech. Bulletins/ Popular articles/ Book chapters	Total
NBAIR, Bangalore	62	36	22	120
AAU, Anand	2	2	1	5
AAU, Jorhat	-	2	10	12
GBPUAT, Pantnagar	4	-	-	4
KAU, Thrissur	-	1	-	1
MPKV, Pune	7		10	17
PAU, Ludhiana	10	9	9	28
SKUAST, Srinagar	-	-	10	10
TNAU, Coimbatore	4	13	-	17
YSPUHF, Solan	5	5	-	10
MPUAT, Udaipur	3	1	-	4
CISH, Lucknow	-	3	-	3
CPCRI, Kayankulam	2	10	-	12
IIHR	-	5	-	5
IIVR	1	-	-	1
Total	**100**	**87**	**62**	**249**

1. BASIC RESEARCH AT NBAIR, BAGALORE

Taxonomic studies on parasites and predators of insect pests

Surveys for trichogrammatids were conducted in North-east and south India. Over 900 specimens were collected and of these, *Prestwichia, Burksiella, Paracentrobia, Aphelinoidea* and *Tumidiclava* are new genera being recorded from the Andaman Islands. *Trichogramma flandersi, T. achaea, T. manii, Trichogrammatoidea cryptophlebiae* and *T. nana* were collected and recorded for the first time from the Andaman islands. *Oligosita giraulti*, a South American species was collected for the first time from India which extends its range to South and Southeast Asia. *Mymaromma ignatii*, a new species of *Mymarommatoidea* was described the first time from India.

Among natural enemies of aphids and coccids, twelve species of coccinellids and two species of braconids, one species each of Aphelinidae and Pteromalidae were recorded during the survey. Four new host associations of coccinellid predators were reported through this study.

Anthocorid predator *Amphiareus constrictus* was evaluated against BPH in paddy. After five releases, the adult and nymphal counts in treatment cages were 1.8 and 1.4, respectively, while in control, the corresponding values were 6.3 and 3.3, respectively.

Studies on parasitoids of litchi stink bug *Tessaratoma javanica* Thunberg

Eggs of Eri silkworm (ESW) stored in the deep freeze for 2 to 6 days are suitable for rearing *Anastatus acherontiae* Narayanan *et al.* and *A. bangaloriensis* Mani and Kurian. Percent parasitism values recorded was 41.4 to 63.3% in the case of the former and 39.3 to 55% parasitism in the case of the latter. ESW eggs parasitized by *A. acherontiae* were stored for 7, 15 and 21 days and the per cent adult emergence recorded were 85.7, 72.5 and 63.8, respectively.

Optimising mass rearing of *Trichogramma chilonis*

Large cages (3ftx 2ft) can be used for large scale production of Trichocards. Thirty to forty cards can be exposed to adult Trichogrammatids (emerging from three mother cards) in large cages and parasitism ranging from 79 to 81% could be recorded.

Monitoring of invasive pests

Based on the survey conducted in different parts of the state and also the feedback from various AICRP (BC) centers revealed that the papaya mealybug, *Paracoccus marginatus* did not reach pest status in any of the commonly occurring crops like papaya, mulberry and butter fruit (Avocado) in Karnataka, Kerala, Andhra Pradesh, Maharashtra and Tamil Nadu. PMB was reported from New Delhi (in polyhouse) and Gujarat but not in severe form. *A. papayae* was supplied to these areas and very good parasitization was observed in the new localities. Incidence of PMB very low level (< 5%) was recorded on tapioca in Salem and Dharmapuri areas of Tamil Nadu.

- *Tuta absoluta* , a new invasive pest on tomato was recorded in Karnataka, Tamilnadu, Gujarat and Maharastra. Zoophytophagus plant bug *Nesidiocoris sp*. (Miridae) recorded associated with the pest.
- Western flower thrips *Frankliniella occidentalis* (Pergande) reported from Bangalore.
- Banana skipper *Erionota thrax* (Hespiridae: lepidoptera) has become severe in Kerala, Karnataka, Mizoram, Assam and other states.
- *Pseudococcus jackbeardsley* recorded on cocoa in Dakshina Kannada district of Karanataka.
- *Phenacoccus madeirensis* recorded on cashew in Malur area in Karnataka
- Root mealybugs, *Formicococcus polysperes* Williams was observed on pepper

Biosystematics and diversity of entomogenous nematodes in India

An insect associated nematode, *Oscheius* sp. isolated from Utthanapalli village of Tamil Nadu showed 80% of pupal mortality of cucumber fruit fly *Bactrocera cucurbitae* at 48h after treatment with a dose of 200 IJs/pupa.

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

A total of 80 isolates of *Bacillus thuringiensis* were purified from soil and insect cadaver samples of Almora region. Forty of these isolates were screened for cry gene diversity using degenerate primers. All of them harboured *cry*1 and *cry*2 genes.

The vip3a gene was amplified using by PCR and the 2.3Kb product was sequenced and confirmed. PCR amplicon (~2.3Kb) was successfully cloned into a cloning vector (pUC29) at NdeI and XhoI restriction sites. Sub-Cloning of Sequence Confirmed vip3a gene in pET21a was confirmed by PCR amplification.

Screening of *Beauveria bassiana* isolates against maize stem borer, *Chilo partellus* (Laboratory Bioassay)

Among the 87 isolates tested, five isolates (Bb-7, 14, 19, 23 and 45) showed significantly higher mortality (86.4.-100%). Among these five isolates significantly higher mycosis (84.4-97.8%) was shown byBb-14, 23& 45. Dose and time mortality studies indicated the lowest LC_{50} (5.02 $x10^4$ conidia ml^{-1}) and LT_{50} (136.25 hr) values with Bb-45 isolate.

Establishment of *Beauveria bassiana* as endophyte in maize

In a field trial with three isolates of *B. bassiana* (Bb-14, 23 & 45) foliar application ($1x10^8$spores/ml)/ at 30 days of crop age showed that Bb-14 and Bb-45 colonized stem and leaf tissues for a period of 15days after treatment. In crown application method, Bb-23 and Bb-45 isolates colonized in leaf tissues for a period of 15days after treatment.

2. BIOLOGICAL CONTROL OF PLANT DISEASES USING ANTAGONISTS

a. Biological control of diseases of rice, wheat and chickpea

GBPUAT: In rice among 21 *Trichoderma* isolates tested, TCMS 43, TCMS 9, TCMS 36 and Th-14 were found effective in improving plant health, reducing sheath blight and brown spot diseases and in increasing yield. In wheat, TCMS 16 and TCMS 65 in combination with chitosan (500ppm) and cow urine (10%) reduced yellow and brown rust. In chickpea Th-75, Th-3 and TRPCh-4 were found very promising in reducing seed as well plant mortality in the field.

b. Management of bacterial wilt of brinjal with *Pseudomonas fluorescens* (CH*Pf*-1)

CAU: In the susceptible variety Anamika (brinjal), the lowest incidence of bacterial wilt of 16% was recorded in the plot treated with seedling root dip + soil drenching with CHF*Pf*-1 and it was on par with soil drenching with CHF*Pf*-1 (20% wilted plants). Soil drenching with CHF*Pf-1*was comparable with soil drenching with streptomycin (19.66% wilted plants), The highest average plant height (68.00cm), highest average number of fruits per plant (9.20 fruits) and average fruit weight (113.46g/fruit) was recorded in seedling root dip + soil drenching with CHF*Pf*-1. The highest yield was recorded in the treatment with seedling root dip + soil drenching with CHF*Pf*-1 (242.60q/ha) and it was comparable with soil drenching with CHF*Pf*-1 (221.80q/ha).

C. Biological control of chilli anthracnose disease

AAU-Anand: *Pichia guilliermondii* (Y12) seed treatment, seedling dip and foliar spray ($2x10^8$cfu ml-1) reduced 72.78% of the disease. Significantly higher green chilli fruit yield was recorded with recommended fungicide (105 q/ha). The other best treatment with respect of yield was *P. guilliermondii* (Y12) with an yield of 95.00 q/ha.
PAU: Lowest per cent fruit rot of 6.78% was recorded in chemical control and was at par with *Trichoderma harzanium* treatment with 9.3% fruit rot as against 19.87% of fruit rot in untreated control. Highest yield of 72.25 q/acre was recorded in chemical treatment followed by *T. harzanium* treatment with an yield of 71.5 q/acre as against the yield of 67.45 q/acre in untreated control.

3. BIOLOGICAL SUPPRESSION OF PESTS OF SUGARCANE, COTTON, RICE MAIZE & SORGHUM

Sugarcane

a. Monitoring of sugarcane woolly aphid and its natural enemies: Monitoring of sugarcane woolly aphid (SWA) incidence and impact assessment of natural enemies on its biosuppression was carried out in Maharashtra. The average pest incidence and intensity were 1.27 per cent and 1.35, respectively. The natural enemies recorded in the SWA infested fields were mainly predators like *Dipha aphidivora* (0.8-2.7 larvae/leaf), *Micromus igorotus* (1.1-5.8 grubs/leaf), syrphid, *Eupeodes confrator* (0.4-0.8 larvae/leaf) and spider (0.1-0.3 /leaf) during

July to March, 2015. The parasitoid, *Encarsia. flavoscutellum* was distributed and established well in sugarcane fields and suppressed the SWA incidence in Solapur, Pune and Satara districts. The SWA was noted in patches in Tamil Nadu and the occurrence of *D. aphidivora. M. igorotus* and *E. flavoscutellum* were also observed along with the population of SWA. In Andhra Pradesh, sporadic incidence was noticed in Chittoor and adjoining areas of southern Andhra Pradesh.

B. Large-scale demonstration of biocontrol technologies in Sugarcane

PAU: Large scale demonstration of effectiveness of temperature tolerant strain of *Trichogramma chilonis* (tts) @ 50,000 per ha at 10 days interval (eight releases) against early shoot borer (*Chilo infuscatellus)* over an area of 1000 acres at farmers' fields was conducted in collaboration with two sugar mills. Bioagent treated plots showed 54.1 per cent of reduction of pest damage. Release of *T. chilonis* @ 50,000 per ha at 10 days interval during July to October, 2014 (twelve releases) over an area of 3800 acres at farmers' fields in collaboration with two sugar mills reduced the incidence of stalk borer, *Chilo auricilius* by 55.2 per cent. Large scale demonstration of effectiveness of *T. japonicum* @ 50,000 per ha at 10 days interval during mid-April to June end, 2014 (eight releases) against top borer, *Scirpophaga excerptalis* over an area of 900 acres in collaboration with two sugar mills indicated 53.2 per cent reduction of top borer.

OUAT: Large-scale Demonstration on the use of *T.chilonis* against early shoot borer and internode borer of sugarcane in farmers' fields covering 100 acres in Korada village of Angul district of Orissa showed lesser incidence of early shoot borer (ESB) ranged from 6.7 to 9.3% compared to 29.4 to 39.1% in the fields where no parasitoids were. Similarly, internode borer incidence was also least in parasitoid released plots (13.8% and 16.3%) as compared to 24.45% and 30.3% in farmers practice. The yield was higher (149.8/ha to 159.4t/ha) in parasitoid released plots, whereas, it was 111.5 t/ha to 115.8 t/ha in farmers practice.

Cotton

a. Monitoring of mealybugs and other sucking pests in *Bt* cotton

MPKV: The recording of mealybug incidence was carried out in cotton from 1st fortnight of August 2014 till January, 2015 in the experimental plot. However, the mealybug was not observed on cotton till January, 2015. The natural enemies generally present in cotton ecosystem were predatory coccinellids, *Coccinella, Menochilus* and *Scymnus*, chrysalides, *Brumoides* and spiders. Very less infestation of mealybug was noticed in the months of November, December, 2014 in the farmers fields during November-December 2014. The parasitism of *Aenasius bambawalei* was found on cotton, parthenium, marigold and *Hibiscus*. The cotton mealybug on *Hibiscus* was effectively controlled by *A. bambawalei.*

PAU: Regular surveys of mealy bugs and its natural enemies from different hosts during June to September 2014 revealed only one mealybug species, *Phenacoccus solenopsis* on cotton. There was no major outbreak of pests on cotton. However, coccinellid predators such as *C. sexmaculata, C. septempunctata* and *B. suturalis* and green lace wing, *Chrysoperla zastrowi sillemi* were noticed at the rate of 0.2 to 3.4 predators per plant. The parasitization by parasitoids under field conditions varied from 42-73 per cent, out of which endoparasitoid

Aenasius bambawalei (75.7%) was predominant. The per cent emergence of *Aenasius* females (61.7 %) was more as compared to males (38.3 %) and ratio of male to female was 1: 1.61. Among sucking insect pests, leafhopper, *Amrasca biguttula biguttula* and whitefly *Bemisia tabaci* were key pests on *Bt* cotton hybrid (Ankur 3028 BG II) and remained active through the cropping season in Ludhiana. The population of leafhopper, whitefly, thrips and aphid varied from 0.0 to 9.2, 0.2 to 55.6, 0.0 to 33.0 and 0.0 to 0.4 per three leaves, respectively. Among predators population of coccinellids, *Chrysoperla* and spiders varied from 0.0 to 9.5, 0.0 to 2.5 and 0.0 to 4.0 per 10 plants, respectively. The seasonal incidence of sucking pests was also recorded at the PAU Regional Station, Bathinda on *Bt* cotton hybrid (RCH 134 Bt). The population of leaf hopper, whitefly and thrips varied from 0.00 to 14.8, 0.00 to 98.0 and 0.0 to 15.2 per 3 leaves, respectively. The population of coccinellids, *Chrysoperla* and spiders varied from 0.0 to 2.0, 0.0 to 0.5 and 0.0 to 2.5 per 10 plants, respectively.

PJTSAU: Largely, three genera of mealy bugs, *viz*., cotton mealy bug, papaya mealy bug and grape mealy bug were noticed in *Bt* cotton. Among them, cotton mealy bug, *Phenacoccus solenopsis* was found to be predominant with nearly 85.33 per cent incidence.

TNAU: Survey conducted in Coimbatore, Erode and Tiruppur districts of Tamil Nadu on cotton host plants indicated the incidence of five species of mealybugs and *Paracoccus* was predominant.

UAS-R: To monitor the activity of cotton mealybug, cotton hybrid, RCH-668 BG-II was grown in an area of 500 sqmt under unprotected situation. The results indicated that the activity of mealybug appeared during second fortnight of August and continued till the harvest of the crop. The peak activity was noticed during January with average population of 191.69 crawlers per 10 cm shoot length. The peak activity of coccinellids (0.31/plant) was noticed during December while the spiders and chrysoperla activity was high during September. The predominant parasitoid associated with mealybug was *Aenasius bambawalei* (12.30%) followed by *Anagyrus dactylopii* (3.01%), *Promuscidea unfasciativentris* (2.66%), *Hamalotylus eytelweinii* (2.43%) and *Prochiloneurus pulchellus* (1.68%).

b. Bioefficacy of microbial insecticides against sucking pests in *Bt* cotton

AAU Anand: Significantly minimum number of jassids (1.24 /leaf), whiteflies (1.04 /leaf), aphids (2.49 /leaf) and thrips (0.71 /leaf) were registered in insecticide treated plots. However *Beauveria bassiana* or *Lecanicillium lecanii* @ 40 g/ 10 liter also proved better by recording lower number of the pests. Similarly, the highest seed cotton yield was noted in plot treated with chemical insecticide and it was at par with *B. bassiana* or *L. lecanii* treated plots.

Rice

a. Seasonal abundance of predatory spiders in rice ecosystem

PAU: Regular surveys were conducted to collect spiders from rice growing areas (Ludhiana, Patiala, Bathinda, Fatehgarh Sahib) of Punjab. The population of spiders was quite high (0.1 to 2.0 spiders/plant) during the season with maximum population (2.0 spiders/plant) during

38th SMW (3rd week of September). Eight species in the areas of Ludhiana and six species of spiders in the areas of Nabha were noticed.

b. Large scale adoption of proven biocontrol technologies in rice

AAU-J: Large scale demonstration of bio control based IPM package in rice was carried out in the farmer's field at village Borholla in Jorhat district on variety 'Ranjit' covering an area of 30 ha. There was no significant difference in population of *Nephotettx sp*/hill in BIPM and farmers practice. The incidence of dead hearts (3.41%) and damaged leaves due to *Cnaphalocrocis* sp. (3.85 %) was significantly high in farmers' practice plots whereas they were 2.60 and 2.57% in BIPM after 65 DAT, respectively. In case of white ear heads, the per cent incidence was 2.77 in BIPM plots which was significantly superior to farmers' practice plots (3.76) at 125 DAT. Maximum yields of 4126.0 Kg / ha was registered in IPM package which was at par with farmers practice. The yield of farmers' practice plots was 3984.4 Kg/ha. The population of natural enemies like spiders and coccinellids were significantly high in BIPM when compared to farmers' practice. It can be concluded that BIPM package proved as effective as farmers' practice on large scale for the management of important key pests of rice. The cost benefit analysis showed net return of Rs. 36709 /ha in BIPM package as compared to Rs. 29250/ha in farmers' practice.

KAU: The incidence of pests was below ETL in BIPM plots. Natural enemies were found high in BIPM plots. There was no significant difference in grain weight in BIPM and conventional farming. Presently, BIPM is practiced in paddy in all the districts of Kerala.

PAU: Large scale demonstration of biocontrol based IPM (six releases of *T. chilonis* and *T. japonicum* each @ 1, 00,000/ha in four locations in the village Saholi (Patiala) in organic *basmati* rice (var. Pusa 1121) over an area of 50 acres resulted in lower incidence of rice insect pests. The net returns in biocontrol package were Rs 14652 as compared to Rs. 8379 in farmers' practice with cost benefit ratio of 1:3.88 and 1:2.76 respectively.

OUAT: Demonstration in 100 acres of Angul district of Orissa showed IPM practice was superior to the farmers' practice in all locations. Dead heart and white were recorded as 5.2 and 8.2% in IPM package, while in farmers' practice the corresponding figures were 9.3 and 13.6% respectively. Leaf folder, case worm and skipper population in IPM plots were 4.8, 3.2 and 1.8 % respectively whereas, in the non-IPM plots they were 8.1, 6.3 and 3.9 %. The GLH population in IPM fields was 5.1/hill as against 9.3/hill in non IPM fields. It was observed that the beneficial fauna like spiders and ladybird beetles were more in number in IPM plots which were 7.1/hill and 4.9/hill respectively, whereas the corresponding population in non IPM plots was 1.9 and 1.1/hill respectively. Yields obtained in IPM plots were significantly higher than the non IPM plots.

GBUAT: During kharif season 2014, large scale field demonstrations of biocontrol technologies were conducted in 42 farmer's fields covering an area of 36.8 hectares in different villages of Nainital district. The Pant bioagent-3 was applied as soil application with FYM/ vermicompost (5-10 t/ha colonized with PBAT-3), as seed treatment (10 g/kg seed), seedling dip treatment (10 g/lit. water) and need-based foliar sprays of PBAT-3 (10g/lit.

water) were given. By adopting bio-control technologies, an average yield of 43.0 q/ha was obtained as compared to conventional farmer's practices (36.0 q/h).

Maize

a. Large scale adoption of proven biocontrol technologies in maize

PAU: The demonstrations on the biological control of maize stem borer, C*hilo partellus* were conducted at farmer's fields on an area of 202 acres in Hoshiarpur and Ropar districts of Punjab. Dead heart incidence of 6.2 % was observed in fields where *T. chilonis* was released and was on par with chemical control (4.7 %) as against 14.8% incidence in untreated control. The yields recorded in the bioagent treated plots and in the chemical treated plots were on par (47.89 & 50.10 q/ha respectively) as compared to the yield of 41.17 q/ha in untreated control. The net returns in biocontrol package was Rs. 8630.20/- as compared to Rs.10978.30/- in farmers' practice with cost benefit ratio of 1: 47.91 and 1: 15.25 respectively.

Sorghum

a. Evaluation of fungal pathogens against sorghum stem borer

IIMR: The application of *Metarhizium anisopliae* (NBAIR-Ma 36 & Ma 35) formulations caused significantly low dead hearts (9.1, 9.3 %), low stem tunnelling (3.5 and 3.3 %); less exit holes/ stalk (1.5, 1.4 nos/ stalk) and realized significantly higher grain yield (5.54 and 5.48 kg/ plot) over the control. However, application of Carbofuran 3G was the superior treatments in terms of damage reduction and yield increase**.**

4. BIOLOGICAL SUPPRESSION OF PESTS OF PULSES, OILSEEDS AND COCONUT

Pulses

a Evaluation of *Bt* formulations against pulse borer (*Helicoverpa armigera*) and legume pod borer (*Maruca testulalis*)

MPKV: Pooled analysis of three years data revealed 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. 0.8 larvae/plant) and *M. vitrata* (av. 2.1 larvae/25 inflorescence) on pigeon pea and recorded minimum pod damage (9.0%) and seed damage (6.4 %) with an yield of 16.4 q/ha. It was however, at par with the *Bt* strain NBAII-BTG4 @ 2% in respect of pod damage (9.8%) and yield (15.0 q/ha). The *Bt* strain NBAII-BTG4 @ 2% ranked next best to the insecticidal spray in recording surviving larval population of *H. armigera* (av. 1.9 larvae/plant) and *M. vitrata* (4.6 larvae/25 inflorescence).

UAS-R: Three years of experimentation on efficacy of *Bt* formulations showed that NBAII BTG 4 *Bt* @2g/lit was effective in reducing pod borer population with higher grain yield in pigeon pea ecosystem. Large scale demonstration of NBAII BTG 4 *Bt* was done in a Kallur of Raichur taluka over an area of 5 ha. Minimum per cent pod damage of 9.46 was observed in farmers practice which was statistically superior compared to NBAII BTG 4 *Bt* (13.46%). Similarly lowest grain damage (1.44%) was noticed in farmers practice compared to NBAII

BTG 4 *Bt* (2.19%). Higher grain yield of 14.98 q/ha was noticed in farmers practice compared to NBAII BTG 4 *Bt* which recorded 12.14q/ha grain yield.

PJSTAU: Evaluation against pulse pod borers showed that NBAII-BTG 4 (2%) maintained its supremacy in *Helicoverpa* management by recording the least no. of larvae (0.4 to 0.9/plant) followed by *Beauveria bassiana* (0.8 to 1.1/plant /plant) and are comparable with insecticidal check (0.4 to 1.3/plant). Least pod damage was also noticed in NBAII-BTG4 (2%) followed by *B. bassiana* confirming their supremacy in *Helicoverpa* management in pigeon pea

PAU: PDBC-BT1 (2%) and Delfin (1 or 2 kh/ha) treatments gave the lowest pod damage in moong bean and at par with each other, followed by chlorpyriphos 20 EC @1.5 l/acre.

Oilseeds

a. Biological suppression of safflower aphid

MPKV: Pooled analysis of three years data revealed that three sprays of dimethoate @ 0.05 % at fortnightly interval found significantly superior over other treatments in suppressing the aphid population (4.54 aphids/5 cm apical twig) on non-spiny variety of safflower and increased the yield (11.21 q/ha). However, similar sprays of *M. anisopliae* @ 10^{13} conidia/ha given at fortnightly interval was found to be the next best treatment in reducing the aphid population (7.45 aphids/5 cm apical twig and 10.79 q/ha).

PJSTAU: Among the botanicals and biopesticides tested, *Lecanicillium lecanii* recorded significantly lesser populations of aphids (4.89 aphids) followed by neem oil (7.01) on top five cm of shoot of five randomly selected plants per plot.

b. Management of white grubs in groundnut

NCIPM: Thirteen different IPM treatments were carried out in groundnut field for the management of whitegrub (*Holotrichia consanguinea*) in one acre area of the sandy loam soil at village Phogat, Bhiwani, Haryana. Lowest root grub infestation (18%) was recorded in FYM+ *M. anisopliae* 500 ml/50 kg as against 35% infestation in untreated control. Higher yield of (22.90 kg/100 sqm) was found in the treatment with *Rhizobium* + FYM+ *M. anisopliae* 500 ml/50 kg.

c. Evaluation of entomopathogens and botanicals against soybean pest complex

MPKV: Pooled analysis of three years data revealed that three sprays of *Sl*NPV @ 250 LE/ha (1.5×10^{12} POBs/ ha) was significantly superior in suppressing the larval population of *S. litura* (2.0 larvae/m row) with 77.5 per cent mortality due to virus infection and gave maximum of 22 q/ha yield of soybean. It was, however, at par with *N. rileyi* strains of MPKV as well as NBAIR. The MPKV strain of *N. rileyi* showed 2.5 surviving larval population of *S. litura* per m row with 63.8 per cent mortality and 19.9 q/ha yield.

d. **Validation of IPM module in soybean**

MPUAT: Soil application of *Metarhizium anisopliae* and two sprays of NSKE 5% were found significantly effective in controlling major pests of soybean (green semi looper and sucking pests) and produced higher grain yield of 16.05 q/ha against 8.75 q/ha in the farmers practice.

e. Biological suppression of mustard aphid, *Lipaphis erysimi*

MPKV: Three sprays of dimethoate @ 0.5 % at fortnightly interval found significantly superior over rest of the treatments in suppressing the mustard aphid population (4.4 aphids/5 cm apical twig) and increased the yield (7.4 q/ha). However, it was at par with combination treatment of *Lecanicillium lecanii* @ 10^8 conidia/ml + *Metarhizium anisopliae* @ 10^8 conidia/ml in reducing the mustard aphid population (6.0 aphids/5 cm apical twig) and increase in seed yield of mustard (7.2 q/ha).

Coconut

a. Demonstration on Integrated management of *Opisina arenosella* in Kerala and Karnataka

CPCRI: An outbreak of *O arenosella* was noticed in Trivandrum during April 2014. Monthly releases of larval parasitoids viz., *Goniozus nephantidis* and *Bracon brevicornis* were undertaken and the plot was monitored. 49.3% reduction of the pest population was noticed. Demonstration of IPM of *O arenosella* initiated in December 2013 at Jajuru village, Arasikere (Tq.), Hassan (Dist.) in Karnataka was monitored during 2014-15 and stage specific parasitoids *viz.*, *Goniozus nephantidis* and *Bracon brevicornis* @ 20 parasitoids/ palm were released subsequently. Significant recovery of the palms was noticed in the demonstration plot. There was no fresh feeding damage by the pest and this forms a model plot for nearby farmers to emulate the IPM strategies in the management of *O. arenosella*

5. BIOLOGICAL SUPPRESSION OF PESTS OF FRUIT AND VEGETABLE CROPS, POLYHOUSE CROP PESTS AND STORAGE PESTS

Tropical Fruits:

a. Field evaluation of *Metarhizium anisopliae* formulations against mango hoppers *Idioscopus niveosparsus*

KAU: Field evaluation of *Metarhizium anisopliae* formulations against mango hoppers *Idioscopus niveosparsus* showed significant reduction in hopper population in Imidacloprid and Nimbicidine treated plots (94.4 & 91.1% reduction) and were on par. Oil and talc formulations of *M. anisopliae* showed 57.4 & 47.4% reduction of hopper population.

MPKV: The pooled data of three years indicated that the spraying of *M. anisopliae* @ 1 x 10^9 spores/ml during offseason in the month of December followed by four sprays of the

entomofungal 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 11.0 hoppers and 11.8 fruit sets per inflorescence in this treatment as against 54.4 hoppers and 6.0 fruits set per inflorescence in untreated control.

TNAU: Maximum fruit set of 2.7 / inflorescence was recorded in liquid formulation of *M. anisopliae* treatment whereas the least fruit set of 1.1 / inflorescence was noted in untreated check. Though superior performance of imidacloprid in checking the hopper population was noted, the fruit set (2.5 /inflorescence) was comparable with *M. anisopliae* liquid formulation. The *M. anisopliae* spray recorded a fruit set ranging from 2.1 to 2.7 fruits / inflorescence. The order of efficacy among the different formulations of *M. anisopliae* in checking the hopper population was liquid formulations > talc formulation > oil formulation.

b. Field evaluation of entomopathogenic fungi against banana pseudo stem borer *Odoiporus longicollis*

KAU: Leaf axil filling of *M. anisopliae* (10^8 spores/ml) was next best treatment to the chemical control with 12.5% pest incidence as against 65.5% pest incidence in untreated control plot.

c. Field evaluation of entomopathogenic fungi against pineapple mealybug, *Dysmicoccus brevipes*

KAU: Spraying of *Lecanicillium lecanii* (10^7,10^8 and 10^9 spores/ml) gave 65.7-76.03% reduction of pineapple mealbug population and was found to be the next best treatment to the chemical control of imidacloprid (0.3/l).

d. Bioefficacy of EPNs against citrus trunk borer, *Pseudonemophas versteegi*

CAU: Bio-efficacy of EPNs against citrus trunk borer, *Pseudonemophas versteegi* were carried out at two locations *viz.* Pasighat and Rengging of Arunachal Pradesh. In both the locations, all the treatments recorded a significant reduction in the trunk borer infestation than the untreated control. Among the EPN treatments, CAU-1 stem injection (40.5 % reduction) was observed as the best treatment and it was closely followed by CAUH-1 stem injection (36.50% reduction). However, at Rengging, CAUH-1 stem injection gave the highest reduction in trunk borer infestation (36.64%) and it was closely followed by CAU-1 stem injection (36.0% reduction). The stem injections of the EPNs were found more effective than their respective cadaver treatments.

NBAIR: At Kolazib, Mizoram, a demonstration of organic sealer cum healer for the management of citrus borer was done and found to be effective against the pest.

Temperate Fruits:

a. Evaluations of entomopathogenic fungi and EPNs for the suppression of apple root borer, *Dorysthenes hugelii*

YSPUHF: Among different biopesticides tested, *Metarhizium anisopliae* (10^6 conidia/cm^2) was the most effective with 77.1% mortality of grubs and was on par with chlorpyriphos, 0.06% which resulted in 82.9 per cent mortality of the grubs

Vegetables

a. Field demonstration of BIPM package for the management of key pests of tomato

TNAU: The population of sucking pests like thrips (2-4 per plant) and whiteflies (1-3 per plant) were low in BIPM plots as compared to farmer's practice which had a thrips population of 7-11 per plant and whitefly population of 4-6 per plant. The fruit damage of *H. armigera* was higher in plots of farmer's practice (10-13%) as compared to 4-6 per cent in BIPM plots. Untreated plots recorded maximum pest populations. The occurrence of predators like green lace wings and coccinellids were higher in plots which received the BIPM package and lower in plots of farmer's practice. The total fruit yield was 32.6 t/ha in BIPM as against 28.3 t/ha in farmer's practice. The untreated plot showed a fruit yield of 25.6 t/ha. The cost benefit ratio in BIPM plot was 1:3 whereas farmer's practice with insecticide sprays showed 1:2.6.

b. Validation of *Ha N*PV in tomato against *H. armigera* at farmers field

MPUAT: Fruit damage was significantly low in BIPM module (12.5%) comprising of five weekly releases of *T. Chilonis* @ 1 lakh/ha followed with 2 sprays of *Ha* NPV as against 18.2% fruit damage observed in Farmer practices with three applications of insecticides. The yield observed in BIPM module was higher (240 q/ha) than the yield recorded in Farmer practices (225 q/ha).

c. Validation of different BIPM modules against shoot and fruit borer, *Leucinodes orbonalis* in brinjal

MPKV: BIPM module consisting release of *T. chilonis* @ 50,000 parasitoids/ha followed by spraying of NSKE 5% and *B. thuringiensis* @ 1 lit./ha twice at weekly interval was the next best treatment to the chemical treatment showing 10.6% shoot and 15.3% fruit infestation with 42.5% parasitism of *T. chilonis* and gave 217.8 q/ha yield.

d. Biological control of brinjal mealybug *Coccidohystrix insolitus*

TNAU: Release of *Cryptolaemus* @ 1500/ha was the next best treatment to chemical control with a population of mealybugs of 32.4/plant after 15 days of 1st release and 5.3/plant after 15 days of second release with an yield of 67.8t/ha. Highest number of predators were found in the treatment with *Cryptolaemus* @ 1500/ha (5.3 and 8.6/10 plants after 1st and 2nd release respectively).

e. Field evaluation of biocontrol based IPM module against pests of cauliflower/ (*Plutella xylostella, Spodoptera litura, Pieris brassicae*)

PAU: The chemical control treated plots and BIPM module showed minimum number of *Pieris* larvae / plant (4.27 & 3.32 respectively) and aphids/plant (11.08 & 8.82 respectively) and were on par with each other. The untreated control plot showed higher *Pieris* larvae / plant (37.27) and aphids/plant (15.13). The BIPM module showed maximum population of natural enemies per plant (4.41 coccinellids + 2.5 syrphid larva + 2 cocoon cluster of *Cotesia glomeratus*), where as insecticidal treated plot did not show any population of natural enemies. The highest marketable yields were obtained in chemical treated plots and BIPM module plots (47.32 and 43.12 q/acre) as against 29.56 q/acre recoded in the untreated plots.

f. Efficacy of *Bt* strains against diamond back moth in cauliflower

TNAU: NBAII BTG4 and PDBC BT1 *Bt* strains @ 2% spray were effective in reducing the larval population up to 59 per cent over control after 1st round of spray. After three rounds of spraying, the *Bt* strains were able to reduce the larval population of DBM up to 84 per cent (NBAII BTG 4 @ 2%) as compared to 90 per cent reduction of larval population in insecticide treated plot. The curd yield was maximum in insecticide treated plot (12.4t/ha) as against 11.32 to 11.86 t/ha in *Bt* strains treated plots.

g. Evaluation of fungal pathogens against sucking pest of hot chilli (*Capsicum sinensis*)

AAU-J: The mean population of *Aphis gossypi* and *Scirtithrips dorsalis* in NBAIR Bb5a treated were 8.50 and 2.50 per 10 leaves after third spray and was on par with insecticide treatment. Highest yield of hot chilli (53.8q/ha) was recorded in imidacloprid and this was followed by NBAIR-Bb5a with an yield of 51.29q/ha.

h. Validation of BIPM on thrips of onion

IIHR: Validation of BIPM trial against *Thrips tabaci* on onion with var. Arka Niketan indicated a significant reduction in thrips population by 73 % and 79% with liquid spray of *Beauveria bassiana* @1x10^7 spores/ml and *Metarhizium. anisopliae* @1x10^7 spores/ml, respectively.

MPKV: Pooled analysis of three years data revealed three sprays of *M. anisopliae* @ 10^8 cfu/ml (av. 7.6 thrips/plant)/six releases of *B. pallescens* @ 20 nymphs/m row (av. 9.9 thrips/plant) were the next best treatments in the bio suppression of pest population and also with regard to yield (18.7 & 18.1 q/ha respectively)

i. Evaluation of local and NBAIR entomopathogenic strains against soil insects in potato

AAU-J: NBAIR-Bb-5a strain treated plots showed 15.5% damage by *Dorylus orientalis* and 17.25% damage by *Agrotis ipsilon* with an yield of 85.00 q/ha, although imidacloprid treated plots showed lesser tuber damage (10.25 & 9.0% respectively) with higher yield of 89.5q/ha.

j. Biological suppression of fruit borer, *Erias vitella* in okra

MPKV: Three sprays of *B. thuringiensis* @ 1 kg/ha at fortnightly interval was superior in reducing the shoot (8.8 %) and fruit (19.5 %) infestation and gave maximum marketable yield of 180 q/ha. However, this was on par with Chlorpyriphos @ 0.04% treatment which showed 10.7 % shoot and 24.2 % fruit infestation with 173.2 q/ha yield.

k. Evaluation of biointensive IPM module against *Aleurodicus dispersus* on cassava

TNAU: The implementation of BIPM module effectively reduced the spiralling whitefly population (77.03% reduction) as compared to 25.89 % reduction in insecticide sprays. The yield of tubers in BIPM plot was 33.25t/ha which was superior to the tuber yield of 29.62 t/ha recorded in farmer's practice with insectidal treatment. The BCR was 1:3.26 in BIPM plot and 1:2.34 in farmer's practice

Polyhouse crop pests

a. Monitoring of pests and natural enemies in *Chrysanthemum* under polyhouse conditions.

TNAU: Survey on the pests of *Chrysanthemum* grown in polyhouse was carried out in different places viz., Kothagiri, Yercaud and Kodaikanal. The survey revealed occurrence of whitefly (*Bemisia tabaci*), serpentine leaf miner (*Liriomyza trifolii*) and tetranychid mite (*Tetranychus urticae*).

b. Evaluation of efficacy of predators against cabbage aphids in polyhouse

SKUAST: *Coccinella. septempunctata* was found superior to *C. zastrowi* in terms of pest suppression, as evident from statistically significant differences in aphid densities after second release of predators. Per cent reduction in aphid density were 23.6 to 55.3 and 13.9 to 38.4 for *C. septempunctata* and *C. zastrowi* respectively indicated the supremacy of the former.

c. Evaluation of predatory mite, *Neoseiulus longispinosus* against phytophagus mite in carnation under polyhouse conditions

YSPUHF: Among different treatments of bio-pesticides and bio-agents, *N. longispinosus* at 1:10 predator: prey ratio was the most effective resulting in 84.7 per cent reduction of mite population over control which was on par with fenazaquin (0.0025%) treatment resulting 92.1 per cent reduction of mites.

Storage Pests

Evaluation of *Uscana* sp. (Trichogrammatidae) against *Callosobruchus* sp. on storability of pigeonpea seed

Dir. Seed Res.: The results of the experiments showed that increase in number of *Uscana* sp. is directly proportional to the level parasitization The highest parasitization of 42 per cent was observed in the treatment (40 *Uscana* sp released). Lowest infestation of seed was noticed in the treatment of 40 *Uscana* sp released.

6. Tribal Sub Plan(TSP): TSP programme was implemented in 11 states. In Assam, BIPM technology of pest and disease management in vegetable crops was implemented in 24 tribal farmers plots in three villages in Jorhat and Golaghat districts of Assam. Seeds of vegetable crops, bioagents, biopesticides and bio fertilizers were supplied to the farmers and trainings were given to them on BIPM technology. The inputs provided to the farmers and the benefit derived from them significantly helped them in their net returns.

In Gujarat, Under the TSP project 50 tribal farmers were selected from Panchmahal and Mahisagar districts of the Gujarat. Biocontrol agents like *Trichoderma viride*, biopesticides like Azardiractin and pheromone traps were provided as inputs to control pests and diseases. The feedback from the farmers indicated that the BIPM package was very effective in minimizing the losses due to pests and diseases and in increasing the yields of chick pea.

In Uttarakhand during Kharif season (2014) and Rabi season (2014-15) a total of 531 farmers from 4 blocks and 28 villages were adopted and given inputs of 5.5 quintals of bioagent (Pant Bioagent 3), 50 kg earthworms for vermicomposting and polysheet for soil solarization for the crops of rice, French bean, cowpea, okra, cucumber, bittergaurd, bottlegaurd, green chilli, brinjal, cauliflower, cabbage and onion. The Buksa and Tharu tribes of the adopted villages in Udham Singh Nagar have developed confidence in adopting low cost technology using on farm resources in growing quality vegetables.

In Maharashtra, Tribal dominating areas of Harsul and Daltpatpur in the Taluka Trimbak of Dist Nasik in Maharashtra were selected for implementation TSP. Fifty Wadis (fruit orchards) of tribal farmers were selected to carry out operation of TSP. Bio fertilizer and bio pesticides and fruit fly and yellow sticky trap has supplied to the selected tribal farmers.

In Rajastan, seventy five tribal farmers were selected in five villages of the panchayat Girwa in Udaipur district for implementation of TSP programme. Inputs like, maize seed (var. HQPM-1), *Trichogramma chilonis* and *Ha*NPV were supplied to the tribal farmers. The yield in the TSP implemented plots were higher (19.7-22.5 q/ha) compared to the yields in the untreated plots (12.82-15.2 q/ha).

In Jammu & Kashmir, eighteen small groups of farmers, each comprising 8-10 farmers, from eight different localities including Slikchey, Poyen, Bagh-e-Khomini, Chanigund, Majed Dass, Gound Minji, Hardass and Mangmore were selected for distribution of desired items for use in their apple orchards during 2014-15. Inputs like, pheromone traps, neem formulations, *Bt* fomulations and sprayers were given to the tribal farmers. Training was given to the tribal farmers on following management practices of apple codling moth.

In Tamil Nadu, forty tribal farmers were trained on the establishment of kitchen garden and its utility on nutritional security with free supply of vegetable seeds and other inputs.

In Karnataka, IPM in paddy was implimented in eleven tribal farmers fields in Vaddepalli village in Raichur district. Formulations of bio agents and vermibeds for vermicoposting were supplied to the farmers. Training on production of vermicompost was given to the tribal youths to engage themselves in mitigating the purchase of fertilizers. TSP was carried out during rabi, 2014-15.

A total of 149 tribal farmers three locations viz., Jhampani, Ruksin and Pasighat in Arunachal Pradesh were provided with plant protection materials for the management of insect pests. Incidence of insect pests were low and yields were higher in the TSP implemented fields compared to the non TSP implemented fields.

In Himachal Pradesh, three hundred and thirty tribal farmers were selected from five villages in Kinnaur district for implementation of TSP. Inputs like, water traps, Delta sticky lines, Delta sticky traps, yellow sticky traps, blue sticky traps, neem baan, *Helicoverpa* pheromone lure, *Spodoptera* pheromone lure, DBM pheromone lure, *Trichoderma viride* and *Pseudomonas fluorescens* were supplied to the tribal farmers along with training on BIPM practices for pest and disease management of vegetables and apple.

In Orissa, TSP was implimented in in two tribal villages of Dubula and Kantapalli in Sonepur District. Twenty five farmers of each village were trained on biological control of crop pests and weeds. In Dubula, Bio Intensive Pest Management was demonstrated in 10 Acres of paddy. In Kantapalli, Bio Intensive Pest Management was demonstrated in 10 Acres of brinjal.

PROCEEDINGS OF THE TECHNICAL SESSIONS

The results of the experiments from each centre were presented through six sessions. In the VI session on Institute-industry/Public private partnership, Dr.S. Balaji and Mr. Balachander discussed about the critical needs of industry and the need for collaboration with research institutes. The meeting concluded with a plenary session chaired by **Dr.Abraham Verghese**, Director, NBAIR and **Dr. R. J. Rabindra former** Director, NBAII and the Technical Programme for 2015-16 for various AICRP centers were finalized.

SESSION I: BASIC RESEARCH AT NBAIR & BIOLOGICAL CONTROL OF PLANT DISEASES

Chairman : Dr.K.Ramaraju, Director, CPPS, TNAU, CBE.
Co-chairman : Dr.Alice, Professor and Head, Dept. of Pathology, TNAU, CBE
Rapporteurs : Dr. T.Venkatesan, NBAIR, Bangalore
: Dr. Jagadeesh Patil, NBAIR, Bangalore

Speakers and Topics :
Dr.Prashanth : Biodiversity, Biosystematics, Molecular Characterization and biocontrol potential of newer natural enemies (NBAIR)
Dr. A.K.Tiwari : Biological control of plant diseases using antagonists

Recommendations

1. Molecular characterization of parasitoids/ predators in relation to host insects may be attempted (NBAIR).
2. Management of *Tuta absoluta*, including using of microbial may be explored (NBAIR).
3. Results regarding biological control of plant disease should be presented as per the technical programme given to centres (GBPUAT).
4. Efforts may be made to change the name of *Trichoderma viride* into *T. asperellum* with the concerned registration / regulation authorities (NBAIR)

SESSION II. BIOLOGICAL SUPPRESSION OF PESTS OF SUGARCANE, COTTON, RICE, MAIZE AND SORGHUM.

Chairman : Dr. C. A Viraktamath Chairman, RAC, NBAIR, Bangalore.
Co-chairman : Dr. G. Gajendran, Dean, AC & RI,, Kudumiyanmalai, TNAU.
Rapporteurs : Dr. S. M. Galande, MPKV, Pune.
: Dr. P. S. Shera, PAU, Ludhiana.

Speakers and Topics :
Dr. K. S. Sangha, PAU, Ludhiana : Sugarcane & Cotton
Dr. Madhu Subramanian, KAU, Thrissur : Rice Maize & Sorghum

Recommendations:

1. Sugarcane Breeding Institute, Coimbatore should be involved for large scale demonstrations on sugarcane (NBAIR)
2. Identification of the hot spots of sugarcane woolly aphid and relese of the recommended biocontrol agents, to prevent the spread of the pest to other areas (All centres dealing with Sugarcane).
3. *Anaesis bambawali* should be reported as *Anaesis arizonensis* in future reports (All centres dealing with Cotton).
4. Identification of the hot spots of cotton mealybug and relese of the recommended biocontrol agents, to prevent the spread of the pest to other areas (All centres dealing with Cotton).
5. The success story of BIPM in rice in Kerala may be documented (KAU).
6. Avoid giving pre count data of insect pests in IPM trials (All centres).
7. Avoid the trade names of insecticides in the report (All centres).
8. Uniform treatments should be used in same experiment at all centres (All centres).
9. IPM package on different crops should be uniform for all centres (All centres).

SESSION III. BIOLOGICAL SUPPRESSION OF PESTS OF PULSES, OILSEEDS AND COCONUT.

Chairman : Dr.A.Krishnamoorthy, Principal Scientist, IIHR, Bangalore.
Co-chairman : Dr.S.K.Jalali , HOD ,NBAIR, Bangalore.
Rapporteurs : Dr. Arunkumar Hosamani
: Dr. Madhu Subramanian

Speakers and Topics :
Dr. S. J. Rahman : Pulses and Oilseeds
Dr. Chandrika Mohan : Coconut.

Recommendations

1. In evaluating the microbial agents against insects pests dosages should be mentioned uniformly across the locations and the source of the microbial agent shoul be mentioned (All centres).
2. The house also suggested that only approved technical program of AICRP- BC should be presented.

SESSION IV: BIOLOGICAL SUPPRESSION OF PESTS OF FRUITS AND VEGETABLE CROPS, POLYHOUSE CROP PESTS, STORAGE PESTS AND WEEDS

Chairman: Dr. K. Samiayyan, Dean, AC & RI, Eachankottai, Orathanad, TNAU
Co-chairman : Dr.Chandish Ballal, HOD, NBAIR, Bangalore
Rapporteurs : Dr. Jaydeep Halder, IIVR, Varanasi
: Dr. M. Visalakshi, ANGRAU, Anakapalle

Speakers and Topics :

Dr. Jamal Ahmed, SKUAST, Srinagar	: Tropical and Temperate Fruits, Mealybugs and Tea Mosquito Bug.
Dr. R.V.Nakat	: Vegetables
Dr.P.N.Ganga Visalakshi, IIHR, Bangalore	: Poly House Crop pests, Storage pests and weed Biocontrol.

Recommendations

1. Brief description on methodology on spraying of biopestcides on fruit crops may be given in the report (All Centres dealing with Fruit crops)
2. General predators like spiders are abundant in orchard ecosystem.Species richness on spiders in fruit plants may be documented (All Centres dealing with Fruit crops).
3. Acknowledge the source of bioagents obtained from any ICAR institute/SAU in the report (All centres).
4. Number of releases of *Trichogramma* for management of Codling moth infesting apple should be mentioned. Similarly, efforts may be directed to search for native strains of bioagent(s) for better efficacy (SKUAST).
5. On request, ICAR-NBAIR will supply desired "Trichocards" to SKUAST, Srinagar for conducting small scale trial on "Field evaluation of *Trichogramma embryophagum* and *T. cacoecine* against codling moth on apple" for sequential releases in restricted area (SKUAST).
6. Uniformity to be maintained recording the populations of mealy bug and its predator *Cryptolaemus* (All Centres dealing with mealy bugs & *Cryptolaemus*).
7. Dosages, formulations should be uniform for all the centers conducting the same experiment (All centres).
8. Based on the decision of ICAR, biocontrol of weeds will be taken up by DWSR & AICRP on Weeds, Jabalpur.

SESSION V: TRIBAL SUB PLAN PROGRAMME

Chairman : Dr. Abhram Verghese, Director, NBAIR, Bangalore.
Co-chairman : Dr. B. Ramanujam, NBAIR, Bangalore.

Speakers and Topics :
Dr. Usha Chauhan, YSPUHF: Presentation on achievements of Tribal Sub Plan programme of 11 centres of AICRP-BC

Recommendation: In view of the budget cut for TSP during 2015-16, the number of centres undertaking TSP programme may be cut down

SESSION –VI: INSTITUTE - INDUSTRY PARTNERSHIP

Chairman : Dr. R.J. Rabindra, Former Director, NBAIR
Co-chairman : Dr.N. Ragupathi, Director, Students Welfare, TNAU
Rapporteurs : Dr. N. Bakthavastalam, NBAIR, Bengaluru
: Dr. T. Venkatesan, NBAIR, Bengaluru

Speakers :
Dr. Balaji, EID, Parry, Chennai
Dr. Balachandran, PONALAB, Bengaluru

Recommendations

- Suitable application technologies for biopesticides should be standardised.
- Fate of biopesticides applied in the soil should be monitored.
- Efforts may be made for the speedy registration of biopesticides from CIBRC.

SESSION VII: PLENARY SESSION & FORMULATION OF TECHNICAL PROGRAMME

A panel of experts comprising Dr. Abraham Verghese, Director, NBAIR, Bangalore, Dr. R.J. Rabindra, former Director, NBAII, Dr. Chandish Ballal, HOD, NBAIR, Dr. S.K. Jalali, HOD, NBAIR and Dr. B. Ramanujam, AICRP PC Cell I/C discussed the details of the on-going programmes and the final technical programme for the years 2014-15 were finalized.

Recommendations:

1. Incidence of tamerind fruit and seed borer in Chhattisgarh state may be recorded and the natural enemies of the pest may be collected (IGKV, Raipur)

2. In the prorogramme of Surveillance for alien invasive pests in vulnerable areas, monitoring of recently intoduced pests of *Tuta absoluta* (Tomato borer) and *Frankliniella occidentalis* (Western Flower thrips may be included. (all Centres)

3. In the studies on Biodiversity of Pests & Biocontrol agents, each centre will specify five species of insects (pests / natural enemies that are prevalent on crops in their region) that will

be collected during the course of this year and sent to NBAIR as part of the programme on. These names should be sent to NBAIR within a fortnight from the receipt of these proceedings. At least 12 specimens of each species should be collected, curated , labelled and sent securely packed to NBAIR for addition to the repository. You could start by collecting pests / natural enemies that are common in your area. Natural enemies will have to be reared from field collected material and the name of the host insect should be specified on the label; these may be preserved in alcohol and then sent to NBAIR..Other insects should be pinned and dried before they are despatched. Five species and 12 specimens are not the limit. More species and specimens would be welcome (all Centres).

Technical Programme for different centers of AICRP on Biological Control of Crop Pests & for the year 2015-16 is given below.

TECHNICAL PROGRAMME 2015-16

I. BIODIVERSITY OF BIOCONTROL AGENTS FROM VARIOUS AGRO ECOLOGICAL ZONES

For All Centres

- As per ICAR instructions, all centres should additionally collect at periodic monthly intervals all insects of their agro-ecosystems, and send curated labelled specimens to the NBAIR repository **(please refer methodologies on page 31).**

- Each centre will specify five species of insects (pests / natural enemies that are prevalent on crops in their region) that will be collected during the course of this year and sent to NBAIR as part of the programme on. These names should be sent to NBAIR within a fortnight from the receipt of these proceedings.

- At least 12 specimens of each species should be collected, curated , labelled and sent securely packed to NBAIR for addition to the repository.

- Start by collecting pests / natural enemies that are common in your area.

- Natural enemies will have to be reared from field collected material and the name of the host insect should be specified on the label; these may be preserved in alcohol and then sent to NBAIR..Other insects should be pinned and dried before they are despatched.

- Five species and 12 specimens are not the limit. More species and specimens would be welcome.

- For biodiversity analysis, Dr. M. Pratheepa, Senior Scientist, Computer applications, NBAIR, Bangalore may be contacted (mpratheepa.nbaii@gmail.com) 080-2351 1982 Extn. 340

AAU-A:
1. Survey, collection & diversity analysis of spiders in arid zones of India
2. Mapping of EPN diversity in Gujarat

AAU-Jorhat
1. Survey, collection & diversity analysis of *Trichogramma, Chrysoperla,* coccinellids, Spiders, anthocorids, entomopathogens

ANGRAU, Anakapalle
Monitoring and collection of natural enemies of major pests in sugarcane, rice and maize in north coastal zone of Andhra Pradesh.

KAU
1. Survey and collection of natural enemies of banana weevil and banana aphid, pollu beetle and root mealybug of pepper, Entomopathogens

MPKV, Pune
1.Survey and collection of natural enemies of *Trichogramma, Chrysoperla, Cryptolaemus,* spiders, entomopathogens

PAU, Ludhiana
1. Natural enemy complex of rice yellow stem borer & leaf folder, cotton aphids & cotton mirid bug, onion thrips
2. Mapping of EPN diversity in Punjab & Haryana

PJTSAU, Hyderabad
1. Survey, collection and diversity analysis of *Trichogramma, Chrysoperla, Goniozus* and *Braconid* species, *Cryptolaemus,* Spiders, entomopathogens from Telengana state.

SKUAST- Srinagar
1. Survey and collection of natural enemy complex of pests of apple (stem borer, San Jose scale, mite & other pests), apricot (borer from Ladak and other pests), plum, pear, peach, cherry, walnut and almonds

TNAU
1. Survey and collection of natural enemies of coconut black headed caterpillar, *Trichogramma, Chrysoperla, Cryptolaemus,* spiders

YSPUHF
1. Survey and collection of natural enemies of *Trichogramma, Chrysoperla, p*redatory mites *Coccinellids,* spiders, entomopathogens

CAU
1. Survey and collection of *Trichogramma*, *Chrysoperla*, *Cryptolaemus*, entomopathogens

MPUAT
1. Survey and collection of *Trichogramma*, *Chrysoperla*, *Cryptolaemus*

UAS- Raichur
1. Survey and collection of *Trichogramma*, *Chrysoperla*, *Cryptolaemus*

CISH
1. Survey and collection of natural enemies of mango pests

CPCRI
1. Survey and collection of natural enemies of coconut black headed caterpillar, eriophid mite, red palm weevil

CTRI

1. Survey and collection of spiders and parasitoids in tobacco intercropping systems

Directorate of Sorghum Research, Hyderabad

1. Survey and collection of natural enemies of sorghum pests

Dir. Soybean Research, Indore

1. Survey and collection of natural enemies of soybean pests

IARI

1. Natural enemies of cotton mealybugs from northern India.

Indian Institute of Rice Research, Hyderabad

1. Survey and collection of natural enemies of rice pests

IIVR

Survey, collection and identification of mealy bug infesting major vegetable crops and its natural enemies

Methodologies for Collection and Diversity studies

1) *Trichogramma*

Ten geographical populations to be collected by each centre from different crop eco-systems by placing sentinel cards with eggs of *Corcyra cephalonica*/ original host eggs. Eggs of insect pests may also be collected from different crops and maintained for the emergence of *Trichogramma* In the event of *Trichogramma* emerging from these eggs, they may be supplied with freshly laid, UV treated *Corcyra* eggs for parasitisation. Freshly parasitized eggs/ live *Trichogramma* with UV treated *Corcyra* eggs should then be sent by speed post in suitable aerated containers to NBAII, Bangalore.

The cultures are also to be maintained at the respective centres from where they are collected for their own studies. Dead *Trichogramma* are to be preserved in 70 per cent alcohol and sent to NBAII, Bangalore for identification **(All Centres).**

Trichogramma are to be collected from different crop eco-systems, in particular rice, sugarcane, cotton, castor, cashew, tea, ground nut, castor, maize, sunflower.

Protocol for collection of *Trichogramma* and other egg parasitoids:

Trichogramma and other egg parasitoids

a) Put sentinel cards of *Corcyra* egg in the field. Make egg cards with about 100 eggs/card and put cards in the entire field, about 6 cards well distributed. Collect back all 6 cards after 24h of field exposure and record parasitism. Repeat this exposure method once in a fortnight for entire cropping season. Maintain emerged parasitoids on *Corcyra* eggs and ship both live and dead specimens to NBAII, Bangalore for repository maintenance and correct identification.
b) Collect eggs/egg masses wherever possible at fortnightly intervals. Collect at least 20 eggs/ 5 egg masses each time. Observe for parasitism. Maintain emerged parasitoids on *Corcyra* eggs in the laboratory. Collection to be done for entire cropping season.

c) All egg parasitoids are to be preserved in 70% ethyl alcohol along with data on host plant, insect host, date and place of collection and sent by post to Dr. K. Veena Kumari, Principal Scientist NBAIR.

2) *Chrysoperla*

Five geographic populations (at least 20 in each population) are to be collected by each centre and live individuals (eggs/larvae/adults) are to be sent by speed post to NBAII, Bangalore in proper aerated containers **(All Centres)**.

Blister trays will be supplied by BCRL for isolating the larvae of chrysopids individually (to avoid cannibalism) when being despatched by post.

3) *Goniozus* and Braconid species

Five geographical populations are to be collected by those centres in coconut growing areas and live individuals are to be sent by speed post to NBAIR, Bangalore

4) *Cryptolaemus*

Five geographical populations are to be collected by each centre and live individuals (eggs/larvae/adults) are to be sent by speed post to NBAIR, Bangalore. Blister trays will be supplied by BCRL for confining the larvae of *Cryptolaemus* individually (to avoid cannibalism) when being despatched by post.

5) Entomopathogens

The cadavers of insects infected by entomopathogens are to be collected in dry sterile vials and sent to NBAII, Bangalore by speed post for identification**.**

6) Spiders

Methodology for spider collection and preservation

a) Pitfall Trap method

10 plastic traps having 10.5 cm diameter and 11 cm depth may be placed with bottom in the soil and mouth at the surface level, containing 5% formaldehyde solution as a preservative filling the bottom of it up to 2 cm height per trap.

Traps should be placed equi-distant from each other.

The spiders and insects falling in the trap should be collected twice a week, washed with D/W and preserved in 70% ethyl alcohol with proper labelling of trap number and date.

b) General collection

1. The area should be surveyed extensively to collect specimens from all the types of habitats such as roots of grasses, dry hay and grasses, moist places under stones, pebbles, dead leaves, humus, bushes, on the bark and branches of trees, water logged localities, houses and huts, etc.
2. Collections should be made by hand picking or directly into the specimen tubes of 7.2 X 2.5 cms size with screw caps.
3. Stones and logs should be removed and searched for.
4. Web builders can be easily located.

5. In some cases spiders can even be traced out in their retreats made on the lower side of leaf connected by a radial thread, sometimes in the dried crumpled leaf hanging on the threads of the broken orb.
6. The branches of trees should be beaten and jerked with stick to collect the spiders hanging with the silken thread and trying to go up.
7. The bark on the tree trunk should also be searched for.
8. Even the dried bark of dead trees should be pealed off to search for spiders.
9. The holes and gaps on the tree trunks, gaps and crevices on and under the boulders should also be searched for the spiders.
10. All such spiders found were collected and transferred into the specimen tubes.
11. Spiders thus collected should be kept alive, each specimen in a separate tube, as most of the species are cannibals by nature. As soon as the collections are over, the spiders should be killed and preserved in 70% ethyl alcohol.
12. All such specimens should be kept collectively in the tubes properly labeled with date, locality and other notes of importance.
13. After two to three days, the preservative of the tubes should be changed with the fresh one.
14. These specimens should then be sent to NBAIR, Bangalore.

7) Insect-derived EPNs

- Collect 250cc soil samples during wet season from different areas of survey (root zone depth) and place in plastic containers with lid and send one set of soil samples to NBAII and the other set of soil samples can be used for isolation of EPN by the centres.
- Place 5 healthy 5^{th} instar *Galleria* or *Corcyra* larvae at the bottom of containers before filling the samples.
- Examine the larvae for mortality at 24h intervals for 7 days.
- Separate the cadavers from soil and label the samples.
- Preliminary identification of cadavers with EPN: Cadavers do not putrify and do not rot. Cadavers look reddish brown in colour in case of *Heterorhabditis* and creamy white in case of *Steinernema* infection.
- Segregate such cadavers, place in 50cc soil in a plastic container/polythene bag, label and parcel to NBAII for correct identity, recover live EPN and catalogue the natural biodiversity of insect-derived EPN.
- Similarly, collect cadavers of insect larvae/grubs from field during ploughing and field preparation before planting for collecting the natural EPN populations.

8) Soil samples for isolation of antagonistic organisms

Samples of 250g soil are to be collected and sent to NBAII, Bangalore. Samples have to be sent for the isolation of the antagonists for the management of soil borne disease. Soil samples should be collected from a field where the pathogen is known to be present but disease occurrence is low. Soil should be collected to a depth of 15 cm in the upper surface including rhizosphere and rhizoplane. The rhizosphere soil has to be collected from different places (5-6) in a field and a composite sample has to be thoroughly mixed and 250g sample has to be sent.

9) Anthocorids

Search for anthocorid predators on thrips and mite-infested host plants. Collect the adult and nymphal stages. Place in pearlpet containers with the host insects on host plant materials. Additionally provide *Corcyra* or *Sitotroga* eggs (for feeding), french bean pieces and cotton strands (for oviposition). Fresh eggs and bean pieces to be provided on alternate days. The dead adults and the bean pieces/host plant materials/cotton strands (containing the anthocorid eggs) to be sent to NBAII in aerated boxes by speed post for identification.

10) Isolation of native *Bt* isolates from soil

Isolation of *Bacillus thuringiensis* is done according to the method.

- One gram of soil sample was suspended in 10 ml sterile distilled water.
- They were heated for some time.
- One ml of each sample was added to 10 ml of Luria Bertani broth buffered by 0.25M sodium acetate PH 6.8.
- The suspension was incubated at 30ºC for growth and then heated to 80 ºC again for a short time.
- Resulting suspension was serially diluted up to 10^{-6}. Dilutions 10^{-5} and 10^{-6} are serially diluted on T3 agar plates and kept for incubation at 28ºC - 30ºC for 3 days or 5 days.
- Cream coloured colonies represented by fried egg shaped appearance.
- Smears were made on glass slides and Amidoblack staining was done.
- Slides were observed under light microscope at 100X magnification to observe the parasporal crystals of the bacterium.
- For isolation of *Bacillus thuringiensis* from the dead larvae was also done by the same process except the pre pasteurization step.

The information should be collected as given below for diversity analyses of natural enemies complexes

Name of Insect/ microbial agent:

Geographical & other details	
Scientific name of the insect/ **microbial agent**	
Common name of the insect	
Location	
Taluk, District & Agro-climatic zone	
Distance from the HQ	
Date of survey	
Host crop/ sole crop/ intercrop/ etc.	
Stage of the crop	
Stage of the insect	
Weather parameters recorded (max, min temp; rainfall, no. of rainy days)	
GIS data	
Pesticide usage pattern	

1a. Surveillance for alien invasive pests in vulnerable areas (all centres)

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

II. BIOLOGICAL SUPPRESSION OF PESTS AND DISEASES IN FIELD

1. PLANT DISEASES AND NEMATODES

1. Field evaluation of the promising *Trichoderma, Pseudomonas* and *Bacillus* isolates for the management of diseases and improved crop growth (GBPUAT)

Crops: Rice, Chickpea and Pea
Plot size: 3x2 m^2
Design :RBD
Replication: 03
Treatment (10 no.):
T1-T5: Potential *Trichoderma* isolates found good in their respective crops
T6-T7: *Pseudomonas fluorescens*
T8- *Bacillus* sp.
T9- Carbendazim
T10 Control

Mode of application:

Soil application with bio-agent (1kg bio-agent formulation/ton vermicompost per acre)
Seed bio-priming with bio-agents (10g/kg seeds),
Seedling dip treatment only in case of rice (10g/lit). 1 hr before transplanting
Three foliar sprays of bio-agents (45, 70 and 95 DAS)

Observations to be recorded:

- Seed & Plant mortality in chickpea and in pea (30 , 30-75 & 75-100 DAS)
- Disease incidence/severity
- Rhizosphere and rhizoplane population (0, 45 & 90 DAS)
- No. of tiller/hill in rice
- Yield/ha

2. Biological control of chilli anthracnose disease (AAU-A, GBPUAT, PAU,)

Varieties : Centre can choose a suitable variety
Area : 500 m^2 per variety
Treatments : 5

T1: *Pichia guilliermondii* (Y12) Seed treatment, Seedling dip & Foliar spray ($2x10^8$cfu ml^{-1})T2: *Hanseniaspora uvarum* (Y73) Seed treatment, Seedling dip & Foliar spray($2x10^8$cfuml^{-1})
T3:*Trichoderma harzianum* (Th-3) Seed treatment, Seedling dip & Foliar spray($2x10^8$cfu g^{-1})
T-4: Recommended fungicidal control Seed treatment, Seedling dip & Foliar spray
T-5: Untreated control

Method of application

a) Seed treatment: The seeds will be treated with formulations before sowing into nursery. Mix 10ml or grams of concentrated formulation with 100ml with water. This can be used to treat 1 kg of seeds. The seeds will be soaked in formulation for 5 minutes with constant shaking and then the treated seeds can be shade dried for 1 hour and used for sowing.

b) Seedling dip: Chilli seedlings raised in plastic trays or nursery beds can be treated with antagonist formulation just before transplantation. Twenty ml or 20gm of formulation can be mixed in 1litre water to obtain antagonist suspension for seedling treatment. Seedlings should be uprooted carefully from plastic trays or nursery beds and roots should be dipped in antagonist suspension for 5-10 minutes and transplanted to main field.

c) Foliar/fruit spray: Foliar spray of antagonist formulation can be given at the rate of 10g or 10ml per litre of water using a high volume sprayer with a spray fluid volume of 500L ha^{-1}. First spray should be given at initiation of fruit ripening and later 3-4 sprays can be given at monthly intervals or until the last harvest.

Seasons: Kharif/Rabi

Number of plants and replications: RBD design with three replications.

No. of plants/ treatment = 75 (25 plants x 3 replications)

Total number of plants for 5 treatments = 375 (75 x 5 treatments)

Spacing: 2 x 3 feet (Between plants 2 feet, between rows 3 feet)

Observations:

a) Disease intensity –Total numbers of healthy and diseased fruits in each plant should be counted and percent fruit rot incidence in each replication can be calculated using formula

$$\text{Fruit rot incidence (\%)} = \frac{\text{Number of infected fruits per replication}}{\text{Total number of fruits per replication}} \text{ X } 100$$

b) Yield of each treatment can be taken

c) Weather parameters like, Temp., RH, Rain fall

d) Data statistically analysed (ANOVA, CD,)

3. Management of bacterial wilt using different isolates of *Pseudomonas florescence* (CAU)

Treatments

1. Root dip with CAUPF-1 @20gm of $2X10^8$cfu/g in one litre of water and dipping for 30 mins
2. Root dip with CAUPF-3 @20gm of $2X10^8$cfu/g in one litre of water and dipping for 30 mins
3. Root dip with CAUPF-3 @20gm of $2X10^8$cfu/g in one litre of water and dipping for 30 mins
4. Root dip with Su- Mona (*Pseudomonas florescence*) @20gm of $2X10^8$cfu/g in one litre of water and dipping for 30 mins
5. Soil drenching with CAUPF-1 (Soil drenching after planting of 50 ml of solution prepared as mixing 20gm of $2X10^8$cfu/g in one litre of water).
6. Soil drenching with CAUPF-2 (Soil drenching after planting of 50 ml of solution prepared as mixing 20gm of $2X10^8$cfu/g in one litre of water).

7. Soil drenching with CAUPF-3 (Soil drenching after planting of 50 ml of solution prepared as mixing 20gm of $2X10^8$cfu/g in one litre of water).
8. Soil drenching with Su- Mona (*Pseudomonas florescence*) (Soil drenching after planting of 50 ml of solution prepared as mixing 20gm of $2X10^8$cfu/g in one litre of water).
9. Untreated control.

Experiment will be laid out in RBD with the above treatments and each experiment will be replicated three times. Per cent wilted plants will be recorded at monthly interval. For confirmation wilted plant will be observed for the presence of *Ralstonia solani*.

4. Evaluation of potential *Trichoderma, Pseudomonas* and *Bacillus* isolates for the management of pre & post emergence damping-off and improved growth in vegetable nursery beds (GBPUAT) (NEW)

- **Crops:** Chilli, Tomato and onion
- **Plot size**: 0.5x0.5 m^2
- **Design** :RBD
- **Replication:** 03
- **Treatment (10 no.):**
- **T1-T5:** Potential *Trichoderma* isolates
- **T6-T7**: *Pseudomonas fluorescens*
- **T8:** *Bacillus* sp.
- **T9**: Metalaxyl

  T10: Control (without any treatment)

Mode of application:

i. Soil application with bio-agents (1g formulation/100 g vermicompost per m^2)
ii. Seed bio-priming with bio-agents ((10g/kg seeds)
iii. Two foliar sprays with bio-agents (15& 30 DAS)
iv. Application of Metalaxyl as seed treatment (6g/kg seed) and two foliar sprays (15& 30 DAS)

Observations to be recorded:

i. Germination percentage
ii. Pre-emergence mortality (15 DAS)
iii. Post-emergence mortality (45 DAS)
iv. Rhizosphere and rhizoplane population (0 & 45 DAS)
v. Plant vigour (45 DAS)

2. SUGARCANE

1. Monitoring the sugarcane woolly aphid incidence and impact assessment of natural enemies on its biosuppression (MPKV, TNAU, PJTSAU, UAS-R)

The sugarcane wooly aphid incidence and occurrence of natural enemies (*Dipha aphidivora, Micromus igorotus, Encarsia flavoscutellum,* syrphid and spider) will be recorded from different agro-ecological zones of Maharashtra, Tamil Nadu and Karnataka and correlated with abiotic factors. Identification of the hot spots of sugarcane woolly aphid and relese of the recommended biocontrol agents, to prevent the spread of the pest to other areas.

Observations:
Record per cent incidence of SWA, pest intensity rating and natural enemies population on leaf at five spots and five clumps/ spot at monthly interval during crop growth period.

2. Management of white grub*, Holotrichia consanguinea* Blanch in sugarcane through Biological means (ANGRAU, Anakapalle) (New)

Location: Farmers field in endemic areas of Navabharat Ventures, Sugar Division Samarlakota , East Godavari District, Andhra Pradesh.

Treatments :

Dosage :

T1:*Beauveria bassiana* @ 10^{13}spores/ha in 250 kg FYM per ha
T2: *Metarhizium anisopliae* @10^{13} spores / ha in 250 kg FYM per ha
T3: *Heterorhabditis indica* WP @ 20 kg/ha in 150 kg moist sand per ha
T4: *Steinernema sp* WP @ 20 kg/ha in 150 kg moist sand per ha.
T5: *Heterorhabditis indica* WP @ 20 kg/ha in 150 kg moist sand per ha, two times at 2 month interval
T6: *Steinernema sp* WP @ 20 kg/ha in 150 kg moist sand per ha , two times at2 month interval.
T7: Neem cake @ 500 kg/ha
T8: Phorate 10G @ 15kg/ha
T9: Untreated control
Furrow application of treatments immediately after first rain.
Light irrigation to maintain moisture for fungal growth and nematode multiplication .

Design : RBD
Replications: Three
Date of planting : January- February, 2015.
Season : 2015-2016.

Observations:
1. Plant damage due to white grub will be recorded forthree rows of 10 meter length in each treatment at monthly interval till harvest .
2. White grub population per 10 m row in the root zone for three rows in each treatment will be recorded by digging standard pit of 0.5X0.5X0.5 m under clump at monthly interval till harvest.
3. Number of millable canes, cane yield and juice quality will be recorded at harvest.

3. Bioefficacy of entomopathogenic fungi in suppression of termite incidence in sugarcane (ANGRAU, Anakapalle) (New)

Location: Regional Agricultural Research Station, Anakapalli.
Treatments :
Dosage :
T1: *Beauveria bassiana* @ 10^{13}spores/ha in 250 kg FYM per ha
T2: *Metarhizium anisopliae* @10^{13}spores/ha in 250 kg FYM per ha
T3: *Heterorhabditis indica* WP @ 20 kg/ha in 150 kg moist sand per ha
T4: *Steinernema sp* WP @ 20 kg/ha in 150 kg moist sand per ha.
T5: Neem cake @ 500 kg/ha
T6 : Chlorpyriphos 50 EC @ 5 ml/lt .
T7: Untreated control
* Furrow application of treatment before planting. Light irrigation to maintain moisture for fungal growth.
Design: RBD

Replications: Three

Plot size : 20x20 m^2

Season : 2015-2016.

Date of planting : June- July, 2015.
Duration : Three years.

Observations:

1. The number of buds will be counted before and two months after planting to determine the percentage germination of sugarcane setts.
2. Bud damage was assessed for two months after planting by randomly choosing five one square metre areas. Sugarcane setts were carefully removed from the soil and the number of buds damaged by termites will be counted.
3. Termite population per square metre will be estimated by taking soil core with soil sampler from three places in each treatment from 15 days after planting at fortnightly interval till cane attain a height of 2 metre.
4. Number of millable canes, cane yield and juice quality will be recorded at harvest.

4. IPM module for the sustainable management of early shoot borer (*Chilo infuscatellus*) and internode borer (*Chilo infuscatellus* ; *Chilo sacchariphagus indicus*) in sugarcane. (ANGRAU, Anakapalle) (New)

Location: Regional Agricultural Research Station, Anakapalli.
Treatments :
Dosage :
Module1 Trash mulching + *Trichogramma chilonis* release @ 50,000/ha from 30 DAP for 4 times at 7 -10 days interval
Module 2: Trash mulching + *Trichogramma chilonis* release @ 50,000/ha from 30 DAP for 4 times and 2 releases after node formation

Module 3: Trash mulching + *Trichogramma chilonis* release @ 50,000/ha from 30 DAP for 6 times and 2 releases after node formation
Module 4: Trash mulching + *Trichogramma chilonis* release @ 50,000/ha from 30 DAP for 6 times and 4 releases after node formation
Module 5 : Trash mulching + Soil application of Carbofuran 3G @ 33 kg/ha at planting
Module 6 : Trash mulching + Soil application of Carbofuran 3G @ 33 kg/ha at planting and 90 days after planting.
Module 7:Control.
Design Randomised block design
Replications Three
Plot size 15x20 m^2
Spacing 80 cm between 2 rows
Seed rate 40,000 three budded setts/ha.
Season 2015-16
Date of planting April, 2015.
Duration Three years

Observations:
1.Counts of dead hearts will be recorded at 45, 60, 90 and 120 days after planting.
2.Per cent incidence of inter node borer will be recorded from a sample of 50 canes per treatment at the time of harvest.
3.Number of millable canes, cane yield and juice quality will be recorded at harvest.
4. Incremental benefit cost ratio will be calculated

3.COTTON

1. Monitoring biodiversity and outbreaks for invasive mealybugs on cotton (PJSTAU, MPKV, TNAU, PAU, UAS-R)

Survey for incidence of mealy bugs on cotton and collection of their natural enemies.

1. Fortnightly surveys will be conducted in orchards/fields for mealy bug incidence. Infested plant parts to be brought back to the laboratory and held under caged conditions for emergence of natural enemies.

2. Alternate host plants, if any, to be recorded.

3. Specimens of mealy bugs and natural enemies collected will be sent to NBAIR..

4. Crop - wise records will be maintained for extent of damage by the mealy bug, level of natural enemies present, etc. to be maintained

5. If invasive species of mealy bugs are observed during the surveys, it is to be brought to the notice of the Director, NBAIR for initiation of appropriate action.

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

The *Bt* cotton plots will be monitored at fortnightly intervals for the incidence of sap sucking pests and occurrence of natural enemies. At least 25 plants per plot/ ha will be observed and quantitative data will be gathered to study the effect of *Bt* cotton on biodiversity of pests and indigenous fauna of natural enemies.

3. Bio-efficacy of microbial insecticides against sucking pest in *Bt* cotton (AAU-A)

Experimental details :

1. Treatments 10
2. Replication 03
3. Design Randomized Block Design (RBD)
4. Crop / variety *Bt* cotton
5. Plot size : Gross : 12 m x 4.8 m
   Net 9.6 m x 3.6 m
   Spacing : 120cm x 60 cm

Details of treatments

T_1 : *Beauveria bassiana* (1 x 10^8/g) @ 3g/ litre
T_2 : *Beauveria bassiana* (1x 10^8/g) @ 4 g / litre
T_3 : *Verticillium lecanii* (1 x 10^8/g) @ 3g /litre
T_4 : *Verticillium lecanii* (1 x 10^8/g) @ 4g /litre
T_5 : *Metarhizium anisopliae* (1 x 10^8/g) @ 3 g / litre

T_6 *Metarhizium anisopliae* (1 x 10^8/g) @ 4g /litre
T_7 *Nomurea rileyi* (1 x 10^8/g) @ 3 g / litre
T_8 *Nomurea rileyi* (1 x 10^8/g) @ 4 g / litre
T_9 Recommended insecticide
T_{10} Control (water spray)

Observation to be recorded:

1. No. of sucking pests per leaf (Jassid, whitefly, thrips and aphid)
2. Seed cotton yield (q/ha)

Methodology:

Considering the pest population in experimental area, three sprays will be given on need basis. The observations on population of sucking pests will be made on five plants selected randomly in each plot. On each plant, three leaves will be selected randomly from top, middle and bottom canopy and population counts will be made before the first spray as well as 3, and 7 days after each spray. Moreover, impact of different treatment on seed cotton yield in kilograms will be recorded plot-wise and picking-wise and converted to quintal/ha. The periodical data on pest population will be subjected to ANOVA after transforming them to square root while yield data analyzed statistically without transformation.

4. Biological suppression of sap sucking pests on *Bt* cotton (MPKV, UAS- R, PJTSAU) (New)

T1: *Metarhizium anisopliae* (1 x 10^8 conidia /g) @ 5g/ litre
T2: *Lecanicillum lecanii* (1 x 10^8 conidia /g) @ 5g/ litre
T3: *Beauveria bassiana* (1 x 10^8 conidia /g) @ 5g/ litre
T4: NSE @ 5% suspension
T5: Dimethoate @ 0.05% spray
T6: Control
Net Plot size: 40 sq.mt (5 x 8m) **No. of Replications** : 3 **Design:** RBD
Variety: The suitable *Bt* cotton variety may be selected as per the university recommendation.
Timing of Treatmental Applications:
The first spray was given on initial occurrence of the pest and rest based on abundance of pest. Cloth screen was used to avoid drift into neighbouring plots.
Observational Protocol:
Aphid/ Jassid/Whitefly population in 5 randomly selected plants (terminal shoots) from each plot will be recorded before treatment and 10 days after each treatment. Yield per plot will be recorded at harvest.

5. Diversity of sucking insect pests, bollworms and their natural enemies in transgenic *Bt* and non-*Bt* cotton (PAU) (New)

Treatments

1. Bt sprayed (transgenic cotton with need based insecticide application)
2. Non-Bt sprayed (non- transgenic cotton with need based insecticide application)
3. Bt unsprayed (transgenic cotton without insecticide application)
4. Non-Bt unsprayed (non-transgenic cotton without insecticide application)

Plot size: 200-250 sq m each divided into three blocks representing replicates
Variety/ hybrid: Any recommended variety/hybrid
Spacing: Recommended plant to plant and row to row spacing
Insecticide application: Under sprayed plots, recommended insecticides will be sprayed based in economic threshold levels for sucking insect pests and bollworms

Observations

- Seasonal abundance of sucking insect pests from three leaves (top, middle and lower) of 20 plants selected at random from each block at weekly interval
- Record incidence of American bollworm (eggs, larvae/ 10 plants), Spotted bollworm (larvae/10 plants), pink bollworm (larvae/ 20 green bolls) and tobacco caterpillar (larvae/ 10 plants) at weekly interval
- Record bollworm damage on boll and loculi basis at harvest
- Pheromone trap catches for bollworms
- Record population of predators on whole plant basis from 20 plants selected at random from each block at weekly intervals
- The immature stages of sucking pests and bollworms will be collected and brought back to laboratory and kept under caged conditions to record the emergence of parasitoids.
- Place sentinel cards (100 eggs/ card) of *Corcyra cephalonica*/ original host eggs uniformly in each block. Collect the cards after 24h of field exposure and record parasitism
- The specimens of natural enemies will be sent to NBAIR, Bangalore.
- Seed cotton yield from each plot

6. Screening for temperature tolerance in Cotton mealybug parasitoid, *Aenasius arizonensis* (Girault) (= *Aenasius bambawalei* Hayat) (PAU, IARI)

Screening for high temperature tolerance in parasitoid *A. arizonensis*
No of places to be sampled is 3 states i.e Punjab- culture will be provided by Dr.Shangla (PAU) Haryana and Delhi
Temperature – 27,32,37,40 and 45^{o}c
Exposure period 1, 2, 4 and 6 hrs
Observation to be taken
Effect of temperature on % parasitisation and emergence
Impact of high temperature on sex ratio of the parasitoid

4. TOBACCO

1. Bio-intensive integrated management of tobacco aphid, *Myzus nicotianae* Blackman in Central Black Soils of Andhra Pradesh (CTRI) (New)

Objective: To evaluate effective bio-module for the management of tobacco aphid under field conditions.

Treatments:

T1. Maize border (two rows) + two sprays of *Lecanicillium lecanii* @10^{13} spores/ha at and 65 days after planting (DAP)
T2. Maize border (two rows) + one spray of *Lecanicillium lecanii* @10^{13} spores/ha at 55 DAP and one spray of imidacloprid 0.03% at 65 DAP
T3. Maize border (two rows) + one spray of imidacloprid 0.03% at 55 DAP and one spray of thiomethaxam 0.02% at 65 DAP
T4. Maize border (two rows)
T5. Two sprays of *Lecanicillium lecanii* @10^{13} spores/ha at 55 and 65 days of planting
T6. One spray of *Lecanicillium lecanii* @10^{13} spores/ha at 55 DAP and one spray of imidacloprid 0.03% at 65 DAP
T7. One spray of imidacloprid 0.03% at 55 DAP and one spray of thiomethaxam 0.02% at 65 DAP
T8. Control (no border and no spray)

Replications: 3	Design: RBD
Variety: Siri (FCV)	Plot size: 15X15m

Observations:

1. Aphid infested plants
2. Aphid population (score) on 5 infested plants (top and middle leaf)
3. Sooty mold incidence
4. Yield parameters of tobacco (green leaf, cured leaf, bright leaf & grade index)

5. RICE

1 Seasonal abundance of predatory spiders in rice ecosystem (PAU)

Season: *Kharif*

Objective: To determine the diversity and fluctuation of spiders in relation to environmental factors as well as insect pests (prey).

Collection will be made during morning hours in two seasons

1. Kharif
2. Summer

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

Methodology to be followed:

1. Five fields of paddy will be randomly selected from the intense paddy growing area.
2. All the spiders will be 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 will be collected first. Later, each plant will be searched from top to bottom on leaves, tillers and panicles for spiders. Ground area near each plant within the quadrate will be searched. Collected specimens will be preserved in 70% ethanol with proper labelling of locality, date and area of the field.
3. Five pitfall traps on each border (20/field) will be installed in each field. Collections will be made on alternate days.
4. Adult males and females shall be identified upto spesies level with the help of available literature. Help from Dr. B. H. Patel, Retd. Professor of Zoology, Bhavnagar University, (expert in spider taxonomy) residing at Anand will be sought.
5. Data collected shall be subjected to analyses.

a) Species richness will be calculated using formula

Species richness (S) = number of species collected

b) 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 ($\log_e$)

c) 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.

d) 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

6. Comparison between the seasons and comparison with the data available of the year 2000 shall be carried out.

2. Diversity of insect pests and their natural enemies in organic and conventional rice (PAU)

Treatments

- Organic Rice
- Conventional rice

Plot size: One acre each divided into three blocks representing replicates
Variety/ hybrid: Any recommended variety

Observations

- Record the seasonal abundance of insect pests (stem borer, leaffolder, hispa, plant hoppers) and natural enemies from each plot.
- Record total tillers, dead hearts, total leaves, damaged leaves from 20 randomly selected hills from each block at weekly intervals
- Record total panicle bearing tillers and white ear heads prior to harvest.
- Pheromone trap catches for yellow stem borer
- Record population of plant hoppers from 20 randomly selected hills from each block at weekly intervals.
- Record natural enemies through sweep nets
- The eggs and immature stages of stem borers and leaffolder will be collected and brought back to laboratory and kept under caged conditions to record the emergence of parasitoids.
- Place sentinel cards (100 eggs/ card) of *Corcyra cephalonica*/ original host eggs uniformly in each block. Collect the cards after 24h of field exposure and record parasitism
- The specimens of natural enemies will be sent to NBAIR, Bangalore.

6. MAIZE

1.Bio suppression of *Chilo partellus* with *Trichogramma chilonis* on rabi Maize (ANGRAU, Anakapalle) (New)

Location: Regional Agricultural Research Station, Anakapalli.
Treatments :
Main plot treatments : T1, T2, T3
T1: Release of *Trichogramma chilonis* beginning from 15 DAE
T2: Release of *Trichogramma chilonis* beginning from 20 DAE
T3: Release of *Trichogramma chilonis* beginning from 25 DAE
Sub plot treatments : S1, S2, S3
Dosage :
S1: at the rate of 50,000/ha ,thrice at 7 day interval
S2 : at the rate of 75,000/ha ,thrice at 7 day interval
S3 : at the rate of 1,00,00/ha ,thrice at 7 day interval
DAE : Days after emergence
Design : Split plot design.
Replications : Three
Plot size : 15x20 m^2
Spacing : 60cmX20cm
Seed rate : 20kg/ha
Date of Sowing : December,2015 - January, 2016
Variety : DHM 117
Season : Rabi, 2015-2016.
Duration : Three years.

Observations:
1. Counts of dead hearts will be recorded at weekly interval starting from initial incidence of stem borer.
2. Leaf damage will be recorded at weekly interval starting from initial incidence of stem borer.
3. Cob Yield will be recorded at harvest.

2. Evaluation of NBAII entomopathogenic strains against maize stem borer (ANGRAU, Anakapalle) (New)

Location: Regional Agricultural Research Station, Anakapalli.
Treatments : 8
Dosage :

T1 : Bb 23 (1x 10^8 conidia /ml) @ 5 ml/lt
T2 : Bb 45 (1x 10^8 conidia /ml) @ 5 ml/
T3 : Bb 14 (1x 10^8 conidia /ml) @ 5 ml/
T4 : Ma 35 (1x 10^8 conidia /ml) @ 5 ml/
T5 : Ma 36 (1x 10^8 conidia /ml) @ 5 ml/t

T6 : Ma 52 (1 x 10^8 conidia /ml) @ 5 ml/
T7 : Carbofuran whorl application @ 8 kg/ha at 20 DAE
T8 : Untreated control
DAE : Days after emergence

Formulated isolates will be supplied by NBAIR, Bangalore and will be applied thrice at an interval of 30 days, starting from 20 day after emergence of plant

Design : RBD
Replications : Three
Plot size : 15x20 m^2
Spacing : 60cmX20cm
Seed rate : 20kg/ha
Date of Sowing : December,2015 - January, 2016
Variety : DHM 117
Season : Rabi, 2015-2016.
Duration
Three years.

Observations:

1.Counts of dead hearts will be recorded at weekly interval starting from initial incidence of stem borer.
2.Leaf damage will be recorded at weekly interval starting from initial incidence of stem borer.
3. Number of exit holes/plant.
4. Extent of stem tunneling.
5. Cob Yield will be recorded at harvest.

7. SORGHUM

1. Field evaluation of NBAII entomopathogenic strains against sugarcane stem borer, *Chilo partellus* (Swinhoe) in Kharif sorghum (IIMR)

Plot size 15 Sq m, Rep 03, Design: RBD, Likely Date of sowing: second week of August, 2013

Treatments
T1 : Bb 23 (1 x 10^8 conidia /ml) @ 5 ml/lt
T2 : Bb 45 (1x 10^8 conidia /ml) @ 5 ml/
T3 : Bb 14 (1x 10^8 conidia /ml) @ 5 ml/
T4 : Ma 35 (1 x 10^8 conidia /ml) @ 5 ml/
T5 : Ma 36 (1 x 10^8 conidia /ml) @ 5 ml/t
T6 : Ma 52 (1x 10^8 conidia /ml) @ 5 ml/
T7: Recommended practice (Insecticides)
T8. Control (Untreated)

Formulated isolates will be supplied by NBAIR, Bangalore and will be applied thrice at an interval of 30 days, starting from 20 day after emergence of plant.

8. PULSES

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

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

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:

1. % pod damage.
2. % seed damage
3. Pest severity
4. Yield data

***Bt* formulations will be supplied by NBAIR for the trials.**

2. Demonstration of NBAII liquid formulation (PDBC BT1 AND NBAII BTG4) against pigeon pea pod borer (*Helicoverpa armigera*) (AAU-A & UAS-R)

AAU-A

Demonstration will be carried out at farmer's field to control *Helicoverpa armigera* in pigeon pea. Three farmers will be selected for large scale demonstration of NBAII liquid formulation against pod borer in pigeon pea

Location: Farmer's fields (0.2 hector/ farmer)
Treatments: 1. PDBC-BT1 @ 2% spray
2. NBAII BTG4 @ 2% spray
3. Farmer's practices

Observations to be recorded:

1. No. of larvae per plant
2. Pod damage (%)
3. Grain damage (%)

UAS-R

Large scale demonstration of NBAII BTG 4 *Bt* isolate against pigeon pea pod borer (Area: 5 ha)

3. Evaluation of microbial agents for management of Lepidopteran pests on Moong bean (*Spodoptera litura, Helicoverpa armigera, Maruca vitrata*) (PAU)

Treatments: 07

1. PDBC-BT1 @ 1% spray
2. PDBC-BT1 @ 2% spray
3. NBAII-BTG4 @ 1% spray
4. NBAII-BTG4 @ 2% spray
5. Commercial formulation of Bt @ 300 g/acre
6. Chemical Control (Recommended insecticide)
7. Control

Spray schedule: 3 sprays (pre flowering, post flowering and pod emergence)
Design : RBD
Replications : 3
Variety : Any recommended variety
Plot size : 5 x 8 m.

Observations:

- Record number of webs (*Maruca vitrata*) from 5 tagged plants before and 7 days after spray.
- Record number of *Spodoptera litura* and *H. armigera* larvae before, 5 and 10 days after spray in each plot
- Total and damaged pods at harvest

- Record natural enemies from 5 plants in each plot
- Pod yield will be recorded on whole plot basis

4. Evaluation of IPM module o of Green gram (MPUAT) (New)

Treatments:

A. IPM Module

1. Seed treatment with Trichoderma spp @10 gms/kg seed
2. Installation of pheromone traps.
3. Two spray of 5% NSKE at vegetative stage.
4. To release *T. chilonis* @ 1 lakh/ ha first at pod formation stage, second at 10 days interval
5. Two spray of HaNPV first at flowering stage and second at 15 days after first spray.

B. Farmer's Practices

Observations to be taken:

- Plant mortality at 30 days and 60 days will be taken for 5 plants/plot
- Per cent pod damage will be taken at 5 randomly selected plants/ plant
- Yield

5. Evaluation of biocontrol agents against pod borers of cowpea (KAU) (New)

Design: RBD
Treatments: 7
Replication: 3
Variety: Lola
Plot size: 5x8 m^2

Treatments:

T1: Three sprays of *Beauveria bassiana* ($1x10^8$ spores/ml) @5g/litre at 7 days interval from flowering
T2: Three sprays of *B. bassiana* ($1x10^8$ spores/ml) @5g/litre at 15 days interval from flowering
T3: *Bacillus thuringiensis* NBAIR formulation @ 1 kg/ha at 7 days interval from flowering
T4: Three sprays of *Bt.* NBAIR formulation @ 1 kg/ha at 15 days interval from flowering
T5: Quinalphos 25EC –250g.a.i/ha
T6: Control

Observations:

Number of damaged fruits, yield per plot.

9. OILSEEDS

1. Biological suppression of safflower aphid, *Uroleucon compositae* on safflower (PJTSAU)

Objective of Experimentation:
As Non Spiny safflower is mainly is mainly used for Herbal Tea and other ancillary usages, evolving of certain eco friendly management practices for thier efficacy under field conditions became imperative to meet the requirement. Hence, the experimentation is planned to be carried out with the following set of treatments.

Treatments:

T1 *Verticillium lecanii* @ 1.5 x 10^{13} conidia/ha
T2 *Beauveria bassiana*@ 1.5 x 10^{13} conidia/ha
T3 *Metarhizium anisopliae* @ 1.5 x 10^{13} conidia/ha
T4 Azadirachtin 10000 ppm @5 ml /l
T5 Insecticidal check
T6 Untreated Control

Net 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 screen to be used to avoid drift into neighboring plots.

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

2. Biological suppression of mustard aphid, *Lipaphis erysimi* (MPKV)

Treatments:
T1: *Metarhizium anisopliae* (2x10^8 spores/g) @5g/litre
T2: *Lecanicillum lecanii* (2x10^8 spores/g) @5g/litre
T3: *Beauveria bassiana* (2x10^8 spores/g) @5g/litre
T4: NSKE @ 5% suspension
T5: *L. lecanii+ M. anisopliae* (2x10^8 spores/g) @5g/litre
T6: Dimethoate @ 0.06% spray
T7: Control
Methodology and observations: The trial will be laid out in RBD with 3 replications. Plot size: 5x8 m; Treatment applications will be started at initial occurrence of aphid colonies. In all, three sprays will be given during evening hours at fortnightly interval.

Observations:

1.Aphid population before treatment as pre-count and post count 5, 7 and 10 days after each spray (Aphid population will be recorded on 5 cm apical twig per plant from 5 randomly selected plants per plot)

2. Record seed yield per plot.

10. COCONUT

1. Entomopathogenic nematodes for management of Red palm weevil (*Rhynchophorus ferrugineus*) (CPCRI)

Isolation, pathogenicity studies &Field testing of EPN

Protocol:

T1: *H. indica* NBAIR strain talc formulation 100g/palm
T2: *S. carpocapsae* NBAIR strain talc formulation 100g/palm
T3: *S. abbasi* NBAIR strain talc formulation 100g/palm
T4: *H. Indica* CPCRI talc formulation 100g/palm
T5: *S. carpocapsae* CPCRI strain talc formulation 100g/palm
T6: Chemical recommendation

NBAIR to provide EPN formulations for the trials

Replications: 10 plants each

Treatments to be imposed as per the entomological requirements. Observe for infected grubs/adults 7-10 days after treatment.

11. TROPICAL FRUITS

1. Field evaluation of *Metarhizium anisopliae* formulation against mango hoppers (KAU, TNAU)

Protocol

1. Selection of mango orchard: Orchards having about 50- 100 trees are to be selected.

2. The selected blocks must be isolated from each other since hoppers are migratory.

Treatments:

BLOCK-1

S. No	No. of trees	Details of treatment	Frequency of spray	Observation
1	25 -50	*M.aniisopliae* $1x10^9$ 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 eneration) 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.aniisopliae* $1x10^9$ 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.aniisopliae* $1x10^7$ 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.

2. Survey, Collection, Identification and Mass Culturing of Trichogrammatids and Entomopathogenic Nematodes from Mango Ecosystem in Uttar Pradesh and Uttarakhand for evaluation against mango leaf webber (*Orthaga euadrusalis*) (CISH)

i. Entomopathogenic nematodes:

a. Survey and collection of soil samples and isolation of entomopathogenic nematodes (*Steinernema* spp. and *Heterorhabditis* spp.) from mango orchards of Uttar Pradesh and Uttarakhand**.**

Methodology:

Survey and collection of soil samples

Baiting with last instar larvae of greater wax moth

Isolation of entomopathogenic nematodes

Confirmation of Koch postulates and mass multiplication

b. Testing the bioefficacy of the isolated strains of entomopathogenic nematodes against mango leaf webber (*Orthaga euadrusalis*) under laboratory conditions.

Methodology:

Test insect: Last instar larvae of mango leaf webber (*Orthaga euadrusalis*)

EPN: Fresh infective juveniles (IJs) of *Steinernema*/*Heterorhabditis*

Doze: 50 and 500 IJs/insect

Arena: 6 well bioassay plate

Temperature and Relative humidity: 28 C and 65% in BOD

ii. Parasitoids

Survey and collection of natural enemies (predators and parasitoids) from mango orchards of Uttar Pradesh and Uttarakhand.

Lab rearing and Evaluation of trichogrammatids against leaf webber (*Orthaga euadrusalis*)

3. Monotor and record of incidence of papaya mealy bug and its natural enemies on papaya and other alternate hosts (AAU-A, MPKV, KAU, TNAU, NBAIR)

Monitor for the occurrence of papaya mealy bug on papaya & other hosts

Check for occurrence of *Acerophagus papayae*

Collect *A. papayae* from the host plants where they occur and distribute on host plants where the parasitoids are absent or less.

Other species of mealy bugs competitive to PMB for invasion of papaya and other crops will be recorded from different zones.

Survey for ascertaining the outbreak of mealybug will be carried out in 5 randomly selected villages in each district of middle Gujarat region to determine the infestation of papaya mealy bug, *P. marginatus*. Farmers' fields will be visited at fortnightly interval. Percentage of plants infested with mealy bug will be assessed by observing 25 randomly selected plants and intensity of damage (grade in the scale of 1-5) will be determined.

Grade	Population
	very low
	low
	medium
	high
	very high

Observations to be recorded:

1. Date of survey
2. Name and full address of the farmer
3. Crop plants infested.
4. Chemical pesticides if any used with dose
5. Existing natural enemies in 25 randomly selected plants
6. Papaya mealybug Parasitoid *Acerophagus papaya* will be released @ 10 days interval
7. Post observation on per cent parasitism will also recorded in release plot.

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

Replication : 10 no (Trees)
Design : RBD

Treatments

1. Stem injection with CAU-1 @50 ijs/ml
2. Stem injection with CAU-2@50 ijs/ml
3. Stem injection with CAU-3@50 ijs/ml
4. Stem injection with CAUH-1@50 ijs/ml
5. Stem injection with CAUH-2@50 ijs/ml
6. Cadaver application with CAU-1 @ 2 cadaver/plant (wrapping cadaver by muslin cloth and binding at one meter height from the ground level).
7. Cadaver application with CAU-2 @ 2 cadaver/plant (wrapping cadaver by muslin cloth and binding at one meter height from the ground level).
8. Cadaver application with CAU-3 @ 2 cadaver/plant (wrapping cadaver by muslin cloth and binding at one meter height from the ground level).
9. Cadaver application with CAUH-1 @ 2 cadaver/plant (wrapping cadaver by muslin cloth and binding at one meter height from the ground level).
10. Cadaver application with CAUH-2 @ 2 cadaver/plant (wrapping cadaver by muslin cloth and binding at one meter height from the ground level).
11. Stem injection with NBAII-1@50 ijs/ml
12. Cadaver application with NBAII @ 2 cadaver/plant (wrapping cadaver by muslin cloth and binding at one meter height from the ground level).
13. Untreated control

The experiment will be carried out at two locations (Pasighat and Ringging) of Arunachal Pradesh against Citrus trunk borer, *Anoplophora versteegi*. Two rounds of application will be made once during last week of April and the second application at second week of May. Observations will be 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

expelled. For application of the EPNs, in each location three orchards will be selected and in each orchard, five infested plants will selected for each treatment.

6. Field evaluation of entomopathogens against banana pseudostem weevil (KAU)

Design: RBD
Treatments: 6
Replication: 6 (4plants/rep.)
Treatments
T1: *Metarhizium anisopliae* (10^8 spores/ ml) - leaf axil filling
T2: *M. anisopliae* (10^8 spores/ ml) – spraying
T3: *Beauveria bassiana* (10^8 spores/ ml) - leaf axil filling
T4: *B. bassiana* (10^8 spores/ ml) – spraying
T5: Chlorpyriphos spraying @ 2.5 ml/l
T6: Control
Observations: Number of infested plants in each treatment
Mean number of grubs per plant at harvest

7. Field evaluation of entomopathogens against pineapple mealybug, *Dysmicoccus brevipes* (KAU)

Design: RBD
Treatments : 5
Replication: 9 (1 plant/replication)
T1: *Lecanicillium lecanii* @ 10^7 spores/ml
T2: *Lecanicillium lecanii* @ 10^8 spores/ml
T3: *Lecanicillium lecanii* @ 10^9 spores/ml
T4: Imidacloprid 0.3ml/l
T5:Control
Observations: Pre and post count of mealy bugs

8. Laboratory and field evaluation of entomopathogenic fungi against banana root mealy bug *Geococcus citrinus*

Design: CRD
Replication: 3
Treatments: 11
Treatments
T1-T3: *Lecanicillium lecanii* @ 10^7, 10^8, 10^9 spores/ml
T4-T6: *Beauveria bassiana* @ 10^7, 10^8, 10^9 spores/ml
T7-T9: *Metarhizium anisopliae* @ 10^7, 10^8, 10^9 spores/ml
T10: Chlorpyriphos spraying @ 2.5 ml/l
T11: Control
Observations: Per cent mortality, mycosis
Superior treatments will be evaluated in field following standard procedure.
Observations: Pre and post count of mealy bugs

9.Laboratory evaluation of entomopathogenic fungi against pepper root mealybug *Formicoccus polysperes* (KAU)

Design: CRD
Replication: 3
Treatments: 11
Treatments
T1-T3: *Lecanicillium lecanii* @ 10^7, 10^8, 10^9 spores/ml
T4-T6: *Beauveria bassiana* @ 10^7, 10^8, 10^9 spores/ml
T7-T9: *Metarhizium anisopliae* @ 10^7, 10^8, 10^9 spores/ml
T10: Chlorpyriphos spraying @ 2.5 ml/l
T11: Control
Observations: Per cent mortality, mycosis

12. TEMPERATE FRUITS

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

Treatments:
T1: *Steinernema* sp. 80 IJ/cm ^{2}
T2: *Heterorhabditis* sp. 80 IJ /cm ^{2}
T3: *Beauveria bassiana* @10 ^{6} conidia/cm ^{2}
T4: *Metarrhizium anisoplae* @ 10 ^{6} conidia / cm ^{2}
T5: Chlorpyriphos @ 0.06%
T6: Absolute Control

Replications: 4

Observation to be recorded:
The treatments will be applied during July (at the time of fresh infestation). The observations will be recorded during November.
The larval population in different treatments will be compared with control. The soil sample will also be drawn for the recovery of EPNs.

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

Location: Leh & Kargil

1. Survey of apple and apricot orchards for the presence of GV, *Trichogramma* and other natural enemies
2. Collection of infested larvae of codling moth and identification of associated entomopathogens
3. Exploration of indigenous *Trichogramma* spp., through sentinel cards, their identification and mass production for future exploitation

3. Evaluation of predatory mite, *Blaptostethus pallescens* against European red mite *Panonychus ulmi* on apple (SKUAST)

i. Collection of ERM infested apple leaves
ii. Release of nymphs and adults on infested leaves
iii. To study the response of *B. pallescens* against eggs of ERM in laboratory conditions

Observations to be recorded:

- Predatory potential of nymphs and adults of *B. pallescens*
- Per cent reduction of ERM eggs
- Determination of prey : predator ratio

4. Field evaluation of *Trichogramma embryophagum* and *T. cacoeciae* against codling moth, *Cydia pomonella* on apple (SKUAST)

1: *T.embryophagum* @ 100,000/ ha.
2: *T. cacoeciae* @ 100, 000/ha.
3: Insect pheromone subject to availability

Location: Laddakh
Plot size: Approximately 500 m^2 each (As per the availability of plants)
Replication: 10
Observations to be recorded:

i. Field persistence of parasitoids by placing sentinel *Corcyra* egg cards
ii. Per cent fruit damage
iii. Yield at harvest

5. Field evaluation of anthocorid bug, *Blaptostethus pallescens* against two spotted spider mites, *Tetranychus urticae* on apple (SKUAST) (New)

Details of Treatment :

Crop	**Apple**
Variety	Red delicious
Treatments	05 (5 weekly releases)

T1 100 nymphs/ plant
T2: 200 nymphs/ plant
T3 Untreated control
Replication :05

Observations to be recorded :

- % Decline in mites' population/ 10 leaves
- Survival ability of released bug recorded/ week
- Comparison of data with untreated check

13. VEGETABLES

1. Demonstration of BIPM package fro management of key pests of tomato (TNAU, AAU-J, MPUAT, SKUAST)

TNAU

T_1 BIPM package

- Spraying of *Pseudomonas* 2% solution on protray/seed bed one day before pulling out of seedlings
- African Marigold as trap crop
- Installation of yellow sticky trap @ 50 No's /ha.
- Installation of bird perches @ 10/ha.
- Need based application of *B.t* and NPV based on pheromone monitoring
- Sucking pests management through NSKE/ Neem oil emulsion /Azadirachtin spray
- Release of *Trichogramma pretiosum* @ 50,000 No's /ha.
- Release of *Chrysopa* grubs @ 50,000 No's /ha.

T_2 Farmer's practice
Plot size : One acre/treatment

Observations

- Population of aphids, thrips, leafhoppers, whiteflies and fruit borer will be recorded at 15 days interval
- Natural enemy activity will be recorded
- Yield will be recorded at harvest

MPUAT

Treatments:

1. Installation of pheromone trap 5/ha.
2. Six release of *Trichogramma* starting at flowering stage in tomato.
3. Two sprays of Bt @ 1 kg/ha first at flowering stage and second after 15 days of first
4. Two sprays of HaNPV first at flowering stage and second after 15 days of first spray

AAU-J (New)

Experimental details:
Location: Farmers field (Uttar garumara, Jorhat)
Target pest: Tomato fruit borer, *Helicoverpa armigera*
Area : 0.5 hectare/ treatment
Year of commencement:2015-16

Tratments : 3

T1= BIPM Package

- Seedling root dip with *Pseudomonas* 2% solution
- Installation of yellow sticky trap @50 no./ha
- Installation of bird perches @10/ha
- Spray of NSKE@5% against sucking pest
- Raising of African marigold as trap crop (planting a row of marigold after 14 rows of tomato)
- Use of sex pheromone traps @ 5/ha for each *Helicoverpa armigera, Spodoptera litura*
- Six release of *Trichogramma chilonis* @ 1,00,000/ha from flower initiation stage at weekly intervals
- Rouging of leaf curl disease affected plants
- Regular collection and destruction of damage fruits
- Need based spray of HaNPV

T2= Chemical control
T3= Untreated Control

Observations:

- Population of aphids, whiteflies, thrips, per cent damage of leafminer and fruit borer will be recorded.
- Natural enemies population will be recorded.
- Yield will be recorded at each picking
- Per cent yield loss, increase in yield over control will be worked out

YSPUHF (New)

Treatments
For *Helicoverpa armigera*:

i. *Trichgramma chilonis* @100000/ha – 3-4 releases
ii. Neem pesticide @ 2-5ml/l of 1500ppm azadirachtin
iii. NPV of *H.armigera* @250 LE/ha
iv. *Bt formulation* @ 1.0kg/ha
v. Chemical control (deltamethrin @ 0.0028%)
vi. Untreated control

For greenhouse whitefly, *Trialeurodes vaporariorum*:

i. Release of *Chrysoperla* larva @ 1/plant
ii. *Verticillium lecanii (*NBAIR Strain) (1 x 10^8 spores/g) @ 5g / litre
iii. Neem pesticide @ 2-5ml/l of 1500 ppm azadirachtin
iv. Chemical control (methyl demeton @0.025% or triazophos@0.08%)
v. vi Untreated control

For phytophagus mites:

i. Release of *Neoseiulus longispinosus* @ 5 mites/plant
ii. Release of *Neoseiulus longispinosus* @ 10 mites/plant
iii. Neem 1500 ppm azadirachtin@2-5ml/l

iv. Chemical control (fenazaquin @0.0025%)
v. Untreated control

Design: RBD, replications: 5, plot size2x5m

Observations to be recorded

1. Number of larvae of *H.armigera* per plant from 5 plants per replication before and 7 days after application
2. Population of whitefly nymphs before and 7 days after application on 3 leaves/plant from 5 plants per replication
3. Population of mites before and 7 days after application on 3 leaves/plant from 5 plants per replication

2. Survey and Surveillance of Ne's of Pin Worm, *Tuta Absoluta* on Tomato (AAU-A, AAU-J, KAU, MPKV, MPUAT, PAU, PJSTAU, SKUAST, YSPUHF, CAU, UAS-R, IIVR, IIHR) (New)

Monitoring the activity of adult moths by sex pheromone

	Particulars	**Details**
1	*T. absoluta* pheromone source	BCRL, Bangalore
2.	Loading type	Water pan / yellow sticky trap
3	Number of traps to be installed	Two per acre or in a small holding less than an acre
4	Period of operation	Seedling stage to last harvest
5	Placement in field	Place the traps at canopy level
6	Observations	Count the moth catches at weekly interval
7	Replacement of pheromone septa	Every 4-6 weeks
8	Crops to be monitored	Tomato, potato, brinjal, chilli/capsicum and tobacco

Monitoring crop damage:

	Particulars	**Details**
1	Leaf damage	Select 10 plants randomely for approximately every 100 sq m crop area and observe all the leaves /leaflets for the presence of leaf mine caused by larva Start the observation from seedling to last harvest at weekly interval Workout the damage percentage
2.	Fruit damage(Fruits of tomato, brinjal, chilli/ capsicum and tubers of potato)	Select 10 plants randomely for approximately every 100 sq m crop area and observe all the fruits for the presence of pin head sized holes / damage caused by larva Start the observation from fruit formation till last harvest at weekly interval Work out the damage percentage
3	Crops to be observed	Tomato, potato, brinjal, chilli/capsicum and tobacco

- The natural enemies will be collected from the tomato plant parts affected by *Tuta absoluta*
- The Bioagents will be collected, cultured and send for identification to the NBAIR, Bangalore.
- The observations will be recorded on alternate host plants

3. Biological suppression of American pinworm, *Tuta absoluta* on tomato (MPKV, AAU-A, UAS-R, PJSTAU, IIHR) (New)

Treatments:

T1: *Trichogramma achaeae* @ 50000 per release (6 releases)
T2: *Trichogramma pretiosum* @ 50000 per release (6 releases)
T3: *Metarhizium anisopliae* @ 10^8 conidia/ ml
T4: *Lecanicillum lecanii* @ 10^8 conidia/ ml
T5: *Beauveria bassiana* @ 10^8 conidia/ ml
T6: Azadirachtin 1000 ppm @ 2 ml/lit.
T7: Indoxacarb @ 2 ml/ha
T8: Control

Methodology and observations: The trial will be laid out in RBD with 3 replications. Plot size: 3 x 2 m^2; Treatment applications will be started at initial occurrence of American pin worm. In all, three sprays will be given during evening hours at fortnightly interval.

Observations:

1. Randomly selected 10 plants per 100 m^2 crop area and observed all the leaves for presence of leaf mine caused by larva.
2. Observations will be recorded at weekly interval from seedling to last harvest.
3. Work out the leaf damage percentage.
4. Randomly selected 10 plants per 100 m^2 crop area and observed all the fruits for the presence of pin head sized holes/damage caused by larva.
5. Observations will be recorded at weekly interval from fruit formation to last harvest.
6. Work out the fruit damage percentage

4. Biological control of Brinjal mealy bug *Coccidohystrix insolitus* (TNAU)

T_1 Release of *cryptolaemus* @ 1500/ha
T_2 Release of *Scymnus*@ 1500/ha
T_3 Release of *Brumus suturoides* @ 1500/ha
T_4 *Verticillium lecanii* 10^8 cfu /ml
T_5 *Chrysopa* 50,000 first instar grubs/ha
T_6 Profenphos 50 EC 2ml /l
T_7 Control

Plot size: 4x5m
No. of releases: Based on pest intensity

Observations:

i. Observations on mealybug will be recorded on 3 leaves/plant.
ii. Record number of predators (adult)/plant.
iii. Yield data at harvest

5. Biological suppression of shoot and fruit borer, *Leucinodes orbonalis* in brinjal (MPKV)

Treatments:

T1: *Nomuraea rileyi* @ 10^8 conidia/ ml
T2: *Metarhizium anisopliae* @ 10^8 conidia/ ml
T3: *Beauveria bassiana* @ 10^8 conidia/ ml
T4: *Trichogramma chilonis* @ 60,000 parasitoids/ha, 15 releases
T5: *B. thuringiensis* @ 1 kg/ha
T6: NSKE 5%
T7: Chlorpyriphos @ 0.04% spray
T8: Untreated control

Methodology: Plot size: 3 x 2 m.

- Monitoring the incidence of *L. orbonalis* using pheromone traps.
- Releases of parasitoids and sprays of entomopathogens, *Bt* and NSKE will be followed at weekly interval starting from 50% flowering stage of the crop.

Observations: The observations will be recorded on five randomly selected plants/ plot.

1. Pre-treatment incidence on shoot infestation and catches from pheromone traps.
2. Post-counts of shoot and fruit infestation at weekly interval.
3. Yield of healthy marketable fruits at each picking.

6. Validation of different BIPM modules against shoot and fruit borer, *Leucinodes orbonalis* in brinjal (PAU)

Treatments:

i. *Trichogramma chilonis (Tc)* @ 50,000/ ha, 6 releases
ii. *Trichogramma chilonis* + NSKE 5% suspension (*Tc*+*Tc*+NSKE+*Tc*+*Tc*+NSKE)
iii. *Trichogramma chilonis*+ *Bacillus thuringiensis* @1 kg/ha (*Tc*+*Tc*+*Bt*+*Tc*+*Tc*+*Bt*)
iv. *Trichogramma chilonis*+ NSKE 5% suspension + *Bacillus thuringiensis* @ 1 kg/ ha (Tc+ NSKE +Bt+Tc +NSKE+Bt)
v. NSKE 5% suspension+ *B. thuringiensis* @ 1 kg/ha (NSKE + NSKE + *Bt* + NSKE + NSKE+*Bt*)
vi. Farmer's practice
vii. Untreated control.

Plot size: 15×6 m block divided into 3 subplots as replicates.

Methodology:

i. Hand collection and destruction of infested shoots along with larval stages of *L. orbonalis* before treatment and application

ii. Monitoring the incidence of *L. orbonalis* using pheromone traps
iii. Releases of parasitoids and/or sprays of NSE and Bt will be followed at weekly intervals starting from 50 % flowering stage of the crop.

Observations:

Observations will be recorded from five randomly selected plants/ plot

i. Pre-treatment pest incidence based on percent shoots infested and catches from pheromone traps
ii. Post counts of percent shoot and fruit infestation at weekly intervals
iii. Record percent parasitism by *T. chilonis* through retrieval by placing sentinels *Corcyra* egg-cards containing 100 eggs each at three spots in each block.
iv. Yield of healthy marketable fruits at each picking.

7. Development of Bio- control base IPM module against *Leucinodes orbanalis* of Brinjal (AAU-J) (New)

Location: Farmes' field, *Dang dhora,* Titabar, Jorhat
Plot size: 500 sq.m
Crop: Brinjal
Variety: JC-1
Replication: 10
Treatments: 2

T1

- Application of MOC @ 250 kg /ha 5 days before transplantation of crop
- Use of sex pheromone traps @10 /ha for *L. orbanalis*
- Mechanical collection and destruction of infested shoots and fruits
- Six releases of *Trichogramma chilonis* @ 10,00,000 /ha /week at 10 days interval
- Spray of NSKE 5 % (three round of spray from vegetative stage at 15 days interval)
- Two spray of Bt @ 1kg /ha (before flowering and 10 days after flowering)

T2 = Farmers practice (chemical module)
Alternate spray with trizophos@ 500 g *a.i*/ha and cypermethrin @ 50 g a.i /ha and bifenthrin @ 50 gm ai/ha

Observations to be recorded:

- Pre and post treatment count of shoot and fruit infestation (%) from 10 randomly selected plant
- Collection of larvae for emergence of parasitoids
- Yield data at each harvest

8. Bio-efficacy evaluation of EPN formulations of NBAIR against ash weevil in Brinjal (TNAU) (New)

Treatments

T1. Soil application of EPN WP formulation of NBAIR – 20kg/ha
T2. Soil application of *Metarhizium anisopliae* NBAIR formulation @ 2.5kg+250kgFYM/ha
T3. Soil application of *Metarhizium anisopliae*TNAU formulation @ 2.5kg+250kgFYM/ha

T4. Soil application of EPN (20kg/ha)+*Metarhizium anisopliae* NBAIR @ 2.5kg+250kgFYM/ha
T5. Soil application of EPN (20kg/ha)+*Metarhizium anisopliae* TNAU @ 2.5kg+250kgFYM/ha
T6. Neem cake 100 kg/ acre as amendment in basal and one month after planting.
T7. Soil drenching with Chlorpyriphos 5ml /l of water
T6. Control

- No of replication- 3
- Plot size: 5×4 m

Observations

30 days and 45 days after application of inoculants in soil
10 plants per replication
No of adult weevils per plant.
Per cent leaf damage.
Grub population per square meter soil area.

9. Bio-efficacy of microbial insecticides against *Spodoptera litura* in cabbage (AAU-A)

Experimental details:

1. Treatments : 10
2. Replication : 03
3. Design : Randomized Block Design (RBD)
4. Crop / variety : Cabbage (Local variety)
5. Plot size : Gross : 4.5 x 3.15 cm
   i. Net : 3.6 x 2.25 cm
6. Spacing : 45 cm x 45 cm

Details of treatments:

T_1 : *Bacillus thuringiensis* 1.0 kg/ha
T_2 : *Bacillus thuringiensis* 2.0 kg/ha
T_3 : *Beauveria bassiana* (1 x 10^8 spores/g) @ 3g / litre
T_4 : *Metarhizium anisopliae* (1 x 10^8 spores/g) @ 3g / litre
T_5 : *Metarhizium anisopliae* (1 x 10^8 spores/g) @ 4g / litre
T_6 *Nomurea rileyi* (1 x 10^8 spores/g) @ 3g / litre
T_7 *Nomurea rileyi* (1 x 10^8 spores/g) @ 4g / litre
T_8 *SI* NPV 1 x 10^{10} POB/ha
T_9 Recommended insecticide
T_{10} Control (water spray)

Observation to be recorded:

1. No. of larva(e) /plant
2. Cabbage head damage (%)
3. Yield (q/ha)

Methodology:

Standard agronomical practices were followed for raising the crop. The first spray of respective microbial insecticides will be applied as per the treatments on appearance of *Spodoptera* and subsequently two sprays will be given at 15 days interval. For recording the observation of *Spodoptera* larval population five plants will be select and tag from each net plot area. The observations will be recorded prior to first spray as well as 3 and 7 days of each spray. Similarly, per cent cabbage head damage by *S. litura* will be assessed by counting the healthy and damaged cabbage head from the each plot during picking. Treatment wise yield will also be recorded separately.

10. Role of habitat manipulation on natural enemies of cabbage pests (AAU-J) (New)

Location: Horticultural Orchard, AAU, Jorhat
Plot size: 137.5 sq.m.(27.5 X 5)
Treatments: 5
Design: Exported Block Design

Treatments:
T1 = Cabbage intercropped with mustard and cowpea
T2 = Cabbage intercropped with mustard and sorghum as border crop
T3 = cabbage intercropped with cowpea and sorghum as border crop
T4 = cabbage with sorghum as border crop
T5 = cabbage as sole crop.

Observations:

- Larval counts of lepidopteran and sucking pests randomly from 5 plants from each treatment at 7 days interval starting from 20 DAP.
- Counting of natural enemies in 5 randomly selected plants in each treatment at 7 days interval from 20 DAP
- Eggs and larvae of lepidopteran pests and immature stages of sucking pests will be collected and kept in laboratory for emergence of parasitoids, if any
- Collection of information of activities of pests and natural enemies on the border as well as inter crop will be recorded in 5 randomly selected plants in each treatment at 7 days interval starting from 20 DAP
- Yield data of border crop, intercrop and sole crop will be recorded individually.

11. Efficacy of *Bt* strains against Diamond backmoth in Cauliflower (TNAU)

Treatments:
T_1 PDBC-BT1 @ 1% spray
T_2 PDBC-BT1 @ 2% spray
T_3 NBAII-BTG4 @ 1% spray
T_4 NBAII-BTG4 @ 2% spray
T_5 *Beauveria bassiana* @ 2.0kg/ha
T_6 NSKE 5%
T_7 Chlorpyriphos @ 0.04 % spray
T_8 control

Spray schedule: 3 sprays at 15 days interval
Design: RBD
Replications: 3
Crop / variety: cauliflower
Plot size: 5 x 8 m.

Observations:
Pest population at 15 days interval
Yield data at harvest

***Bt* formulations will be supplied by NBAIR for the trials.**

12. Field evaluation of biocontrol based IPM module against pests of cauliflower/ cabbage (*Plutella xylostella, Spodoptera litura, Pieris brassicae*) (PAU)

Treatments:
a. BIPM Module

1. Release of *Chrysoperla zastrowi sillemi* @ 5 larvae/ plant against aphids
2. Planting of mustard crop to collect and destroy eggs of *P. xylostella*
3. Spray of NSKE 5%
4. Release of *T. chilonis* and *T. brassicae* @ 1,00,000/ ha against *S. litura* and *P. xylostella*, respectively at 7 days interval when moths or eggs are seen in the field
5. Release of *T. pieridis* @1,00,000/ ha against *P. brassicae*
6. Release of *Cotesia glomerata* cocoons against *P. brassicae*
7. Mechanical collection and destruction of *P. brassicae* eggs at weekly interval.
8. Spray of Bt formulation (Delfin WG) @ 750g/ ha

b. Farmers Practice: Need based application of chemical insecticides like Spinosad 2.5%
c. Control

Replications 4, Plot size 4×4 m, Design RBD

Observation to be recorded:

i. Population of lepidopteran pests at 15 days interval on 5 plants / replication
ii. Population of natural enemies on observed plants
iii. Yield at harvest

13. Evaluation of fungal pathogens against sucking pests of hot chilli (*Capsicum sinensis*) (AAU-J)

Target pests: aphid,Jassid and mite
Plot size: 3mx3m
Replication: Three
Treatment: to be included

Treatment details:
1.)Metarhizium anisopliae: (1 x 10^8 spores/g) @ 5g / litre
2) *Beauveria bassiana* : (1 x 10^8 spores/g) @ 5g / litre
3) Imidacloprid @15 g ai/ha
4) Untreated control
The NBAII entomopathogenic strains are to be included in the treatment details along with local strains

The treatment will be imposed coinciding with the occurrence of Sucking pests (aphid,Jassid and mite)
Obsevations:

- Population of the pests will be recorded from 5 randomly selected plants before treatment as well as 5 and 7 days after each treatment
- Population of natural enemies of target pest
- Per cent leaf damage by target pests
- Yield per plot
- C;B ratio

14. **Evaluation of different entomopathogenic fungi (EPF) against sucking pests of chilli (*Capsicum annum*) (IIVR) (New)**

Target pests – *Polyphagoustarsonemus latus, Scirtothrips dorsalis, Aphis gossypii, Bemisia tabaci*
Plot size – 4 m X 4.5 m
Variety – Kashi Anmol
Replication – 3
Fertilizer dose – 120:60:60 kg (N:P:K)
Treatments –

- *Metarhizium anisopliae* (IIVR strain) (1 x 10^8 spores/g) @ 5g / litre
- *Beauveria bassiana* (IIVR strain) (1 x 10^8 spores/g) @ 5g / litre
- *Metarhizium anisopliae* (Ma-4) NBAIR strain (1 x 10^8 spores/g) @ 5g / litre
- *Beauveria bassiana* (Bb-5a) NBAIR Strain (1 x 10^8 spores/g) @ 5g / litre
- Imidacloprid @ 0.35 ml/lit
- Untreated control

Data to be taken –

- Number of each sucking pests on five randomly selected plants from each plots at 10 leaves (top, middle and bottom) before and after spraying at regular intervals
- Yield (q/ha) on each treatments

15. Development of bio-intensive IPM package for the suppression of insect pests of capsicum under field conditions (YSPUHF) (New)

Treatments
For aphids
Release of *Chrysoperla* larva @ 1/plant

i. *Verticillium lecanii* (NBAIR Strain) (1 x 10^8 spores/g) @ 5g / litre

ii. Neem pesticide @ 2-5ml/l of 1500 ppm azadirachtin
iii. Chemical control (methyl demeton @0.025%)
iv. Untreated control

For *Spodoptera litura*

i. Neem pesticide @ 2-5ml/l of 1500ppm azadirachtin
ii. NPV of *S.litura* @ 250LE/ha
iii. Bt formulation @ 1.0Kg/ha
iv. Chemical control (malathion @ 0.05%)
v. Untreated control

Design: RBD, replications: 5, plot size 2x5m

Observations to be recorded

1. Population of aphids before and 7 days after application on 3 leaves/ plant from 5 plants per replication
2. Population of *S.litura* before and 7 days after application on 5 plants per replication

16. Biological suppression of fruit borer, *Earis vitella* in okra (MPKV)

Treatments:

T1: *Lacanicillium lecanni* (1 x 10^8 spores/g) @ 5g / litre
T2: *Metarhizium anisopliae* (1 x 10^8 spores/g) @ 5g / litre
T3: *Beauveria bassiana* (1 x 10^8 spores/g) @ 5g / litre
T4: *Trichogramma chilonis* @ 60,000 parasitoids/ha, 15 releases
T5: *B. thuringiensis* @ 1 kg/ha
T6: NSKE 5%
T7: Chlorpyriphos @ 0.04% spray
T8: Untreated control

Methodology: Plot size: 3 x 2 m.

- Releases of parasitoids and sprays of entomopathogens, *Bt* and NSKE will be followed at fortnightly interval.

Observations: The observations will be recorded on five randomly selected plants/ plot.
1. Pre and post- treatment counts on fruit infestation at weekly interval.
2. Yield of healthy marketable fruits at each picking.

17. Evaluation of Bio-intensive IPM module against *Aleurodicus dispersus* on cassava (TNAU)

Crop: Tapioca
Design: RBD
Spacing: 60 x 60 cm

T_1 Bio-intensive IPM

The biointensive IPM consists of the following components

- Yellow sticky traps @ 12 per ha for monitoring
- Release of *Encarsia gaudalopae* @ 4 parasitized pupae per plant

- Release of *Mallada* @ 50,000 first instar grubs per ha
- Application of entomopathogens *viz*., V. *lecanii* and *P. fumosoroseus* @ 1 x 10^8 conidia per ml
- Application of NSKE 5% or neem oil 3%
- Application of triazophos 20% EC @ 2 ml/l or acephate 75 SP @ 2 g/l

T_2 Farmer's practice

T_3 Control

Observations: *A. dispersus* population per leaf and population of parasitoids and predators will be recorded from 10 randomly selected plants at 15 days interval. Economic analysis of BIPM modules involving yield and the cost benefit ratio (CBR) will be estimated.

18. Evaluation of predatory mite, *Blaptostethus pallescens* against saffron thrips on saffron (SKUAST)

- Collection of saffron thrips during flowering period of saffron
- To study the response of *B. pallescens* against saffron thrips in laboratory conditions

Observations to be recorded:
Predatory potential of nymphs and adults of *B. pallescens*

19. Biological Suppression of Bud Worm (*Hendecas*is sp) and Blossom Midge (*Contarinia* sp) in Jasmine (TNAU) (New)

Crop: Jasmine (Guntu Malli)
Treatments:

T1 -NSKE 5 % three times starting from bud initiation stage at 10 days interval
T2 -Release of *T. chilonis* @ 40,000/ acre at 10 days interval for two months from bud initiation based on light trap monitoring
T3 - T2+ three rounds of spraying with *Beauveria bassiana* NBAIR formulation (1 x 10^8 spores/g) @ 5g / litre at 10 days interval
T4 - T2+ three rounds of spraying with *Metarhizium anisopliae* NBAIR formulation (1 x 10^8 spores/g) @ 5g / litre at 10 days interval
T5 - Soil drenching with *Metarhizium anisopliae* 10^{13} spores/ha- two times at fifteen days interval
T6 - Soil application of Neem cake @100 kg/acre two times per year
T7- Soil application of Carbofuran 3G @ 20 gm/plant
T8- Control

- No. of plants per replication: 10
- No. of Replications: 3

Observations

- 3 branches / plant / replication
- No. of infested buds/ flowers will be counted on 7, 15 days after each application
- Per cent damage, yield will be worked out

20 Effect of host plants on natural parasitism of *Diaphania* indica by the larval parasitoid D*olichogenidea stantoni* (IIHR) (New)

Crops: Cucumber, bitter gourd and ridge gourd

15. MEALYBUGS

1. Monitoring the biodiversity and outbreaks of invasive mealy bugs on major horticultural crops (TNAU, KAU)

a) Fortnightly surveys will be conducted in orchards/fields for mealy bug incidence. Infested plant parts will be brought back to the laboratory and held under caged conditions for emergence of natural enemies.
b) Alternate host plants, if any, to be recorded.
c) Specimens of mealy bugs and natural enemies collected will be sent to NBAII.
d) Crop - wise records will be maintained for extent of damage by the mealy bug, level of natural enemies present, etc. to be maintained
e) If invasive species of mealy bugs are observed during the surveys, it is to be brought to the notice of the Director, NBAIIR

III. BIOLOGICAL SUPPRESSION OF POLYHOUSE CROP PESTS

1. Monitoring the diversity of pests and natural enemies in chrysanthemum in Poly house conditions (TNAU)

a. Survey will be conducted monthly intervals in polyhouses for the incidence of major pests and their natural enemies. Infested plant parts will be collected and observed for the emergence of natural enemies.
b. Alternate host plants, if any will be recorded

2. Evaluation of anthocorid predator, *Blaptosthetus pallescens* against spider mites in poly houses (PAU)

Crops: Brinjal, Chilli, Okra
Treatments:
a) *Blaptostethus pallescens* @ 10 nymphs/ m row
b) *Blaptostethus pallescens* @ 20 nymphs/m row
c) *Blaptostethus pallescens* @ 30 nymphs/m row
d) Chemical control (Recommended dose of acaricide)
e) Untreated control

- Six releases will be made at weekly intervals on appearance of pest.
- Spray of insecticide as per recommendation
- Plot size: 2×3 m; Net house
- Replications: Three

Observations:

- Mite population from 10 randomly selected plants before release or spray
- Mite population from 10 randomly selected plants after 7 days of treatment
- Number of leaves with yellow specks or webbing and percent leaf damage will be calculated
- Marketable yield

3. Evaluation of efficacy of predators against cabbage aphids in polyhouses (SKUAST)

Crop: Cabbage & Kale
T1: 5 Weekly releases of 2nd instar grubs of *Coccinella septumpunctata* @ 5/ plant
T2: 5 Weekly releases of 2nd instar grubs of *C. undecimpunctata* @ 5/ plant
T3: 5 Weekly releases of 2nd instar grubs of *Chrysoperla z. sillemi* @ 5/ plant
T4: Chemical control (endosulfan @ 1 ml/ lit)
T5: Untreated Check

Observations to be recorded:

i. No. of aphids/ 10 leaves before treatment
ii. No. of aphids/ 10 leaves after every treatment
iii. Per cent Leaf infestation/ 10 plants
iv. Yield at harvest

4. Evaluation of entomopathogenic fungi against mite, *Tetranychus urticae* on capsicum/bell pepper under protected conditions (PAU)

Treatments:
1. *Beauveria bassiana* (1 x 10^8 spores/g) @ 5g / litre
2. *Metarrhizium anisopliae* (1 x 10^8 spores/g) @ 5g / litre
3. *Lecanicillium lecanii* (1 x 10^8 spores/g) @ 5g / litre
4. Standard chemical insecticide/ acaricide
5. Untreated control

Variety: Recommended variety

Replications: 3
Observations:
1.Mite population from selected leaves before spray
2. Mite population from selected plants 7 days after spray.
3. Yield

5. Biological management of red spider mite *Tetranychus urticae* infesting rose in polyhouse conditions (MPKV)

Treatments:
T1: *Lecanicillium lecanii* (1 x 10^8 spores/g) @ 5g / litre
T2: *Hirsutella thompsonii* (1 x 10^8 spores/g) @ 5g / litre
T3: *Beauveria bassiana* (1 x 10^8 spores/g) @ 5g / litre
T4: *Metarhizium anisopliae* (1 x 10^8 spores/g) @ 5g / litre
T5: Predatory mite
T6: Abamectin 0.3 ml/litT7: Untreated control

Observations:

- Initial mite population per plant on 3 leaves from 10 plants.
- Mite population 7 days after each spray.
- Yield parameters.

Methodology: Micro-plot/pot size: 1.5 x 1.0 m; Replications: Three

1. Planting of seedlings in raised beds/plastic pots.
2. Apply organic manure as per recommendations.

6. Evaluation of biocontrol agents against sap sucking insect pests of ornamentals in polyhouses. (YSPUHF)

Crop: Rose
Design: RBD
Plot size: 2x5m
Replications: 4

Treatments:

a. *Beauveria bassiana* (1 x 10^8 spores/g) @ 5g / litre
b. *Metarrhizium anisopliae* (1 x 10^8 spores/g) @ 5g / litre
c. *Lecanicillium lecanii* (1 x 10^8 spores/g) @ 5g / litre
d. Release of coccinellid beetles
e. Release of *M. longispinosus*
f. 20 anthocorids (4-5 releases)
g. Standard chemical insecticides
h. Untreated control

Observations:

i. Sap sucking population from 10 randomly selected plants before spray
ii. Sap sucking population from 10 randomly selected plants 7 days after spray
iii. No. of leaves/flowers with yellow specks or webbing on each plant and per cent leaves/ flowers damaged by mites to be computed
iv. Yield to be recorded

7. Evaluation of predatory mite, *Neoseiulus longispinosus* against phytophagus mite in carnation under polyhouse condition. (YSPUHF)

Treatments:

T 1: 10 predatory mite / plant /release (4-5 releases)
T 2: 20 predatory mite / plant /release (4- 5 releases)
T 3: 30 predatory mite / plant/release (4-5 releases)
T 4: Neem pesticide 2-3 ml of 0.15% azadirachtin
T 5: Recommended acaricides
T 6: Control
Design: RBD, Replications 5, Plot size 2x5m

Observation to be recorded:

i. 10 rose plants will be selected randomly; Mite population will be recorded on these 10 plants by choosing 5 flowers and 5 top leaves / plant. Similar observations will also be recorded on these plants 7 days after spraying.
ii. Number of leaves and flowers with yellow specks or webbing caused by mites will be recorded to calculate the percentage of leaves damaged by mites.
iii. Yield / plot will also be recorded.

8. Evaluation of anthocorid predator, *Blaptosthetus pallescens* against spider mites in poly houses (NCIPM and optionally at Growers' Polyhouse in larger area) (NCIPM) (New)

Location: NCIPM Centre Polyhouses

Crops: Cucumber
Treatments:

a) *Blaptostethus pallescens* @ 10 nymphs/ m row
b) *Blaptostethus pallescens* @ 30 nymphs/m row
c) Chemical control (Recommended dose of acaricide)
d) Untreated control

- Six releases will be made at weekly intervals on appearance of pest.
- Spray of insecticide as per recommendation
- Plot size: 1×3 m; NCIPM Polyhouse
- Replications: 4
- Observations: (1 sq. Cm each for five leaf avg)
- Mite population from 10 randomly selected plants before release or spray
- Mite population from 10 randomly selected plants after 7 days of treatment
- Number of leaves with yellow specks or webbing and percent leaf damage will be calculated
- Marketable yield

IV. BIOLOGICAL SUPPRESSION OF STORAGE PESTS

1. Evaluation of *Uscana* sp. (Trichogrammatidae) against *Callosobruchus* sp. on storability of pigeonpea seed (Dir. Seed Res. Mau)

Objectives:

1. To evaluate *Uscana* sp. against *Callosobruchus* sp damaging pigeonpea seed
2. To assess parasitisation effect of *Uscana* sp. on the eggs of *Callosobruchus* sp. under ambient condition
3. To find out longevity of *Uscana* sp. on the eggs of *Callosobruchus* sp. in pigeonpea seed under storage
4. To monitor the effect of *Uscana* sp. release on seed quality attributes particularly seed viability during storage

Treatments:

1. Release of 10 *Uscana* sp. + 50 eggs of *Callosobruchus* sp.
2. Release of 20 *Uscana* sp. + 50 eggs of *Callosobruchus* sp.
3. Release of 30 *Uscana* sp. + 50 eggs of *Callosobruchus* sp.
4. Release of 40 *Uscana* sp. + 50 eggs of *Callosobruchus* sp.
5. Control: 50 eggs of *Callosobruchus* sp.

Methodology:

Certified seeds of pigeonpea with very high percentage of germination and low moisture content (about 10%) should be taken for the experiment. Prepare cards by pasting pigeonpea seeds (12-15 no.) with gum and keep it in test tubes. Allow freshly emerged bruchids into test tubes for egg laying on the seeds pasted on cards. Remove the bruchids after egg laying from test tubes. Transfer cards with egg into new test tube and maintain equal no. of eggs on each card (50 no.). Release required no. of freshly emerged *Uscana* sp. into test tubes containing eggs. Test tubes will be closed with cotton plug and keep it in room under ambient condition. The temperature and relative humidity of the room will be recorded on standard weekly basis.

Observation to be recorded:

1. No. of eggs parasitized
2. No. of adult parasitoids emerged
3. Insect infestation (% seed damage)
4. No. of adult insects emerged
5. Seed germination and seed moisture

At every 12-15 days for a total period of 6 months or loss of germination below Indian minimum seed certification standard (IMSCS) whichever is early.

VI. ENABLING LARGE SCALE ADOPTION OF PROVEN BIOCONTROL TECHNOLOGIES

A. RICE (AAU-J, KAU, PAU & GBPUAT)

The Adat model to be replicated

- Select a variety moderately resistant to sucking pests
- Seed treatment with *Pseudomonas* @ 8g/kg of seeds/seedling, dip in 2% suspension
- Apply *Beauveria bassiana* 10^{13} spores/ha against sucking pests. Repeat sprays if necessary.
- Erect bird perches 10/ha.
- Release of *Trichogramma japonicum* @ 1 lakh/ha when either the leaf folder or stem borer occurrence is noticed. Initiate releases as soon as the moth activity is seen. Repeat releases at weekly intervals depending upon the moth activity.
- Spray *Bt* @2kg/ha, 2-4 sprays depending on the occurrence of caterpillar pests.
- Spray *Pseudomonas fluorescens* (dose as per university recommendation) against foliar diseases.
- Need-based or spot application of botanicals if sucking pests are not controlled by *B. bassiana* (specify the formulation and dosage when applied).

Observations to be recorded:

- All observations to be recorded in IPM plots as well as plots where farmers' practice will be followed, for making comparisons.
- Dead hearts/white ear and leaf folder damage at 15 days interval starting from imposition of treatments. Observe and record incidence of other lepidopteran pests.
- Population of leaf folder, skippers, caseworms and hairy caterpillar larvae in 10 randomly-selected plants/plot – before treatment as well as 2, 5 and 7 days after treatment with *Bt.* Record leaf damage and dead hearts before and 7 days after each spray from 20 randomly selected plants. Record white ears at late grain formation stage once from 20 randomly- selected plants.
- Number of sucking pests before and seven days after each spray of *B. bassiana* from 10 randomly selected hills, count mycosed insects also separately.
- Record disease incidence
- Yield to be recorded in IPM plots as well as plots with farmers' practice.

i. AAU-J: 30ha in Naugon district, Assam.

ii. KAU: 5 ha in Palghat district of Kerala

iii. PAU: 10ha *Basmati* rice (stem borer, leaf folder and plant hoppers)

Treatments

1. **IPM**
   - Recommended variety resistant to bacterial leaf blight disease
   - Seed treatment: *Trichoderma harzianum* @ 15 g/ kg seed
   - Judicious use of fertilizers (leaf colour chart)
   - Optimum plant spacing (33 hills/ sq m)
   - Water management: Alternate wetting and drying for plant hoppers
   - Monitoring of yellow stemborer through pheromone traps
   - Bird perches 10/ha.
   - Augmentative releases of *Trichogramma chilonis and T. japonicum* each @ 1,00,000/ha at weekly intervals starting from 30 days after transplanting DAT
   - Monitoring and surveillance for insect pests and diseases at weekly intervals (to determine ETH level)
   - Need based application of botanicals/ microbials (specify the formulation and dosage when applied).

2. **Farmer's Practice**

3. **Untreated control**

Observations to be recorded:

- Record the observations on the incidence and populations of various insect pests, diseases and grain yield from each plot.
- Record total tillers, dead hearts, total leaves, damaged leaves from 20 randomly selected hills 45 and 60 days after transplanting at vegetative stage.
- Record total panicle bearing tillers and white ear heads prior to harvest.
- Record population of plant hoppers from 20 randomly selected hills at weekly intervals starting from 30 DAT
- Record disease incidence
- Record grain yield at harvest in IPN, farmer's practice and control plots.

iv. GBPUAT: Demonstration of biocontrol technologies

Biocontrol agents: *Trichoderma* and /or *Pseudomonas fluorescens*
Crops and diseases: Root and foliar diseases of rice, pea, tomato, capsicum, etc.
Plot size: Minimum 100 m^2
Area covered under each crop: 5-10 acre

Treatment 1:

1. Seed treatment with *Trichoderma* and /or *Pseudomonas fluorescens* (@10g/kg seed)
2. Seedling root dip treatment with *Trichoderma* and/or *Pseudomonas fluorescens* (rice, tomato, capsicum) @10g/lit. of water
3. Soil application of FYM/vermicompost enriched with *Trichoderma* and /or *Pseudomonas fluorescens* (1kg formulation/100kg FYM or vermicompost/acre)

Treatment 2:

- Farmer's practices

Observations to be recorded:

- Disease incidence/severity
- Yield
-

B. SUGARCANE:

1. Enabling large scale adoption of proven biocontrol technologies against early shoot borer, top borer & stalk borer of sugarcane in collaboration with sugar mills (PAU)

a. Sugarcane (early shoot borer, stalk borer and top borer in collaboration with sugar mills)

a. Use of *Trichogramma chilonis* against early shoot borer *Chilo infuscatellus*
Area: 200 ha.

- Release of *T. chilonis* @ 50,000/ha at weekly intervals from mid-April to end-June. A total of 8 releases will be made depending on the pest situation.

Observations

1. Record pre-release infestation of early shoot borer in each field/block.
2. Post release observations on dead hearts due to early shoot borer to be recorded at fortnightly intervals after initiation of releases till the crop. Infestation to be recorded at least at 15 spots in each field/ block.
3. Record the number of tillers on each observation day at each spot. The tillers are to be counted at 15 spots in each field/block.
4. Record and compare yields at harvest in each block.

b.Use of *Trichogramma chilonis* for the suppression of the stalk borer *Chilo auricilus*

Area: 1500ha.

Release *T. chilonis* from July to October @ 50,000/ha at weekly intervals. A total of 10-12 releases to be made depending on the pest situation.

Observations:

1. Record pre-release infestation of stalk borer in each field/block.
2. Post release observations on incidence of stalk borer to be recorded at fortnightly intervals after initiation of releases. Infestation to be recorded at least at 15 spots in each field/ block.
3. Record the number of tillers on each observation day at each spot. The tillers are to be
4. counted at 15 spots in each field/block.
5. Record and compare yields at harvest in each block

c.Use of *Trichogramma japonicum* for the suppression of Top borer (*Scirpophaga excerptalis*) of sugarcane

Area: 200 ha

Observations:

1. Record pre-release infestation of top shoot borer in each field/block.
2. Release of *T. japonicum* @ 50,000/ha, six times at seven days interval starting with the first release after first observation of adult moths.
3. Post release observation on infestation/dead hearts to be recorded at fortnightly intervals after initiation of releases and observations to be recorded till the crop is 4 months old. Infestation to be recorded at least at 15 spots in each field/ block.
4. Record number of tillers on each observation day at each spot. The tillers are to be counted at 15 spots in each field/block.
5. Record yields at harvest and compare with the farmer's field.

C. MAIZE (PAU)

1.Demonstration of biological control of maize stem borer, C*hilo partellus* using *Trichogramma chilonis*

Area: 20 ha

Treatments:

i. *Trichogramma chilonis* @ 1,00,000 parasitoids/ha at 10-15 days after germination.
ii. Farmer's Practice
iii. Untreated control

Observations:

i. Percent egg parasitism: Placing sentinel egg cards (*Corcyra* cards) and collecting the cards at 24-48 hrs after each release of *Trichogramma chilonis* and confirming the adult parasitoid emergence in glass vials
ii. Record dead hearts from 20 randomly selected plants at 30 and 45 days after sowing
iii. Record leaf injury from 20 randomly selected plants at 30 and 45 days after sowing
iv. Grain yield at harvest

D. TOMATO

1. Large scale field demonstration of BIPM package for the management of key pests of Tomato (AAU-A)

Large scale demonstration will be carried out at farmer's field village Runaj near Sojitra to control *Helicoverpa armigera* in tomato.

Location: Runaj (Ta. Tarapur) and surrounding area
No. of farmers: About 50 or more
Area: 2 hector per farmer

Treatments: 1. Installation of pheromone trap (By farmers)
2. Release *Trichogramma chilonis* (By department)
3. Need base of pesticide application (By farmer)

Observations to be recorded:

1. No. of larvae per plant
2. Fruit damage (%)

Tribal Sub Plan Programme (TSP)

1. AAU-A: Biocontrol technologies for management of *Fusarium* wilt and pod borer (*Helicoverpa armigera*) in pigeon pea

50 farmers will be selected from tribal areas of surrounding Tribal Research and Training Centre, Devgadhbariya. Following inputs will be provided to farmers.

1. Trichoderma – 1 kg /farmer
2. Pheromone traps – 5 trap /farmer
3. Neem base pesticide – 1 liter /farmer
4. Farmers awareness programme – cum - training

2. ANGRAU, Anakapalle: Organic paddy cultivation as front line demonstrations and Training programmes

Crop : Paddy
Locations : Two
Ganjigedda (Chinthapalli mandal) and Ramannapalem (Koyyuru mandal),
Visakhapatnam District, Andhra Pradesh
Season : Kharif, 2015
Treatments : 2
Organic farming Vs. Control
Dosage :
Organic farming :
Biofungicide : *Pseudomonas florescence* as seed treatment (10g/kg) and as foliar spray (10g/lt) against diseases .
Biopesticide : *Beauveria bassiana* @ 5g/lt as foliar spray against swarming caterpillar.
Bioagents : *Trichogramma japanicum* @ 1,00,000 /ha against paddy stem borer and *Trichogramma chilonis* @ 1,00,000 /ha against leaf folder.
Organic mannure : Biofertilizers as nutrient supplements for recommended chemical fertilizers.
Observations:

- Pest and Disease incidence will be recorded .
- Number of productive tillers/ square metre and grain yield will be recorded at harvest.
- Incremental benefit cost ratio will be calculated.

3. MPKV, Pune

S. No.	Months Year 2015-16	Tentative monthly plan/programme	Tentative No. of individual/ families to be benefited	Full address Name of village, district & state
1.	July –September 2015	**Rainfed Tomato-Soil Application**: Phosphate solubilising bacteria (PSB), Potash solubilising bacteria (KSB) and *Pseidomonas fluorescence*.	10	Village Dalpatpur and Harsul, Taluka: Trimbak, Dist: Nashik
		Training to Tribal Women Self help Group- 3 days training on mass production of bioagents and Biopesticides in Sept.-Oct., 2015.	50	Harsul and Dalpatpur, Talulka: Trimbak, Dist: Nashik
2.	October- December, 2015	**Foliar Application: Cashewnut**- 1 spray and **Mango**: Off-season spray *M.anisopliae+V.lecanii*	50	Dalpatpur and Harsul, Taluka: Trimbak, Dist: Nashik.
		French bean : 2 sprays *M. anisopliae + V. lecanii + B. bassiana + Bt*	10	Harsul and Dalpatpur, Taluka: Trimbak, Dist:Nashik
		Chickpea: NPV – foliar application	10	Dalpatpur and Harsul, Taluka: Trimbak, Dist: Nashik
3.	January- March, 2016	**Mango** : 3 sprays *M.anisopliae + V. lecanii*	50	Harsul and Dalpatpur, Taluka: Trimbak, Dist: Nashik.
		Cashew nut: 3 sprays *M.anisopliae + V. lecanii*	50	Dalpatpur and Harsul, Taluka: Trimbak, Dist: Nashik
		Total	**230**	

4. TNAU, Coimbatore: Hands on training for Mass Production and free distribution of Biocontrol agents and empowering the tribal farmers on allied Agriculture activites

It is proposed to give hands-on training to tribal farmers of Tamil Nadu at three different districts *viz.,* Salem, Coimbatore and Nilgiris.

Objectives:

- To give awareness about the indiscriminate use of pesticides and their harmful effects
- To educate the importance of various non-chemical methods
- To give hands on training to tribal farmers about mass production of various biocontrol agents
- To distribute bio-inputs to the selected tribal farmers in three different districts
- To offer training on use of biocontrol agents and their conservation methods

During the training programme, mass production techniques of the following biocontrol agents will be taught to the tribal farmers at free of cost in their villages.

1. *Trichogramma* egg parasitoid
2. *Cryptolaemus* and other coccinellid beetles
3. *Acerophagus papayae*
4. *Chrysopa*
5. Fungal pathogen viz. *Beauveria, Metarhizium* and *Lecanicillium*
6. Antagonistic fungal pathogens,*Trichoderma* and *Pseudomonas*

Besides imparting various mass production techniques awareness campaign will be conducted in the tribal villages about the importance of biocontrol techniques, release and conservation methods and also bee keeping techniques to uplift the tribal farmers in Tamil Nadu.

The following three tribal areas will be selected to implement the project.

Year	Village	Crop	District
1	Kolli hills	Vegetables	Namakkal
2	Kothagiri	Vegetables	Nilgiris
3	Kadambur	Vegetables	Erode

One hundred tribal farmers from the respective district will be selected in consultation with nearby KVK's/extension officials/self help groups. The identified farmers will be offered two trainings, distribution of inputs and consultancy services and effective utilization of inputs. Demonstration on the efficacy/ usefulness of biocontrol agents will be done in the farmers fields.

During this year (2015-16) a total of 100 farmers covering three districts will be benefitted out of the project. The utilization of bioinputs in their field, awareness of biocontrol

agents, hands on training will bring remarkable change of their skill, knowledge, economy besides practicing eco-friendly insect pest management strategies.

The following inputs will be distributed at free of cost to the tribal farmers.

S.No	Bio control agents	Quantity
1	Pseudomonas	1kg
2	Trichoderma	1kg
3	Beauveria/ Metarhizium	1kg
4	Chrysopa/coccinellid/ Bt	Need based
5	Neem seed/ neem cake	5kg
6	Indian bee hives	one

5. YSPUHF, Solan : Use of eco-friendly methods of pest management for apple and vegetable crop.

Locations and villages to be covered: Three villages namelyPoh, Lari and Tabo of district Lahaul and Spiti (HP) will be covered under TSP in which an area of about 300 ha will be covered. About 100-150 farmers including self-help groups, Mahilamandals, panchayats officials, etc. will be benefitted through trainings, demonstrations and supply of inputs.
Crops to be dealt: Apple, apricot, peas, cauliflower, cabbage and beans.
IPM technologies to be demonstrated:

i. Use of entomopathogenic fungi and neem products for the management of apple root borer and apple stem borer.
ii. Use of light traps for monitoring or mass trapping apple bores
iii. Need based and safe use of insecticides for the conservationof parasitoids of apple woolly aphid and other natural enemies.
iv. Use of DBM pheromone traps, Bt, neem products in cole crops for the management of DBM and other caterpillar pests.
v. Use of yellow sticky traps against whiteflies in beans.
vi. Use/conservation of predatory mites in beans and apple against phytophagous mites.

Inputs to be supplied to the farmers: Entomopathogenic fungi, neem products, predatory mite, yellow and blue sticky traps, light traps, Bt products, literature and other miscellaneous training material.

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AAU-J	Assam Agricultural University, Jorhat
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CTRI	Central Tobacco Research Institute, Hunsur
CAU	Cental Agricultural University, Pasighat
CISH	Central Institute of Sub-Tropical Horticulture
Dir. Soyben Res	Directorate of Soybean Research, Indore
Dir. Seed Res	Directorate of Seed Research, Mau
Dir. Weed Sci. Res	Directorate of Weed Sciences Research, Jabalpur
GBPUAT	Gobind Ballabh Pant University of Agriculture and Technology, Pantnagar
IARI	Indian Agricultural Research Institute, New Delhi
ICAR	Indian Council of Agricultural Research, New Delhi
IIHR	Indian Institute of Horticultural Research, Bangalore
IIMR	Indian Institute of Millet Research
IISR	Indian Institute of Sugarcane Research, Lucknow
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