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AICRP on Biological Control of Crop Pests

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Annual Progress Report 2023

AICRP on Biological Control of Crop Pests

ICAR-NBAIR, Bengaluru

ICAR

All India Coordinated Research Project on Biological Control of Crop Pests

Annual Progress Report 2023

Compiled and Edited

G. Sivakumar, K. Subaharan, G. Mahendiran, Richa Varshney, K. Selvaraj, U. Amala, M. Sampath Kumar, Jagadeesh Patil, A. Kandan, C. Manjunatha, P. Ram Kumar and S N Sushil

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Technical Programme for 2023

CONTENT

EXPERIMENTAL RESULTS

I. BIODIVERSITY OF BIOCONTROL AGENTS FROM VARIOUS AGROECOLOGICAL ZONES

Basic Research work at National Bureau of Agricultural Insect Resources, Bengaluru

Biodiversity studies on parasitic wasps

Batotheca nigriceps (Cameron) was reported to parasitize caterpillars feeding on *Psidium guajava* and *Spinaria spinator* (Guérin-Méneville) was reported to parasitize slug caterpillar on *Elaeodendron glaucum* in Karnataka. Three egg-larval parasitoids, *Chelonus formosanus* Sonan, *Chelonus nr. blackburni* and *Coccygydium* sp. were reported to parasitize fall armyworm in organic maize production fields.

The following parasitoids associated with the lepidopteran pest complex infesting menthol mint were reported: Braconid species, *Cotesia ruficrus* (Haliday), *Meteorus* sp. and *Glyptapanteles obliquae* (Wilkinson); encyrtid species, *Copidosoma floridanum* (Ashmead) and ichneumonid species, *Campoletis chlorideae* Uchida and *Charops* sp. Parasitoids associated with various pests of medicinal plants at West Bengal were reported. Five larval parasitoids viz. *Copidosoma* sp., *Glyptapanteles* sp., *Dolichogenidea* sp., *Aleiodes* sp. and *Parapanteles* sp. were recorded as parasitoid complex of *Helcystogramma hibisci* (Stainton) (Lepidoptera: Gelechiidae) *on Abelmoschus moschatus*. *Diolcogaste*r sp. was recorded as solitary parasitoid of *Pycnarmon cribrata* (Fabricius) (Lepidoptera: Pyralidae) on *Vitex negundo*. Egg parasitoid, *Telenomus* sp. was recorded on parasitoid of *Selepa discigera* Walker on *Woodfordia fruticosa*.

Spider diversity

The long-jawed spider species, *Tetragnatha nitens* (Audouin) was recorded from South India (Tamil Nadu).

Predators recorded on *Thrips parvispinus* in chilli

The following predators were collected and found feeding on *T. parvispinus*. These are *Dortus primarius*, *Geocoris ochropterus*, Chrysopids and *Orius* sp.

Development of microbial consortia for the management of crop pests

Fresh rhizophere soil samples were collected from various parts of the country i.e Almora, Pantnagar, Bengaluru, Hosur and Salem. Bacteria were isolated from the rhizosphere soils. The bacterial colonies were characterized based on their colony morphology and gram reaction. Molecular characterization was done using 16S rDNA analysis. Purified PCR products were sequenced; homology search of the 16S rRNA sequences was done using the BLAST function of NCBI GenBank. The nucleotide sequences of 16S rRNA were deposited in GenBank, NCBI and the accession numbers were obtained for the submitted sequences. Bacterial species identified were *Lysinibacillus xylanilyticus, Lysinibacillus macroides, Lysinibacillus fusiformis, Paenibacillus lautus, Peribacillus frigoritolerans, Bacillus safensis, Bacillus altitudinis, Bacillus amyloliquefaciens, Bacillus velezensis Bacillus cereus, Priestia megaterium, Priestia aryabhattai, Cytobacillus firmus*.

Invert emulsion based formulation of entomopathogenic fungus and entomotoxic bacteria against fall armyworm (*Spodoptera frugiperda*)

Different combination of invert emulsion formulations were prepared for entomofungal and entomobacterial pathogens and stored at room temperature. All the tested formulation of entomofungal and entomotoxic bacteria showed cell count of more than 10^8 cfu/ml at eight months from the preparation. The efficacy varies between entomofungal and entomotoxic bacteria formulations which ranges from 60 – 80 per cent mortality of the fall armyworm.

Efficacy of *Metarhizium anisopliae* NBAIR-Ma35 against fall armyworm under field conditions

Metarhizium anisopliae NBAIR-Ma35 was found very effective in management of FAW under field conditions. Minimum number of larvae were recorded in plot treated with *M. anisopliae* NBAIR-35 (11.83, 7.00 and 4.58) and highest post larval count was recorded in control plot (16.33, 15.33 and 16.00) (F value = 29.14; $P<0.0001$; F =89.51; $P<0.0001$ and F = 158.89; $P<0.0001$) on 3 , 7 and 10 day after spraying, respectively.

Field efficacy studies of *Anagyrus lopezi* for the management of cassava mealybug

A field efficacy study of *Anagyrus lopezi* was conducted in the farmer's fields (cv. White Thailand) at Alagampatti and Kattampatti, villages under Palacode block of Dharmapuri district, Tamil Nadu during 2023. In both the villages, cassava mealybug, *Phenacoccus manihoti* was the predominant mealybug. Before parasitoids release, level of mealybug incidence (70. 0%), per cent crop damage (25%), cassava mealybug abundance (50 no./ tip) was recorded. After 20 days of post release, parasitoid recovery studies indicated, *A. lopezi* had established very well in the released sites. Maximum of 50.12 per cent parasitism was observed at six months post release of *A. lopezi* with tuber yield of 25 tonnes/ha. The percent parasitism rate of *A. lopezi* in released fields at different districts of Tamil Nadu ranged between 28.02 and 40.23% resulted effective management of mealybug.

Research Progress and achievements

I. 2. Table 1. Biodiversity of biocontrol agents from various agro ecological zones

Sl. no.	Centres	Site of collection	Crop system and host insect	Bioagents	
				Parasitoids/ Predators/ Entomopathogens etc	Parasitism (%) / predatory potential (%)/Natural occurrence of entomopathogens (%)
1.	**UAS Raichur**	15 sites in UAS Raichur campus	Diversified ecosystem with *Galleria mellonella* as a host	Species of EPN *1) Oscheius myriophilus* *2) Metarhabditis raini* *3) Oscheius* sp. *4) Caenorhabdits briggsae* *5) Heterorhabditis indica* *6) Panagrolaimus* sp.	5-10 %
		7 districts of Kalyana Karnataka	Maize, cotton, soyabean, paddy and sugar cane	Parasitoids and Predators Entomopathogens	5-10 % parasitisation 20-25 % Entomopathogens
2.	**TNAU Coimbators**		Paddy, Cassava, Brinjal Coconut, Banana, Custard apple, Papaya, Cabbage, Chillies and Maize	*Cyrtorhinus lividipennis* *Paederus fuscipes* Spider-*Lycosa pseudoanulata* Spider *Argiopes* sp. Spider *Tetragnatha* sp. *Trichogramma pretiosum* *Encarsia guadeloupae* *Acerophagus papayae* *Anagyrus lopezi* *Pseudleptomastix mexicana* *Apertochrysa astur* *Chrysoperla zastrowi silemmi* *Cryptolaemus montrouzieri* *Cheilomenes sexmaculata* Spider *Argiopes* sp Praying mantis	

3.	**CPCRI Kayamkulam**	Vazhuvadi, Alappuzha dist., Kerala	Coconut- root grub, *Leucopholis coneophora* Burm. (Scarabaeidae: Coleoptera)	Entomopathogenic nematode, *Steinernema* sp.	<10%
		Kayamkulam, Kerala	Coconut-Coreid bug, *Paradasynus rostratus* Dist. (Coreidae: Hemiptera)  *Anastatus* sp.	Egg parasitoid, *Anastatus* sp. (Eupelmidae: Hymenoptera)	20% to 25%
		Kayamkulam, Kerala	Coconut-Bondar's nesting whitefly, *Paraleyrodes bondari* Peracchi (Aleyrodidae: Hemiptera)  *Cybocephalus* sp.	Cybocephalid predator, *Cybocephalus* sp. (Cybocephalidae: Coleoptera)	5% to 10%
		Kayamkulam, Kerala	Coconut- Scale insect, *Aspidiotus destructor* Sign. (Diaspididae: Hemiptera)  *Pharoscymnus horni*	Lady beetle, *Chilocorus nirgitus* Fab. &*Pharoscymnus horni* Weise (Coccinellidae: Coleoptera)	30% to 40%
		Kayamkulam, Kerala	Coconut-rhinoceros beetle, *Oryctes rhinoceros* Linn.  *Or*NV infected grub	Entomopathogenic baculovirus, *Oryctes rhinoceros* nudivirus	1% to 5%

		Kayamkulam, Kerala	Coconut- rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin (Aleyrodidae: Hemiptera)	Sooty mould scavenger beetle, *Leiochrinus nilgirianus* Kaszab (Tenebrionidae: Coleoptera)	Devours sooty mould, *Leptoxyphium* sp. on palm leaflets
4.	**SKUAST-K Srinagar**	Shopian	Apple/Apple blotch leaf miner	*Hemerobius* spp.	5 %
		Shopian	Apple/Apple blotch leaf miner	*Tetrastichus* spp.	5%
		Baramulla	Tomato/Tomato Fruit borer	NPV	2-7%
		Baramulla	Cabbage/Cabbage butterfly	GV	3%
5.	**NIPHM Hyderabad**	Rajendranagar	Maize: *Spodoptera frugiperda*	*Metarhizium rileyi*	≥ 10%
				NPV	<10%
				Telenomus remus	≥ 15%
				Trichogramma pretiosum	10 to 15%
6.	**IIVR, Varanasi**	IIVR Experimental farm	Okra, *Phenacoccus solenopsis*	*Aenasius arizonensis*	<10% parasitization
		IIVR Experimental farm	Cabbage, Aphid complex	Predator, *Coccinella septempunctata*	--
		IIVR Experimental farm	Cabbage, Aphid complex (*Myzus persicae, Brevicoryne brassicae*)	Polyphagous Spiders	--
7.	**ANGRAU Anakapalle**	Chinthapalli	Rice fields	*Beauveria bassiana*	10%
		Vantlamamidi	Custard apple orchard	*Beauveria bassiana*	
		Arakuvalley	Cabbage field	*Beauveria bassiana*	
		Lambasingi	Pepper Plantation	*Beauveria bassiana*	
		Arakuvalley	Pepper Plantation	*Pseudomonas* spp.	6%
		Chinthapalli	Coffee Plantation	*Trichoderma* spp.	8%
		Anakapalle	Sugarcane	Aphelinid predator on aphids	26%

8.	**UBKV Pundibari**	Instructional Farm	Kharif Rice Host insects: 1. Yellow stem borer egg masse 2. Leaf folder larvae	**1. Egg parasitoids** (Samples has been sent to ICAR-NBAIR for Identification) **2. Larval parasitoids** i. Braconid wasp ii. Chalcid wasp iii. Ichneumonid wasp (Samples has been sent to ICAR-NBAIR for identification). **3. General predators recorded** A. Coleopteran predators i. Coccinellidae ii. Carabidae B. Odonata predators	Egg parasitoids: Percent Parasitization ranged from 25- 40%
9.	**MPKV, Pune**	Newasa and Shevgaon. Dist- Ahmednagar	Cowpea, French Bean, Tomato, Coconut, Maize and Sugarcane	Chrysopids: *Chrysoperla zastrowi sillemi*	1-2 larvae/m^2
		Biocontrol Farm, COA, Pune	Mango and Hibiscus	*Mallada boninensis* Okam.	2-3 grubs / 10 shoots 2-3 %
		Pune Solapur, Ahmednagar and	Coconut and Guava	*Apertochrysa*	1-2/10 fonds
		Pune Ahmednagar Solapur, Sangali	Sorghum, Maize, Cowpea, French bean, Okra, Soybean, Sugarcane, Mango, Custard Apple and Wheat	Coccinellids: *Coccinella septempunctata L.* *Menochilus sexmaculata* F.	3-4 grubs/beetle/plant
		Pune District	Sugarcane	*Dipha aphidivora, Micromus igorotus,* Syrphid fly	1-2 /plant
			Sugarcane, Maize, Soybean, Mango, Brinjal, Okra & Beans	Spiders	2/10 plants

10.	**AAU, Anand**	Village: Dedarda, Ta: Borsad, Dist: Anand	Brinjal- Shoot and fruit borer	*Trathla* sp.	
		Agronomy farm, AAU Campus, Anand	Cotton-Aphid	*Mallada* sp., *Anglesis cardoni* *Propyla disecta*	
		Meteorology farm, AAU Campus, Anand	Cotton-Mealybug	*Aenasius* sp.	
		AAU Campus, Anand	Hibiscus- Mealybug	*Scymnus* sp.	
		Agronomy Farm, AAU, Anand	Lucerne, Wheat and Indian bean-Ladybird beetle	*Homalotylus* sp., *Pediobius foveolatus* & *Tetrastichus* sp.	
		Medicinal and Aromatic Plants Research Station Farm, AAU, Anand	Dodi-Aphid	*Chrysoperla zastrowi sillemi, Scymnus* sp. & *Prophyla dissecta*	
			Dodi and Isabgul-Ladybird beetle	*Homalotylus* sp., *Pediobius foveolatus* & *Tetrastichus* sp.	
		Biocontrol Farm, AAU, Anand	Indian bean	*Cotesia* sp.	
11.	**AAU, Jorhat**	AAU, Jorhat	Termite colony	*Termitoloemus* sp.  Parasitoid recovered from termite mound	--
		Farmers field, Jorhat	Ash gourd, aphids, whitefly	*Scymnus* sp. 	----
		AAU campus	Coconut, RSW colony	*Scymnus* sp.	--------
		Farmers field, Jorhat	Citrus	*Episyrphus balteatus* 	---------

12.	**PAU Ludhiana**	Hoshiarpur, Jalandhar, Ludhiana	Maize/ Fall armyworm	*Chelonus formosanus*	Parasitism (%) 17.37
				Trichogramma chilonis	4.91
				Charops bicolor	1.45
				Chelonus blackburni	1.16
				Temelucha sp.	0.97
				Campoletis flavicincta	0.58
		Hoshiarpur, Kapurthala, Ludhiana	Sugarcane / Pyrilla	*Fulgoraecia melanoleuca*	14.84 % parasitism
		Fazilka, Abohar, Mansa, Bathinda, Ludhiana	Cotton/ Sucking insect pests (leafhopper, whitefly, thrips)	Spiders	Abundance (%) 54.37
				Chrysoperla zastrowi sillemi	40.78
				Coccinella septempunctata	1.94
				Cheilomenes sexmaculata	0.97
				Brumus suturalis	0.58
				Serangium sp.	0.97
				Geocoris sp.	0.39
		Mansa Ludhiana Bathinda Muktsar	Cotton/ Whitefly	*Encarsia sophia* and *Encarsia lutea*	7.15 % parasitism
		Amritsar, Gurdaspur, Kapurthala, Hoshiarpur, Ludhiana, Patiala, Sangrur	Rice	Spiders *Neoscona theisi*	Abundance (%) 64.13
				Tetragnatha javana	19.10
				Tetragnatha maxillosa	11.25
				Argiope catenulate	3.24
				Leucage decorata	1.37
				Oxyopes sp.	0.91

		Ludhiana	Wheat/ aphid	*Coccinella septempunctata*	1.0 to 4.0 / plant
				Cheilomenes sexmaculata	0.1 to 0.2/ plant
			Gobhi sarson, Raya / Aphid	*Coccinella septempunctata*	1.0 to 11.0 / plant
				Cheilomenes sexmaculata	0.1 to 0.3/ plant
			Raya	*Cotesia glomerata*	25.72 % parasitism
		Ludhiana, Hoshiarpur, Barnala	Gram/ Gram caterpillar	*Campoletis chlorideae*	10.53 % parasitism
		Ludhiana	Cole crops	*Coccinella septempunctata*	27.90 (% abundance)
		Noormahal Ludhiana Jalandhar	Soil samples: Chickpea, Pigeonpea Tomato	Fungal isolates: *Aspergillus flavus* and *Fusarium* sp.	Non-entomopathogenic
		Ludhiana	Soil samples: Wheat, Soyabean	Bacterial isolates: *Alcaligenes ammonioxydans, Aquamicrobium terrae*	Non-entomopathogenic
13.	**Dr YSPUHF, Solan**	District –Solan	Tomato, Cauliflower, cabbage, Broccoli, Pea, Cucumber Peaches	*Coccinella septempunctata, Hippodamia variegata, Cheilomenes sexmaculata, Calvia punctata, Adalia tetraspilota, Oenopia sauzeti, Oenopia sexreata, Adalia* sp. *Novius fumidus, Novius octoguttatus, Episyrphus* sp, *Eupeodus confrater, Ischiodon scutellaris, Sphaerophoria indiana, Anthocoris* sp, *Orius* sp.	5-15 beetle/plant, 1-4 bugs/ leaf curl 2-3 maggots/plant
		District -Sirmaur	Tomato	*Nesidiocoris tenuis, Encarsia formosa, Neochrysocharis formosa, Diglyphus horticola, Coccinella septempunctata, Hippodamia variegata, Cheilomenes sexmaculata*	4-6 bugs/plant; 5-10 % parasitism 1-2 beetles/plant, 2-3 grubs/plant

		District: Mandi	Peach Cabbage Apple	*Coccinella septempunctata, Hippodamia variegata, Chielomenes sexmaculata, Oenopia sexareata, Adalia* sp. *Chilocorus infernalis* *Episyrphus* sp, *Eupeodus confrater, Ischiodon scutellaris, Sphaerophoria indiana*, *Scavea pyrastri* *Cotesia plutellae* *Diaeretiella rapae*	2-3 beetles/plant 2-3 beetles/Plant 1-2 maggots/plant 40-60% parasitisation
		District-Shimla	Apple	*Chrysoperla zastrowi sillemi, Coccinella septempunctata, Hippodamia variegata*, *Oenopia conglobata*, *Harmonia dimidiata*, *Episyrphus balteatus,* Earwigs, *Neoseiulus longispinosus* *Aphelinus mali*	1-2 egg mass/ plant 2-3 beetles/ plant 1-2 maggots/ colony 1-2 deuto- nymphs/ leaf 20-30% parasitism
		District -Kinnaur	Apple, Almond	Predators: *Coccinella septempunctata, Hippodamia variegata, Cheilomenes sexmaculata*, *Episyrphus balteatus, Episyrphus confrater, Scavea pyrastri* Parasitoids: *Aphelinus mali*	1-3 beetles/plant 1-2 maggots/plant 50-60% parasitization 1-3 beetles/plant 1-2 maggots/plant 50-60% parasitisation
		District -Chamba	Apple, Pea	*Chrysoperla z. sillemi, Aphelinus mali* *Chilocorus infernalis, Coccinella septempunctata, Hippodamia variegata, Propylea lutiopustulata, Harmonia dimidiata*, *Diglyphus horticola*, *D. isaea*, *N. formosa*	2-3egg mass/ plant; 30-50% parasitism 2-4 beetles/ plant; 5-10% parasitism

14.	**IGKV, Raipur**	PFDC, IGKV	Thrips (Chilli)	Predator *Chrysoperla* sp.	60 % approx average
		PFDC, IGKV	Thrips (Marigold)	Big eyed bug	70 % (17 thrips / plant)
		AICRP Mustard	Aphid (Mustard)	Lady bird beetle	45% approx average
		KVK	Aphid (Potato and weeds)	Lady bird beetle *C. septempunctata*	55% approx average
15.	**KAU, Thrissur**	Thrissur	Rice bug	One isolate of *Beauveria bassiana* (EPF – 8)	To be assessed
		Thrissur	Cassava mealybug complex	Two isolates of *Simplicillium aogashimaense*, two isolates of *Purpureocillium lilacinum* and one isolate of *Lecanicillium psalliotae*	*S. aogashimaense*-70 and 82.5%, *L. psalliotae* – 75%, *P. lilacinum* 90 and 95% respectively in lab studies. *P. lilacinum* 74.92 and 78.55% mortality in pot culture studies
		Pattambi	Rice stem borer	Egg parasitoids	30-100.00 %
16.	**CAU-Pasighat**	Jampani, East Siang, Arunachal Pradesh	Toria	Predators: Coccinellids and Syrphids on Aphids	40 %
		Rani, East Siang, Arunachal Pradesh	Paddy	Predatory Spiders on Hoppers	10%
		Mebo, East Siang, Arunachal Pradesh	Cabbage	Predators: Coccinellids and Syrphids on Aphids	30%
		Ayeng, East Siang, Arunachal Pradesh	Chilli	Predators: Coccinellids on Aphids and Whiteflies	15%
		CHF, Pasighat Campus	Litchi	Entomopathogenic fungi on Litchi bug	40%

I. 3. NIPHM, Hyderabad

New experiment under basic work: (By Dr. N. Lavanya SO (BP&BC)

Evaluation of NIPHM white media for production of *Nomuraea rileyi (Metarhizium rileyi)* NIPHM MRF-1 strain for management of Maize fall armyworm (*Spodoptera frugiperda*) (NIPHM, Hyderabad)

In continuation to the previous year work, in order to proceed to field studies, the laboratory bisoassay studies were repeated during this year. The bioassay experiment was conducted with the facilities available at entomopathogenic fungus lab at NIPHM. The 2nd instar *S. frugiperda* larvae were treated with different dilutions and incubated in separate petri plates. All the treated larvae were provided with feed and regular observations were taken by changing feed and excreta of larvae. Recorded the data regarding dead and live larvae for each dilution and followed the same procedure for next observation also. Then the mortality % was calculated for each dilution. Dead larvae were separated and incubated in separate petri plates for sporulations. 90% larval mortality in 10^5 dilution was recorded followed by 50%, 70%, 40% mortality in 10^6, 10^7 and 10^8 dilutions respectively. The experiment as repeated for three times and similar results were recorded. In addition, single spore isolation of *M. rileyi* was done. The culture was being maintained regularly for further studies.

Fig 1. *Nomuraea rileyi (Metarhizium rileyi)* NIPHM MRF-1 strain for management of Maize fall armyworm (*Spodoptera frugiperda*)

II. SURVEILLANCE FOR PEST OUTBREAK AND ALIEN INVASIVE PESTS

Table 2. Surveillance for pest outbreak and alien invasive pests

Sl. No.	Centres	Date of survey	Location	Crop	Pests/Diseases incidence	Chemical pesticides if any used	Infestation (%)
1.	**GBPUA&T Pantnagar**	30.07.23 to 31.10.23	District Nainital	Rice	16.50	Dithane, Bavistin, Blitox, Copper Blue, Ridomil, Metalxyl, Kocide, Chloropyrifos, Avant Malathion, Imidacloprid, Glyphosate, Butalachor, Paraquat Pendimrthalin, Steptocycline	
			District U.S.Nagar	Rice	25.60		
2.	**NCIPM New Delhi**	22-09-2023	Village Nidana, Rohtak, Haryana	Rice	Leaf folder	Emamectin benzoate, chlorantraniliprole	30% leaf damage
		18-10-2023	Village Nahri Sonipat, Haryana	Rice	Yellow stem borer	Chlorantraniliprole, flubendiamide, lambdacyhalothrin, thiamethoxam	20-25% white ear
		18-10-2023	Village Badi, Gannaur Sonipat, Haryana	Rice	Yellow stem borer	Chlorantraniliprole, cartap hydrochloride. Lambdacyhalothrin	10-30% white ear in long duration varieties
		20-10-2023	Village: BambawarGautambudhnaga, UP	Rice	Yellow stem borer	Fipronil 5% SC, Chlorantraniliprole, cartaphydrochloride.	30-50 % white ear symptoms in PB1121, PB1885
3.	**ICAR-CPCRI, Kayamkulam Coconut Research Station, Aliyarnagar**	May 2023	Kayamkulam, Kerala	Coconut	Asian Grey weevil, *Myllocerus undatus* Marshal (Curculionidae : Coleoptera) 	Nil	5% to 10% leaf notching on root (wilt) diseased palms

		07.09.2024, 14.09.2024	Shopian, Pulwama	Apple	Apple Blotch Leaf Miner	-	19-77%
		22.08.2024	Nadihal, Baramulla	Apple	Codling moth	-	10%
		05.09.2023 07.09.2024 08.09.2024	Shalimar, Srinagar	Apple	Oriental Fruit Fly	-	5%
		17.09.2024	Pulwama	Apple	Oriental Fruit Fly	-	3%
		14.08.2024 03.11.2024	Bijbehara, Anantnag	Apple	European Red Mite, Two Spotted Spider Mite	-	17-28%
5.	**KAU Vellayani**	Feb 2024	Kumarapuram, TVM	Mango	Shoot midge attack in tender mango fruits	Chlorantraniliprole 0.2ml/L	80 % fruits/ tree
		Dec 2023	Attingal Trivandrum	Cabbage cauliflower	*Spodoptera litura*	Ekalux/ Chlorantraniliprole	Localised outbreak in homestead cultivation (50%)
6.	**RARS Kumarakom**	25.05.2023	Manakkal Padam Palakkuzha grama panchayat Pampakuda block panchayat Ernakulam	Cassava	Cassava root rot (*Fusarium*)  : Symptoms of cassava root rot	SAAF (2% carbendazim + 63% WP mancozeb) @ 2g/L	70-80 %

		19.08.2023	Kumarakom-chelakkapally, Nattakomthek-kekothakery, Thiruvarppthat-takadu, vengilikkadu, manaladupa-dasekharam Kottayam Kerala	Rice	Rice black bug (*Scotinophara bispinosa*)  	Flubendiamide 39.35 SC @ 20 ml/acre	80%
7.	**ANGRAU, Anakapalle**	25.07.23	Boni,Podu-gupalem, Dibbadapalem, Chandaka, Anandapuram (M) Pandrangi, Regidi, Maddi, Pad-manabham (M), Majjiva-lasa, Laxmi-puram,Sigada-labanda, Bheemili (M), Visakhapatnam District	Rice Maize	Stem borer FAW	Nil Emammectin benzoate	4-5% 5-11%
		17.08.23	Govada, Amberupuram, Chodabvaram (M), Anakapal-le district	Sugar-cane	Yellow Mosaic disease, Early shoot borer	nil	>50% 10-18%
		6.10.23	Moolapeta, Munagapaka (M), Anakapal-le District	Rice Maize	BPH Fall army-worm	Acephate Emamectin benzoate	10-12 hoppers/hill 2-5%
		31.10.23	Dakamarri, Maddila-pet, Singa-nabanda,B-heemili (M) Boni,Gottipalli, Chandaka, Anandapuram (M),Visakhapa-tnamDist.	Rice	Stem borer Leaf folder BPH Sheath blight Blast Panicle mite and sheath rot Maize	Chlorpyriphos, Mono-crotophos Acephate Hexaconazole Tricyclozole nil Emamectin benzoate	5-9% 6-10% 22-30 hoppers/hill 12-28% 12-15% >20% 5-16%

		23.01.24	S.Varam, Pathiwadapalem, Sundarapalem, Ranasthalam (M),Srikakulqam District, Kumili, Pusapatirega (M), Vizianagaram District	Maize Coconut Chillies	Fall armyworm Rugose spiralling whitefly Flower thrips	Emamectin benzoate Neem formulation Imidacloprid Monocrotophos	6-13% 26-47% 9-22 thrips/ flower
		17.02.24	Venkataraopeta, Pathiwadapalem, Ranasthalam (M), Rangarayapuram, Regidi(M), Srikakulam District, Ch.Agraharam, Pusapatirega (M), Vizianagaram District	Maize Coconut Chillies Sugarcane	Fall armyworm Rugose spiralling whitefly Flower thrips Early shoot borer Internode Borer	Emamectin benzoate Neem formulation Imidacloprid Monocrotophos Trichocards	8-14% 35-62% 12-25 thrips / flower <5% 25-44%
		23.02.24	Moolapeta, Munagapaka (M), Anakapalle, Anakapalle District	Maize Chillies	Fall armyworm Flower Thrips	Emamectin benzoate Imidacloprid	6-16% 10-16 thrips/ flower
8.	**UBKV Pundibari**	03.04.2023	Baganbari	Chilli	Invasive black thrips	Yes Synthetic Pyrithroids and Neonicotinoid	Severe (90-95%)
			Hedayet Nagar				
			Haripur				
		24.02.2024	Guabar Nagar	Chilli (Variety Eagle Chilli and Tejaswini)			
			Harinahpur				Severe (80%)
		03.06.2023	Gopalpur	Tea	Black inch warm or Black looper (*Hyposidra talaca; H. infixaria*)	Deltamethrin	Severe (90-95%)
			Kamalpur				
		10.05.2023	Dewanhat	Coconut	Rugose Spiralling Whitefly	Nil	Moderate (50-55%)
			Phalimari				
			Talliguri				

		12.05.2023	Birpara	Guava	Bondar's Nesting Whitefly	Nil	Moderate (45-50%)
			Panchkolguri				
			Jogendranagar				
		14.05.2023	Karjipara	Jamun	Rugose Spiralling Whitefly	-	Low (25-30%)
			Taparikhata				
			Chikliguri				
		10.06.2023	Paharpur	Guava	Spiralling Whitefly	-	Low (15-20%)
			Pandapara				
			Thiknikata	Coconut	Spiralling Whitefly & Rugose Spiralling Whitefly	-	Moderate (55-60%)
			Boro Mohansingh				
			Baro Ghoria				
9.	**PJTSAU, Hyderabad**	20.9.2023	Ceryal, siddipet Chandulapur	Cotton	Sucking pests leaf hoppers, whiteflies, thrips, aphids		Moderate to Severe
		21.9.2023	Shadnagar, Nandigama, Keshampet, Kondurg	Cotton, Maize and Paddy	Sucking pests leaf hoppers, whiteflies, thrips, aphids		Moderate
		3.10.2023	Shadnagar,Maheswarm, Kammadanam, Kondurg	Paddy, Maize, Cotton, Redgram	Paddy Stemborer FAW Leaf webber		Moderate to Severe Severe Moderate
		12.10.2023	Bhongir,Chikatimamidi, Pochampalli, Alair	Rice	BPH Stemborer		Moderate Severe
		13.10.2023	Balanagar, Revally, Jadcharla, Nasrullabad	Rice	Leaf folder Leaf thrips		Moderate Moderate
		17.10.2023	Gadwal, Manopad, Rangapur	Cotton	Sucking pests leaf hoppers, whiteflies, thrips, aphids Pink Bollworm		40-50% Bellow ETL

		18.10.2023	Bhoothpur, Bijnepalli, Gopalpet, kothakota, Pebbair	Cotton and Paddy	Sucking pests leaf hoppers, whiteflies, thrips, aphids Pinkboll worm		0-20% Bellow ETL
		20.10.2023	Mamidipalli, Thimmapur, Farooqnagar, Shadnagar, Raikal	Cotton, Maize Paddy	*Spodoptera litura,* Sucking pests leaf hoppers, whiteflies, thrips, aphid FAW Stemborer Pink Boll worm		Severe Severe Severe Bellow ETL
		21.11.2023	Jadcharla, Nasrullabadthanda, Kodgal, Midzil	Paddy & Groundnut	Stemborer & Leaf folder *Spodoptera* Thrips		Severe Moderate Moderate
		22.11.2023	Pochampalli, Indriyala, Ibrahimpatnam, Bhongir	Paddy	False smut Panicle mite		Moderate Moderate
		24.11.2023	Mirzapur,Maneguda, Nyalata, Chevalla	Cotton and Paddy	Whitefly & Pink Boll worm		Bellow ETL to Moderate
		19.12.2023	Pragnapur, Siddipet, Cheryala	Maize, Tomato, Chilli	FAW Pinworm Leaf thrips and Flower thrips		Moderate to Severe
		21.12.2023	Jadcharla, Mahabubnagar, Deverakadra, Maktal	Groundnut and Paddy	Whiteflies		Moderate
		22.12.2023	Shadnagar, Raikal, Balanagar, Rajapur	Tomato Brinjal Cabage	*H.armigera* *Phthorimaea absoluta*, *Spodoptera*		Moderate to Severe
		28.12.2023	Mamidipalli, Thimmapur, Farooqnagar, Shadnagar, Raikal	Chilli and Tomato	Black thrips, *Phthorimaea absoluta*		Moderate
		29.12.2023	Ibrahimpatnam, Pochampalli, Bommalaramaram	Chilli Tomato Brinjal	Black thrips, *Phthorimaea absoluta* Shoot and fruit borer and GLH		Moderate Moderate to Severe

		11.1.2024	Cheryla, Dud-deda	Cabagge, Chillis	DBM, Aphids, *Spodoptera litura*		Moderate
		12.1.2024	RaikalShad-nagar, Kam-madanam	Tomato Brinjal Cabage	*H. armigera Phthorimaea absoluta Spodoptera*		Moderate Moderate to Severe
		29.1.2024	Kesaaram, Mir-zagud, Man-neguda	Ground-nut	GLH and *Spodoptera*		Moderate
		31.1.2024	Raikal, Shadnagar, Kammadanam, Thimapru, Nandigama	Chilli and Tomato	Leaf thrips and Black thrips American Leaf miner		Moderate
		2.2.2024	Pochampal-li, Indriya-la, Gous-ikonda,Kanu-mukkal	Paddy	Stemborer, Leaf thrips		Moderate to severe
		8.2.2024	Kondurg, Chin-naumentyala, Farooqnagar, Shadnagar	Paddy	Stemborer		Severe
		9.2.2024	Kesampet, Shadnagar, Raikal	Maize and paddy	FAW Stemborer		Severe Moderate
		15.2.2024	Jadcharla, Midzil, Chin-naadirala,Ped-da adirala, Nasrullabad Thanda	Paddy, Maize	FAW Stemborer		Severe Moderate
		20.2.2024	Thurkapalli, Praganapur, Komuravelli, Cheryala	Paddy	Stemborer		Moderate
		15.3.2024	Jadcharla, Nas-rullabadthanda, Kothathanda	Paddy Maize	FAW Stemborer		Severe Moderate
		18.3.2024	Jadcherla, Nasrullabad Thanda	Paddy Maize	FAW Stemborer		Severe Moderate

		23.3.2024	Pochampalli, Gousikonda, Ramlingam-pallithanda, Indriyala	Paddy	FAW Stemborer		Severe Moderate
		27.3.2024	Indriyala, Po-champalli	Paddy	FAW Stemborer		Severe Moderate
		28.3.2024	Kothathanda, Jadcharla	Paddy	FAW Stemborer		Severe Moderate
10.	**AAU, Anand**	08.03.23	Horticulture Farm, AAU Campus, Anand	Mango	Mango hopper Leaf Webber Mango Mal-formation		9 % 3 % 2 %
		10.03.23	Agronomy Farm, AAU Campus, Anand	Fennel	Aphid Powdery mildew		12 % 2 %
				Lucerne	Aphid *Spodoptera litura*		8 % 10%
		15.03.23	Main Vegeta-ble Research Station Farm, AAU Campus, Anand	Cab-bage	Dimond back moth Aphid		6 % 9%
				Okra	Jassid White fly Fruit and Shoot borer YMV		6 % 6 % 5 % 2 %
		17.03.23	Medicinal & Aromatic Research Farm, AAU Campus, Anand	Dodi	Psylla		8 %
		21.03.23	Agronomy Farm, AAU Campus, Anand	Maize	*S. frugiperda* Leaf blight		10 % 3 %
		24.03.23	Main Forage Research Station Farm, AAU Campus, Anand	Lucerne	Aphid		8 %

		28.03.23	Main Vegetable Research Station Farm, AAU Campus, Anand	Onion	Thrips Leaf Bloch		7 % 4 %
				Tomato	Leaf miner *H. armigera* Whitefly Leaf curl Late blight		10 % 3 % 4 % 6% 8 %
		03.04.23	Medicinal & Aromatic Research Farm, AAU Campus, Anand	Dodi	Psylla		7 %
		06.04.23	Main Forage Research Station Farm, AAU Campus, Anand	Maize	*S.frugiperda* Leaf blight		10 % 4 %
				Lucerne	Aphid		10 %
		10.04.23	Horticulture Farm, AAU Campus, Anand	Mango	Mango hopper Leaf Webber Mango Malformation		10 % 3 % 3 %
		10.04.23	Main Vegetable Research Station Farm, AAU Campus, Anand	Okra	Mite Jassid White fly Fruit and shoot borer YMV		6 % 5 % 6 % 7 % 2 %
				Brinjal	Jassid		3 %
		17.04.23	Agronomy Farm, AAU Campus, Anand	Lucerne	Aphid *S. litura*		7 % 6 %
		18.04.23	Agronomy Farm, AAU Campus, Anand	Maize	*S. frugiperda* Leaf blight		8 % 4 %
		27.04.23	Main Vegetable Research Station Farm, AAU Campus, Anand	Cucumber	Leaf Miner Fruit fly Mosaic		6 % 3% 4 %

		02.05.23	Main Vegetable Research Station Farm, AAU Campus, Anand	Okra	Mite Jassid		8 % 3 %
		02.05.23	Entomology Farm, AAU Campus, Anand	Okra	Mite Jassid		10 % 2 %
		10.05.23	Main Vegetable Research Station Farm, AAU Campus, Anand	Brinjal	Jassid Fruit and Shoot borer		4 % 2 %
				Cucumber	Leaf Miner Fruit fly Mosaic		8 % 5 % 6 %
		18.05.23	Agronomy Farm, AAU Campus, Anand	Groundnut	*H. armigera*		4 %
		19.05.23	Regional Research Station Farm, AAU Campus, Anand	Groundnut	*H. armigera*		4 %
		23.05.23	Forage Research Station Farm, AAU Campus, Anand	Bajara	-	-	
		25.05.23	Agronomy Farm, AAU Campus, Anand	Okra	Mite Jassid		10% 2 %
		26.05.23	Agronomy Farm, AAU Campus, Anand	Bottle gourd	Fruit fly Leaf miner		8 % 4 %
		02.06.23	Main Vegetable Research Station Farm, AAU Campus, Anand	Brinjal	Fruit &Shoot borer		5 %

		10.06.23	Agronomy Farm, AAU Campus, Anand	Bottle gourd	Fruit fly Leaf miner		8 % 7 %
				Bajara	*H. armigera* Leaf spot		2 % 2 %
				Sunn-hemp	False Chinch bug		2 %
		15.06.23	Pathology Farm, AAU Campus, Anand	Sunn-hemp	False Chinch bug		3 %
		19.06.23	Meteorology Farm, AAU Campus, Anand	Sunn-hemp	False Chinch bug		2 %
		23.06.23	Biocontrol Farm, AAU Campus Anand	Sunn-hemp	False Chinch bug		3 %
		28.06.23	Medicinal Farm, AAU Campus, Anand	Dodi	Scale insects		5 %
				Senna	-		-
		05.07.23	Meteorology Farm, AAU Campus, Anand	Cotton	Jassid Aphid Mealybug		2 % 2 % 3 %
		12.07.23	Agronomy Farm, AAU Campus, Anand	Green gram	Aphid		3 %
		17.07.23	Village: Deda-rada	Okra	*H. armigera* Aphid Jassid Fruit and Shoot borer		2 % 2 % 3 % 4 %
				Brinjal	Fruit and Shoot borerLittle leaf		5 % 3 %
		18.07.23	Village: Dabhasi	Okra	*H. armigera* Aphid Jassid Fruit and Shoot borer		2 % 3 % 2 % 4 %

		18.07.23	Village: Un-tkhari	Okra	*H. armigera* Aphid Jassid Fruit and Shoot borer		2 % 3 % 2 % 3 %
		21.07.23	Agronomy Farm, AAU Campus, Anand	Spider lily	Lily caterpillar		8 %
		31.07.23	Village: Rasnol	Cotton	Aphid Jassid Whitefly		5 % 6 % 5 %
				Brinjal	Fruit and Shoot borer Little leaf		5 % 3 %
		31.07.23	Village: Kun-jarao	Rose	Leaf eating caterpillar		4 %
		01.08.23	Biocontrol Farm, AAU Campus, Anand	Okra	Mealybug Aphid Jassid *S. litura*		2 % 3 % 2 % 2 %
		04.08.23	Horticulture Farm, AAU Campus, Anand	Hibis-cus	Mealybug Scale insect		6 % 8 %
		08.08.23	Meteorology Farm, AAU Campus, Anand	Cotton	Jassid Aphid Mealybug Wilt		4 % 4 % 4 % 3 %
		14.08.23	Agronomy Farm, AAU Campus, Anand	Green gram	Aphid Blister beetle Mosaic		4 % 2 % 1 %
				Okra	Mealybug Aphid Jassid *S. litura*		2 % 3 % 2 % 2 %
		19.08.23	Meteorology Farm, AAU Campus, Anand	Bajra	*H. armigera*		3 %
		21.08.23	Agronomy Farm, AAU Campus, Anand	Bajra	*H. armigera* Stem borer		3 % 2 %

		23.08.23	Regional Research Station Farm, AAU Campus, Anand	G'nut	*S. litura* Jassid *Alternaria* leaf spot		5 % 3 % 3 %
				Soy-bean	Whitefly Mosaic		8 % 4 %
		29.08.23	Weed Control Farm, AAU Campus, Anand	Maize	Aphid *S. frugiperda*		3 % 3 %
				Green gram	Aphid Mosaic		4 % 2 %
		01.09.23	Village: Shin-hol	Papaya	Aphid Whitefly Mosaic		3 % 2 % 3 %
				Cotton	Mealy bug Aphid		4 % 2 %
		01.09.23	Village: Tram-ovad	Paddy	Green leaf hopper Leaf folder		3 % 5 %
		01.09.23	Village: Bhava-nipura	Brinjal	Fruit and Shoot borerJassid Little leaf		10 % 4 % 3 %
		12.09.23	Meteorology Farm, AAU Campus, Anand	Bajra	*H. armigera*		4 %
		12.09.23	Meteorology Farm, AAU Campus, Anand	Cotton	Jassid Aphid Mealybug Wilt		5 % 2 % 4 % 4 %
		20.09.23	Village: Tara-pur	Paddy	Green leaf hopper Leaf folder		5 % 4 %
		22.09.23	Horticulture Farm, AAU Campus, Anand	Lemon	Lemon but-terfly		3 %
		25.09.23	Biocontrol Farm, AAU Campus, Anand	Green gram	*S. litura* Aphid Blister beetle		6 % 2 % 2 %

				Okra	Mealybug, Aphid Jassid *H. armigera* *S. litura* Fruit and shoot borer		3 % 3 % 2 % 2 % 2 % 3 %
		10.10.23	Biocontrol Farm, AAU Campus, Anand	Okra	Mealybug, Aphid Jassid *H. armigera* *S. litura* Fruit and shoot borer		3 % 5 % 2 % 2 % 2 % 4 %
				Green gram	Aphid, *H. armigera* *S. litura* *Maruca* sp. Pod sucking bugs Mosaic		4 % 2 % 3 % 3 % 2 % 3 %
		16.10.23	Main Vegetable Research Station Farm, AAU Campus, Anand	Indian bean	Aphid White leaf hopper		2 % 5 %
				Tomato	Whitefly		4 %
		18.10.23	Pathology Farm, AAU Campus, Anand	Ground nut	*S. litura*		4 %
		19.10.23	Village: Tarapur	Paddy	Green leaf hopper Leaf folder Rice Tungro		6 % 4 % 2 %
		25.10.23	Village: Chakalasi	Cauliflower	*S. litura*		4 %
		26.10.23	Village: Navali	Brinjal	Fruit and shoot borer Whitefly Jassid		8 % 4 % 3 %
		26.10.23	Village: Napad	Brinjal	Fruit and shoot borer Whitefly Jassid Little leaf		6 % 6 % 4 % 3 %

		30.10.23	Biocontrol Farm, AAU Campus, Anand	Indian bean	Aphid White leaf hopper		3 % 4 %
				Marigold	*H. armigera*		2 %
		03.11.23	Village: Sampad	Cauliflower	*S. litura*		4 %
				Cabbage	*S. litura*		2 %
		06.11.23	Entomology Farm, AAU Campus, Anand	Chilli	Black Thrips		2 %
		20.11.23	Biocontrol Farm, AAU Campus, Anand	Indian bean	*S. litura* *Maruca* sp. *H. armigera* Hairy caterpillar Aphid		3 % 2 % 3 % 3 % 2 %
				Marigold	*H. armigera* Mite		3 % 3 %
		25.11.23	Medicinal & Aromatic Research Farm, AAU Campus, Anand	Dodi	Aphid		6 %
		28.11.23	Main Vegetable Research Station Farm, AAU Campus, Anand	Indian bean	*S. litura* *Maruca* sp. *H. armigera* Hairy caterpillar Aphid		2 % 1 % 2 % 3 % 2 %
				Tomato	Whitefly		3 %
		30.11.23	Agronomy Farm, AAU, Campus, Anand	Tomato	Whitefly		4 %
				Castor	*S. litura* Hairy caterpillar		5 % 6 %
		06.12.23	Village: Derol	Chilli	Black thrips Whitefly Leaf curl		2 % 3 % 3 %

		07.12.23	Medicinal & Aromatic Research Farm, AAU Campus, Anand	Dodi	Aphid		8 %
		11.12.23	Biocontrol Farm, AAU Campus, Anand	Indian bean	*S. litura* *Maruca* sp. *H. armigera* Hairy caterpillar Thrips Aphid		2 % 2 % 3 % 3 % 3 % 2 %
				Marigold	*H. armigera* Mite		3 % 4%
		12.12.23	Pathology Farm, AAU Campus, Anand	Brinjal	Jassid		2 %
		12.12.23	Entomology Farm, AAU Campus, Anand	Chilli	Black Thrips White fly Aphid Leaf curl		3 % 4 % 2 % 4 %
		13.12.23	Weed Control Farm, AAU Campus, Anand	Cotton	Red cotton bug		10 %
		18.12.23	Biocontrol Farm, AAU Campus, Anand	Chickpea	*H. armigera* Wilt		2 % 3 %
		28.12.23	Village: Naar	Tomato	Whitefly *H. armigera* Leaf curl		5 % 2 % 2 %
		28.12.23	Village: Silavai	Tomato	Whitefly *H. armigera* Leaf curl		6 % 4 % 3 %
		30.12.23	Village: Derol	Chilli	Black thrips Aphid Whitefly Leaf curl		5 % 3 % 5 % 5 %
		03.01.24	Village: Derol	Chilli	Black thrips Aphid Whitefly Leaf curl		8 % 3 % 5 % 4 %

		09.01.24	Biocontrol Farm, AAU Campus, Anand	Chick-pea	*H. armigera* Wilt		5 % 5 %
		10.01.24	Village: Nis-araya	Tomato	Aphid Whitefly *H. armigera*		2 % 5 % 3 %
		10.01.24	Village: Morad	Tomato	Whitefly *H. armigera*		3 % 5 %
		10.01.24	Village: Band-hani	Tomato	Aphid Whitefly *H. armigera*		3 % 4 % 5 %
		11.01.24	Village: Sama-rakha	Tomato	Whitefly *H. armigera* Leaf curl		5 % 3 % 4 %
		11.01.24	Village: Ajara-pura	Tomato	Whitefly *H. armigera* Leaf curl		4 % 4 % 2 %
		11.01.24	Village: Sama-rakha	Sweet potato	Sweet Potato weevil		8 %
		16.01.24	Village: Undel	Sweet potato	Sweet Potato weevil		12%
		30.01.24	Biocontrol Farm, AAU Campus, Anand	Chick-pea	*H. armigera* Wilt		6 % 8 %
				Cab-bage	DBM		3 %
		01.02.24	Agronomy Farm, AAU Campus, Anand	Wheat	Aphid		6 %
				Chick-pea	*H. armigera*		5%
		02.02.24	Weed Control Farm, AAU Campus, Anand	Chick-pea	*H. armigera*		3 %
				Lucerne	Aphid		5 %
		07.02.24	Agronomy Farm, AAU Campus, Anand	Castor	*S. litura*		5 %

		08.02.24	Pathology Farm, AAU Campus, Anand	Mustard	Aphid		8 %
		16.02.24	Village: Kasor	Tomato	Whitefly *H. armigera* Leaf curl		4 % 3 % **2 %**
		16.02.24	Village: Malataj	Tomato	Whitefly *H. armigera* Leaf curl		5 % 1 % 4 %
		16.02.24	Village: Lin-basi	Tomato	*H. armigera*		5 %
		16.02.24	Village: Tara-pur	Tomato	Whitefly *H. armigera* Leaf curl		2 % 3 % 2 %
		05.03.24	Biocontrol Farm, AAU Campus, Anand	Chick-pea	*H. armigera*		8 %
		07.03.24	Weed Control Farm, AAU Campus, Anand	Chick-pea	*H.armigera*		4 %
11.	**SKUAST-JAmmu**	17.04.2023	Vill. - Sarore District: Samba	Cucur-bits	Red Pumpkin Beetle- Moderate Leaf blight Per cent disease inci-dence: 25%		
		12.05.2023	Vill. – Patli-Morh, District: Samba	Orna-mental	Mealy bug: 30 – 40% plants affected		
		15.06.2023	Vill. –Rakh-Dhiansar District: Samba	Guava	Mealy bug: Moderate to Severe		
		17.07.2023	Vill. – Sarore District: Samba	Cucum-ber Chilli	Mites and Aphids: Moderate Chilli wilt Per cent disease inci-dence: – 30%		

		22.08.2023 22.08.2023	Vill. – Deoli Vijaypura, District: Samba Vill. – Bishnah District: Samba	Rice Turmeric, Bitter gourd	Stunting and yellowing in rice field. Per cent disease incidence: – 30-35% Rice blast disease also observed Per cent disease incidence: – 25% Hairy caterpillar infection Moderate		
		21.09.2023	Vill.deraganotra District: Samba	Spinach	Leaf spot on leaves Per cent disease incidence: – 20%		
		5.10.2023	Vill. - Sarore District: Samba	Cucumber	Yellow mosaic Per cent disease incidence:- 30 - 40%		
		15.11.2023	Vill.-ChakSalaria District: Samba	Mango and Guava	Mealy bug – Moderate to Severe		
		15.12.2022	Vill. – Sangwal, District: Samba	Guava, Mango	Mealybug – Moderate Fruitfly – Moderate		
		18.12.2022	Village: Patli	Guava, Mango	Mealybug – Moderate Fruitfly – Moderate		
		05.01.2023	Vill.-ChakSalaria District: Samba	Mango and Guava	Mealy bug – Moderate to Severe		
		18.01.2023	Village Dhiansar	Chickpea	Wilt (30%)		

		25.01.2023	Vill.-ChakSal-aria District: Samba	Field pea	Wilt (35%)		
		10.02.2024	Village Bish-nah	Spinach	Alternaria Leaf Blight - Per cent disease incidence: -30-35% Anthracnose and leaf blight – Per cent disease inci-dence: 30%		
		12.02.2023	Vill. Deoli	Orna-mental plants	Mealybug – Moderate Fruitfly – Moderate Gall formation - Moderate		
		09.03.2023	Vill. – Patli-Morh, District: Samba	Trees	Mealy bug-Moderate		
		12.03.2023	Vill. – Sang-wal, District: Samba	Guava, Mango	Mealybug – Moderate Fruitfly – Moderate Gall formation - Moderate		
12.	**AAU, Jor-hat**	10.04.2023	Bahphola, 26.79 N: 94.04 E, Jorhat	Chili Brinjal	Whitefly, *Bemisia tabaci* & leaf curl virus *Leucinodes orbanalis*	Imidacloprid 17.8% SL 1ml/l Chlorantraniliprole 18.5% SC 1ml/3 lit	Low Moderate
		09.05.2023	Chola pathar-gaon, Shyam Gaon, Siv-asagar, 27.02 N: 94.90 E,	Ahu rice	Stem borer	-------	Low
		21.05.2023	Panch Mile, Tezpur Tezpur 26.67 N: 92.84E	Cucum-ber	Fruitfly	Fruitfly trap@10-12/ha.	Moderate
		13.06.2023	Rajabari, Jorhat 26.49 N: 94.15E	Ginger	Ginger rot	Spraying with Biozine @100 ml /clump	Low

		29.07.2023	AAUcampus26.71 N: 94.19E	Sali rice,	Blue beetle, *Altica* sp.	Neem oil 300ppm 5ml/L	60%
		03.8.2023	Goalpara East Pt III, Goalpara, 26.39 N:90.80 E	Jute & Rice	Jute hairy caterpillar	---	Low
		08.08.2023	AICRP IFS unit, AAU, Jorhat, Barbheta, Jorhat, 26.71 N: 94.19E	Assam lemon Guava fruits	Citrus trunk borer Fruit borer, *Virachola* sp.	------	low
		21.08.2023	Gossaigaon Part, Kokrajhar, 26.58 N: 89.95E	Apple ber	Trunk borer	Neem oil 300ppm 5ml/L	Moderate
		09.09.2023	Lality Chapari, 26.79 N: 94.04E, Jorhat	Ginger	Ginger rot	Spraying with Biozine @100 ml /clump	Low
		13.09.2023	KVK, Sivsagar	Chilli	Bondar's nesting whitefly	Thiamethoxam 25WG @ 2g/10 lit	Moderate
		20.09.2023	Rajabahar, Jorhat 26.49 N: 94.15E	Rice	Sheath blight	Propiconazole 1m/lit	Moderate
		05.10.2023	Borbheta, Jorhat, 26.72 N: 94.20E	Bitter gourd	Epilachna beetle.	-	Low
		7.10.2023	Lality Chapari, 26.79 N: 94.04E, Jorhat	Cauliflower	*Pieris brassicae*	Neem oil 15000ppm @1ml/L	Moderate
		09.10.2023	Borbheta, Jorhat, 26.72 N: 94.20E	Millet	Blue beetle	Neem oil 15000ppm @2ml/L	Moderate
		29.10.2022	Jorhat tea garden	Tea	Tortricid caterpillar	Cholorantraniliprole 18 SC @ 0.3 ml /L	Low
		18.11.2023	Rajabahar, Jorhat	Rice	Swarming caterpillar	Cholorantraniliprole 18 SC @ 0.3 ml /L	65%
		13.12.2023	Merapani, Golaghat, 26.35 N :94.04 E	Cow pea	Aphids	---	Low
		20.12.2023	Namgaon, Nagaon, 26.52 N: 92.95 E	Rapeseed & mustard	Mustard aphids	-------	Low

		23.12.2023	AAU, Jorhat, 26.72 N: 94.20E	Som plant	Rugose spiralling whitefly and soft scale	--------	Low
		18.01.2024	Lality chapari26.79 N: 94.04 E	Pea	Leaf miner	------	Low
		30.01.2024	Kalachand, Dima Hasao25.34 N: 93.12 E	Mustard	Mustard aphids	-----------	Low
		17.2.2024	Dimarupar, Hojai26.02 N: 92.88E	Maize	Maize stem borer	Cholorantraniliprole 18 SC @ 0.3 ml /L	Moderate
		21.2.2024	Kohar Gaon, Jorhat, 26.65 N: 94.17 E	Banana	Banana leaf scaring beetle	Neem oil 15000ppm @1ml/L & Bagging	Low
		21.3.2024	Bharali chapori, Sonitpur26.73 N: 92.88 E	Rice	Stem borer in boro rice	Cholorantraniliprole 18 SC @ 0.3 ml /L	Moderate
		23.3.2024	Makua chapari, Sonitpur26.68 N: 92.89 E	Brinjal & pumpkin	Brinjal shoot & fruit borer Yellow mosaic in pumpkin	--------	Low
13.	**PAU, Ludhiana**	3.5.2023 11.5.2023 16.5.2023 25.5.2023	Amritsar, Hoshiarpur, Jalandhar, Kapurthala, Nawanshahr, Patiala	Sugarcane	*Chilo infuscatellus*	-	3-4% dead hearts
		2.6.2023 7.6.2023 16.6.2023 19.6.2023 22.6.2023 27.6.2023	Amritsar, Barnala, Bathinda, Fazilka, Hoshiarpur, Jalandhar, Kapurthala, Ludhiana, Mansa, Muktsar, Pathankot	Sugarcane	*Scirpophaga excerptalis*	Chlorantraniliprole @ 10 kg/acre	4-6% dead hearts
				Cotton	*Amrasca biguttulla biguttulla, Bemisia tabaci, Pectinophora gossypiella*	Flonicamid 50WG @ 200 g/ha (for jassid)	2-3jassids/ leaf, 4-5 whitefly adults/ leaf 3-4% PBW damage
				Maize	*Chilo partellus, Spodoptera frugiperda*	-	4-5% dead hearts, 8-10 % FAW damage

		5.7.2023 12.7.2023 18.7.2023 26.7.2023	Bathinda, Fazilka, Hoshiarpur, Jalandhar, Kapurthala, Ludhiana, Mansa, Muktsar, Sangrur	Sugarcane	*Chilo auricilius*	-	4-5% incidence
				Cotton	*Bemisia tabaci, Pectinophora gossypiella*	Flonicamid 50WG @ 200 g/ha and Fenpropathrin 10EC @ 750 ml/ha	6-8 whitefly adults/leaf 3-4% PBW damage
				Maize	*Spodoptera frugiperda*	Chlorantraniliprole 18.5 SC @ 0.4 ml/litre of water	12-15 % FAW damage
				Rice	*Cnaphalocrocis medinalis*	-	4-5 % damaged leaves
		3.8.2023 9.8.2023 17.8.2023 22.8.2023 31.8.2023	Amritsar, Bathinda, Fazilka, Jalandhar, Gurdaspur, Hoshiarpur, Ludhiana, Mansa, Muktsar	Sugarcane	*Chilo auricilius*	-	4-5% incidence
				Cotton	*Bemisia tabaci Pectinophora gossypiella*	Fenpropathrin 10EC @ 750 ml/ha	5-6 whitefly adults/leaf 3-7% PBW damage
				Maize	*Spodoptera frugiperda*	-	10-12 % FAW damage
				Rice	*Scirpophaga incertulas, Cnaphalocrocis medinalis*	Flubendiamide 480 SC @ 50 ml/ha	4-5% dead hearts & 2-damaged folded leaves
		6.9.2023 11.9.2023 21.9.2023 28.9.2023	Amritsar, Bathinda, Fazilka. Gurdaspur, Hoshiarpur, Jalandhar, Kapurthala, Ludhiana, Mansa, Muktsar	Sugarcane	*Chilo auricilius*	-	5-6% incidence
				Cotton	*Bemisia tabaci, Pectinophora gossypiella*	-	3-4 whitefly adults/leaf 8-10 % PBW damage
				Rice	*Scirpophaga incertulas, Nilaparvata lugens*	Pymetrozine 50 WG @ 300 g/ha	5-6% white ears, 3-5 hoppers/ hill
		6.10.2023 11.10.2023 18.10.2023 25.10.2023	Amritsar, Bathinda, Fazilka, Jalandhar, Ludhiana, Mansa, Muktsar, Nawanshahr, Patiala	Sugarcane	*Chilo auricilius*	-	4-7% incidence
				Cotton	*Bemisia tabaci*	-	0-3 whitefly adults/leaf
				Rice	*Nilaparvata lugens*	-	3-5 hoppers/ hill

		4.12.2023 13.12.2023 18.12.2023 26.12.2023	Amritsar, Jalandhar, Kapurthala, Ludhiana, Patiala, Sangrur	Wheat	*Sesamia inferens*	-	1-3% dead hearts
		2.2.2024 8.2.2024 14.2.2024 22.2.2024 27.2.2024	Amritsar, Bathinda, Gurdaspur, Kapurthala, Ludhiana, Faridkot, Ferozepur, Patiala	Wheat	*Lipaphis erysimi*, *Sitobion* sp.	-	2-3 aphids/ earhead
				Mustard	*Lipaphis erysimi*	-	5-8 aphids/ terminal shoot
14.	**IGKV, Raipur**	15.01.2024	IGKV, Raipur	Chilli	*Thrips parvispinus Karny*	No	50%
		20.02.2024	IGKV, Raipur	Indian bean	*Megalurothrips usitatus Bagnall*	No	60%
		02.02.2024	IGKV, Raipur	Linseed	Thrips	-	30%
		29.10.2023	Raipur	Rice	Rice Stem borer *(Sesamia inferens)*	No	34%
		07.10.2023	Raipur	Maize	Fall Army worm *(Spodoptera frugiperda)*	No	25%
		22.10.2023	Raipur	Cotton	*Spodoptera*	-	20%
15.	**KAU, Thrissur**	17.05.2023	Kodassery, Thrissur	Banana	Nematode	Fluopyram 34.48%SC @ 250 g a.i/ha – twice at 30 days interval	50%
		04.12.2023	Kannara, Thrissur	Banana	Leaf spot	Propiconazole 25 EC@ 125 g.ai/ha	30%
		08.12.2023	Pazhanji, Thrissur	Cowpea	Virus disease	Crop sanitation and foliar application of neem-based insecticide	5%
		19.12.2023	Mulloorkkara Thrissur	Rice	BLB and stem borer		50 and 20 %
		03.01.2024	Chelakkara, Thrissur	Coconut	Rhinoceros beetle	Incorporation of *Metarhizium* in cowdung pits.	25%
		25.01.2024	Mullassery, Thrissur	Rice	BLB, leaf folder and stem borer	Bleaching powder. Use of trichocards (next season)	40, 20 and 30 %
		30.01.2024	Paralam, Thrissur	Rice	BLB and stem borer	Bleaching powder. Use of trichocards (next season)	50 and 20 %

16.	**OUAT Bhubaneshwar**	July2023	Baranga and Nimapara areas of Puri District	Rice	Yellow stem borer (*Scirpophaga incertulas)*	NIL	Mild
		August2023	Baranga and Nimapara areas of Puri District	Rice	Yellow stem borer(YSB) (*Scirpophaga incertulas)* *Leaf folder* (*C. medinalis*)	Chlorantraniliprole 18.5% SC 200ml/ha	Moderate Moderate
		September 2023	Baranga and Nimapara areas of Puri District	Rice	YSB (*Scirpophaga incertulas)*		Moderate
					Leaffolder (*Cnaphalocrosis medinalis*)	Indoxacarb 15.8EC200ml/ha	Moderate
			Central farm areas of Bhubaneswar	Maize	Fall armyworm (*Spodoptera frugiperda*)	NIL	Low
		October 2023	Central farm areas of Bhubaneswar	Rice	Yellow stem borer (*Scirpophaga incertulas)*	Chlorantraniliprole 18.5% SC 200ml/ha	moderate
		November 2023	Central farm areas of Bhubaneswar	Rice	Yellow stem borer (*Scirpophaga incertulas)*	Flubendiamide39.35% M/M SC 50ml/ha	moderate
		November 2023	Central farm areas of Bhubaneswar	Maize	Fall army worm (*Spodoptera frugiperda)*	NIL	Mild
		December 2023		Mustard	Mustard aphid (*Lipaphis erysimi)*	NIL	Mild
		January 2024		Mustard	Mustard aphid *(Lipaphis erysimi*)	Dimethoate 30% EC 625 ml/ha	Moderate

		February 2024	Pipili areas of Puri District	Brinjal	Brinjal fruit and shoot borer (*Leucinodes orbonalis*)	Thiacloprid 21.7% SC 750ml/haS	Moderate
		March 2024	(Pipili areas of Puri District)	Brinjal	Brinjal fruit and shoot borer (*Leucinodes orbonalis*)	Lambda-cyhalothrin 5% EC300ml /ha	Moderate
17.	**DrYSPUHF, Solan**	31.07.2023 to 04.08.2023	Nurpur, Indora, Dhera, Nadaun, Sujanpur (Kangra)				30 to -52
		30.06.2023 to 02.07.2023	Amb, Gagret, Bangana (Una)				41 -58
		28.07.2023 to 30.07.2023	Ghumarwin, Swarghat, Jhandutta (Bilaspur)				35-43.33
		18.08.2023	Sundarnagar (Mandi)				15-35
		15.8.2023 to 17.8.2023	Nalagarh, Solan (Solan)				40-65
18.	**CAU-Pasighat**	10.02. 2024	CHF, Pasighat	Litchi	*Aristobia reticulator*	Profenphos+Cypermehrin	25%
		29.09. 2023	Ayeng, East Siang	Paddy	Weevil grub feeding on roots	-	20%
		15.04. 2023	Jorkong, East Siang	Maize	Fall Armyworm	Emamectin benzoate	15%
		20.05. 2023	Balek, Lower Dibang Valley	Bottle gourd	Fruit fly	-	15%
		18.11. 2023	Namsing, East Siang	Cabbage	DBM and Cabbage butterfly	Spinosad	20%

19.	**UAS Raichur**	18-09-2023 04-10-2023 11-10-2023 23-10-2023 08-11-2023 21-11-2023 03-12-2023 18-12-2023 27-12-2023 05-01-2024	Major chilli growing areas of Northeastern Karnataka	Chilli	Black thrips, *Thrips parvispinus*	Biopesticides used by the farmers of *B. bassiana* *I. fumosorosea* *L. lecani* *M.anisopliae* Cyantraniliprole, Chlorantranliprole and Broflanilide	Black thrips infestation 30-40%

PJTSAU

Fig 2. Photo Gallery during surveys for the assessment of insect pest and Diseases in different areas of Telangana State

Fig 3. Sucking pests in Cotton Aphids and Mealy Bug

Fig 4. Cabagge *Spodoptera* infestation and Cotton *Spodoptera* infestation

Fig 5. Chilli flower thrips (*Thrips parvispinus*) Rice Stem borer Adult moth & Checking for Pink Bollworm (PBW)

PAU, Ludhiana

Fig 6. Surveillance for the incidence of insect pests in different crops of Punjab

AAU, Jorhat

		
Fig 7. Swarming caterpillar in rice	**Fig 8.** Tortricid caterpillar in tea	**Fig 9.** *Altica* sp. in millet

Fig 10. *Chionaspis* sp. in muga host plant (1st time report)

Fig 11. *Gynautocera papilionaria* in muga host plant (1st time report)

III. Biological control of plant disease using antagonistic organisms

Biological Control of Cereal Diseases

III. 1. Biological Control of Rice Diseases

III. 1. 1. Large scale demonstration of Pant Bioagent (PBAT-3) for the management of rice sheath blight

NCIPM, New Delhi

Area -02 ha, Location: Barhi, District: Sonepat, Haryana

Large scale demonstration of pant bioagent-3 (PBAT3) against sheath blight of rice was carried out at village Barhi (GPS 29.126678, 77.063195) in district Sonepat, Haryana in two ha area. The incidence of sheath blight was not recorded in both PBAT-3 treated plot and farmers practice fields (FP). However, the presence of sheath rot was observed in most of the rice field from tillering stage and BLB was observed in near maturity stage. The PBAT-3 application as seed treatment, soil application, seedling root dip treatment and foliar application proved effective in reducing occurrence of sheath rot, bakane and BLB diseases in treated fields compared to farmers practice. No fungicide was applied in demonstration plot, however two spray of the recommended insecticides along with Azadirachtin 1500 ppm, were done for the management of stem borer and leaf folders. Whereas in FP plot two spray application of fungicides (Azoxystrobin 18.2% + Difenoconazole 11.4% w/w SC) and insecticides (Cartap Hydrochloride 50 % SP, Chlorantraniliprole18.5) was done. The yield and BC ratio was significantly high in demonstration plots (56 q/ha, 3.6) compared to FP plots (47.5 q/ha, 2.9).

Table 3. Scenario of pests and natural enemies in PBAT-3 demonstration field and FP fields of basmati rice at Sonepat, Haryana

Particular	45 DAT			60 DAT			100 DAT		
Pest	PBAT-3	FP	*t-test P value	PBAT-3	FP	*t-test P value	PBAT-3	FP	*t-test P value
YSB (% Dead heart/ White ear)	3.05	8.74	0.0001	2.40	5.50	0.017	4.69	17.5	0.00011
Leaf folder (% leaf damage)	1.36	1.89	NS	5.71	10.54	0.0001	-	-	-
BPH (No/hill)	0.00	0.00	-	00	00	-	3.45	5.5	<0.0001
Spider (No/hill)	2.1	1.05	NS	3.21	1.45	0.00001	3.9	2.4	0.025
Sheath Blight (% incidence)	0.00	00	-	0.00	00	-	00	00	0.034
Sheath Rot (% incidence)	0.00	5.5	-	0.59	3.68	0.00001	00	2.6	-
Bacterial Leaf Blight (% incidence)	0	0	-	0	0	-	1.5	7.8	<0.0001
Bakane (% incidence)	0.00	0.35	-	0.00	0.42	-	0.01	0.65	<0.0001

***Two tail t-Test: Two-Sample Assuming Equal Variances**

Table 4. Economics of PBAT-3 demonstration and farmers practice in Basmati rice (PB 1121) at Sonepat, Haryana

Parameters	BIPM	FP	% Change in BIPM over FP
Cost (₹/ha)	62300.00	65600.00	-5.03
Yield (q/ha)	56.00	47.50	17.89
Gross return (₹/ha)	224000.00	190000.00	17.89
Net return (₹/ha)	161700.00	124400.00	29.98
BC Ratio	3.60	2.90	

Market price of paddy @ Rs 4000/q

PAU, Punjab

The demonstration on Pant bioagent (PBAT-3) for the management of sheath blight of rice was laid at village Surewal in Anandpur Sahib block of Ropar district, Punjab.

The nursery of PAU recommended variety PR126 was sown on June 19, 2023 after treating it with PBAT-3 formulation @ 10 g/kg seed. Thirty day old seedlings were uprooted and treated by dipping their roots in PBAT-3 formulation @ 10 g/L water for 30 minutes. Treated seedlings were transplanted in the field and PAU recommended agronomic practices were followed for raising the crop. Two sprays of the PBAT-3 formulation @ 1% were given 45 days and 55 days after transplanting with knapsack sprayer by directing the spray towards the base of the plants. The disease data was recorded on October 9, 2023 using 0-9 SES scale of IRRI. Sheath blight incidence in the field treated with Pant bioagent PBAT-3 was 36.7 per cent as compared to 65.6 per cent in control field (Table 5). Maximum yield of 85.00 q/ha was recorded in chemical control while PBAT-3 treatment yielded 77.50 q/ha (Table 5). Least yield of 71.25 q/ha was obtained in untreated control.

Table 5. Demonstration of Pant bioagent PBAT-3 against sheath blight of rice during 2023

Treatment	Sheath blight incidence (%)	Yield (kg/ha)
Pant bioagent (PBAT-3)	36.7	77.50
Trifloxystrobin + tebuconazole @ 200g/ha	Traces	85.00
Control	65.6	71.25

Fig 12. Large scale demonstration of Pant Bioagent (PBAT-3) for the management of rice sheath blight

III. 1. 2. Evaluation of antagonistic microbes against brown spot, blast and sheath blight of rice

ICAR-National Rice Research Institute, Cuttack

The field experiment was conducted at ICAR-NRRI to test the efficacy of bio-agents against sheath blight, brown spot, and blast diseases of rice compared to the POP recommendation. Among the bioagents, *Bacillus amyloliquefaciens* NRRI-BS5 treatment recorded the lowest PDI for sheath blight (11.66%), brown spot (8.13%), and blast (5.16%), followed by NBAIR-PFDWD (*Pseudomonas flourescens*), which recorded PDI of 14.08%, 10.20%, and 6.34% for sheath blight, brown spot, and blast, respectively, in kharif 2023. The percent disease reduction over the control was highest for chemical fungicide against sheath blight (79.74%), brown spot (81.75%), and blast (74.22%), followed by *B. amyloliquefaciens* NRRI-BS5. The highest grain yield per plot (13.96 kg/plot) was recorded in the chemical treatment, followed by plants treated with NRRI-BS5 and NBAIR-PFDWD, which had yields of 13.27 kg/plot and 12.62 kg/plot, respectively (Table 6).

Table 6. Evaluation of antagonistic microbes against brown spot, blast and sheath blight of rice during Kharif 2023

Treatments	Plant height (cm)	Root length (cm)	Sheath blight		Brown spot		Blast		Yield (kg/plot)	Percentage yield increase over control (%)
			PDI (Percent disease incidence)	Disease reduction over control (%)	PDI (Percent disease index)	Disease reduction over control (%)	PDI (Percent disease index)	Disease reduction over control (%)		
T1: *Pseudomonas fluoresens* NBAIR PFDWD	103.2	18.32	14.08	60.27	10.20	64.61	6.34	58.62	12.62	13.55
T2: *Bacillus amyloliquefaciens* NRRI- BS5	105.4	19.41	11.66	67.10	8.13	71.79	5.16	66.32	13.27	17.78
T3:POP Recommendation (Tebuconazole 50%+ Trifloxystrobin 25 % (75% WG)	100.8	17.66	7.18	79.74	5.26	81.75	3.95	74.22	13.96	21.85
T4:Untreated control	90.8	15.12	35.44		28.82		15.32		10.91	
SEm	1.00	0.29	0.34		0.29		0.31		0.24	
CD (0.05%)	3.08	0.90	1.06		0.89		0.96		0.75	

Anand Agricultural University, Anand, Gujarat

Table 7. Evaluation of antagonistic microbes against blast and sheath blight of rice during 2023-24

Treatments	Blast PDI (%)	Disease reduction over control (%)	Sheath blight PDI (%)	Disease reduction over control (%)
T_1: *Pseudomonas fluorescens* NBAIR PFDWD (Seed treatment @10 g/litre + Seedling root dip @ 10 g/litre + Foliar spray @ 10 g/litre on standing crop at 10 days interval, *i.e.* 40, 50, 60 and 70 days after transplanting (DAT).	20.96*[b] (12.80)	36.06	17.61[b] (9.15)	46.62
T_2: POP Recommendation (Application of Tebuconazole 50% + Trifloxystrobin 25% (75% WG) 1 g/litre	18.32[a] (9.88)	50.65	14.18[a] (6.00)	64.99
T_3: Untreated control	26.58[c] (20.02)	-	24.46[c] (17.14)	-
S. Em.± (T)	0.48	-	0.39	-
C.D. at 5% T	1.37	-	1.11	-
C. V. (%)	12.14	-	11.38	-
Note: *Figures outside the parentheses are arcsine transformed values, those inside are retransformed values **PDI**: Per cent Disease Intensity				

Table 8. Evaluation of antagonistic microbes on different plant growth parameters and yield in rice during 2023-24

Treatments	Shoot length (cm)	Root length (cm)	Yield (q/ha)	Yield increase over control (%)	B:C Ratio
T_1: *Pseudomonas fluorescens* NBAIR PFDWD (Seed treatment @10 g/litre + Seedling root dip @ 10 g/litre + Foliar spray @ 10 g/litre on standing crop at 10 days interval, *i.e.* 40, 50, 60 and 70 days after transplanting (DAT).	64.46[a]	8.29[a]	49.14[b]	86.92	2.66
T_2: POP Recommendation (Application of Tebuconazole 50% + Trifloxystrobin 25% (75% WG) 1 g/litre	61.39[a]	7.64[b]	61.71[a]	134.73	3.38
T_3: Untreated control	43.68[b]	6.29[c]	26.29[c]	-	-
S. Em. ± (T)	1.58	0.21	2.03	-	-
C.D. at 5% T	4.48	0.59	6.27	-	-
C. V. (%)	14.35	14.35	11.77	-	-

Results: The per cent disease index (PDI) as well as the growth parameters of individual treatments are presented in the Table 7 and 8. The treatment T_2 - POP Recommendation (Tebuconazole 50% + Trifloxystrobin 25%) recorded the significantly lowest blast per cent disease intensity (9.88%) as compared to treatment T_1- *Pseudomonas fluorescens* NBAIR PFDWD (Seed treatment + Seedling root dip + Foliar spray)(12.80%). Further, treatment T_2 - POP Recommendation (Tebuconazole 50% + Trifloxystrobin 25%) recorded significantly lowest sheath blight per cent disease intensity (6.00%) as compared to treatment T_1- *Pseudomonas fluorescens* NBAIR PFDWD (Seed treatment + Seedling root dip + Foliar spray)(9.15%). The treatment T_2 - POP Recommendation (Tebuconazole 50% + Trifloxystrobin 25%) showed the highest per cent disease reduction over control in case of blast (50.65%) and sheath blight (64.99%) in rice.

Similarly, the observations of growth parameters revealed treatment T_2 and T_1 found to be significantly the most promising due to the increased shoot and root growth. The data of grain yield showed the significantly highest yield (61.71 q/ha) in the treatment T_2 - POP Recommendation (Tebuconazole 50% + Trifloxystrobin 25%) as compared to treatment T_1-*Pseudomonas fluorescens* NBAIR PFDWD (Seed treatment + Seedling root dip + Foliar spray)(49.14 q/ha). The highest (134.73%) increase in yield over untreated control was obtained in the treatment T_2 -POP Recommendation (Tebuconazole 50% + Trifloxystrobin 25%).

Assam Agricultural University, Jorhat

Results: After seed treatment no infection of brown spot, blast and sheath blight was observed in rice. Only in control very low (10%) PDI of sheath blight was observed. There was no significant difference of rice yield among the treatments.

Table 9. Efficacy of antagonistic microbes against brown spot, blast and sheath blight of rice

Treatments	PDI (%)			Shoot length (cm)	Root length (cm)	Grain yield (Kg/ha)	B:C
	Brown spot	Blast	Sheath blight				
T1:*Pseudomonas fluorescens* AAU pf1	0	0	0	145.66	17.5	3450[a]	1.71
T2: *Pseudomonas fluorescens* NBAIR PFDWD	0	0	0	146.0	19.0	3470[a]	1.73
T3: *Pseudomonas entomophila* NBAIR PEOWN	0	0	0	142.0	15.6	3500[a]	1.75
T4: *Bacillus albus* strain NBAIR BATP	0	0	0	146.2	18.8	3740[a]	1.94
T5: *Lysinibacillus sphaericus* NBAIR-BtyoPS	0	0	0	145.0	18.0	3575[a]	1.81
T6: *Trichoderma asperellum* NBAIR TATP	0	0	0	144.5	16.4	3540[a]	1.78
POP Recommendation (seed treatment carboxin @ 2g/kg seed in 1litre of water)	0	0	0	145.0	17.0	3438[a]	1.70
T8: Untreated control	0	0	**10**	143.6	16.0	3150[b]	1.51
CD (0.05)				NS	NS	583.14	

***Disease severity rating scale: (Source: IRRI, 2014). Very high (>50), high (31-50%), moderate (20 to 30%) and low (<20%).**

Price of Rice Rs. 21/kg, Cost of cultivation Rs. 26,672.00

Punjab Agricultural University, Ludhiana

Experiment was conducted on rice variety PR126 at Entomological Research Farm, PAU Ludhiana, The seed treatment, seedling dip and four foliar sprays directed towards the base of plant at 40, 50, 60 and 70 days after transplanting were done as per the protocol. The data were recorded on disease index, shoot and root growth (cm) and grain yield. Disease severity based on SES 0-9 scale, IRRI was recorded from twenty five randomly selected plants from each of the replicated plots.The maximum shoot length (35.10 ± 0.83 cm, 63.30 ± 0.82 cm and 79.50 ± 0.71 cm) was recorded in *Pseudomonas fluorescens* NBAIR PFDWD treated plots during the month of June, July and August, respectively. This was followed by other treatments i.e. *Bacillus amyloliquefaciens* NRRI BS-5 and chemical control. Similarly, maximum root length (5.80 ± 0.99 cm) was recorded in *Pseudomonas fluorescens* NBAIR PFDWD treated plots (Table 10). The per cent disease index in plots treated with *Pseudomonas fluorescens* was recorded to be 63.88 per cent, which was significantly better than other microbial antagonist *Bacillus amyloliquefaciens* NRRI BS-5 treated plot (72.56 %), which further was found to be at par with untreated control (74.85 %) (Table 11). However, sprays of chemical fungicide, Tebuconazole + Trifloxystrobin @ 200 g/ ha was found to be effective in managing the disease (28.80 per cent disease index). Significantly higher grain yield was recorded in *Pseudomonas fluorescens* NBAIR PFDWD treated plots (67.80 q/ ha) as compared to *Bacillus amyloliquefaciens* NRRI BS-5 treated plot (64.06 q/ ha) and untreated control (62.78 q/ ha) (Table 11). The yield in *Bacillus amyloliquefaciens* NRRI BS-5 treated plots and untreated control did not differ significantly with each other. However, chemical control recorded significantly better yield (74.64 q/ha) than all the other treatments.

Table 10. Evaluation of effect of antagonistic microbes on growth parameters of rice

Treatments	Shoot length (cm) Mean ± SE			Root length (cm) Mean ± SE
	23.6.23	23.7.23	22.8.23	23.6.23
T1: *Pseudomonas fluorescens* NBAIR PFDWD	35.10 ± 0.83	63.30 ± 0.82	79.50 ± 0.71	5.80 ± 0.99
T2: *Bacillus amyloliquefaciens* NRRI BS-5	30.10 ± 1.00	59.10 ± 1.61	66.02 ± 1.18	4.06 ± 0.17
T3: Tebuconazole + Trifloxystrobin @ 200 g/ ha	31.50 ± 1.48	57.60 ± 1.65	65.90 ± 1.31	3.20 ± 0.20
T4: Untreated control	32.20 ± 1.36	58.70 ± 1.69	65.30 ± 0.99	3.70 ± 0.25

SE: Standard Error; Mean of ten values

Table 11. Evaluation of antagonistic microbes against sheath blight of rice (2023)

Treatment	PDI	Grain yield (q/ha)
T1: *Pseudomonas fluorescens* NBAIR PFDWD	63.88[b] (53.05)	67.80[b]
T2: *Bacillus amyloliquefaciens* NRRI BS-5	72.56[c] (58.42)	64.06[c]
T3: Tebuconazole + Trifloxystrobin @ 200 g/ ha	28.80[a] (32.33)	74.64[a]
T4: Untreated control	74.85[d] (60.00)	62.78[c]
LSD (p=0.05)	4.48	1.65
CV (%)	15.64	6.38

***Figures in parentheses are arc sine transformed values**

G. B. Pant University of Agriculture and Technology, Pantnagar

Table 12. Effect of Pant Bioagent (PBAT-3) for the management of rice sheath blight

Treatments	Seed germination (%)	Root length (cm)	Shoot length (cm)	Disease incidence (%)	Percentage disease reduction over control	Yield (qt/ha)	Percentage yield increase over control	C:B
T1: (PBAT-3)	67.33 (55.15)	21.33 (27.49)	56.00 (48.44)	10.00 (18.42)	54.55	66.66 (54.74)	9.99	2.46
T2: (POP)	68.23 (55.76)	20.66 (27.03)	54.67 (47.68)	9.66 (18.06)	56.00	66.00 (54.33)	9.00	2.39
T3: (Untreated Control)	60.33 (50.96)	18.00 (25.09)	49.67 (44.81)	22.00 (27.94)	-	60.00 (50.76)	-	1.85
SEm	1.20	0.88	0.19	1.54	-	0.19	-	-
CD (0.05%)	4.69	3.44	1.23	5.01	-	1.23	-	-

Data in parenthesis are angular transformed value

The results of the field demonstration on management of sheath blight of rice using PBAT 3 revealed that the sheath blight incidence was at par in T1 (PBAT3) (10%) and T2(PoP) (9.66%) but significantly high in control (22%) accordingly seed germination percentage (67.33 & 68.33%), root length (21.33 & 20.66 cm), shooth length (56 & 54.67 cm) and yield (66.66 & 66 q/ha) was recorded at par in T1 and T2 but significantly higher as compare to control (Table 12).

III. 1. 3. Field evaluation of ICAR-NBAIR antagonistic organisms against Rice diseases (Blast, Brown spot and Sheath blight)

Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu

Table 13. Effect of various antagonistic organisms agaisnt blast and brown leaf spot of rice

Treatments	Per cent Disease Index		Grain Yield (Kg/ha)
	Blast	Brown leaf spot	
T1 – NBAIR-PFDWD strain *Pseudomonas fluorescens*	13.985	21.08	40.437
T2 – NBAIR-TATP strain *Trichoderma asperellum*	17.867	29.017	36.382
T3 – Propiconazole @ 0.1% and Tricyclazole @ 0.06%	8.983	13.65	44.97
T4 – Untreated control	22.1	35.16	32.323
C.D. at 5%	1.126	1.295	2.884

Antagonistic organisms NBAIR-PFDWD strain *Pseudomonas fluorescens* and NBAIR-TATP strain *Trichoderma asperellum* along with the fungicides were assessed against rice diseases (Blast, Brown spot. Blast and brown leaf spot per cent disease index was significantly lowest in the fungicidal treatment (8.983% and 13.65% respectively), followed by *P. fluorescens*(13.985% and 21.08% respectively). Grain yields also corresponded with the disease index (44.97 and 40.437 respectively in fungicide and *P. fluorescens*).

III. 1. 4. Evaluation of *Bacillus subtilis* TNAU BS1 against major diseases of rice (Blast, brown spot, Bacterial leaf blight) (TNAU Coimbatore)

Tamil Nadu Agricultural University, Coimbatore

Results revealed that *Bacillus subtilis* TNAU BS1 (Seed treatment (10g/kg) + soil application @ 5 kg/ha+ Foliar spray @10 g/kg), *Bacillus subtilis* NBAIR BS1 (Seed treatment (10g/kg) + soil application @ 5 kg/ha+ Foliar spray @10 g/kg) and *Pseudomonas fluorescens* NBAIR-PFDWD (Seed treatment (10g/kg) and soil application @ 5 kg/ha+ Foliar spray @10 g/kg) were equally effective against BLB and brown spot and the incidence of blast and brown spot diseases of these three treatments were significantly higher than the control (Table 14). The grain yield in *Bacillus subtilis* TNAU BS1 (3810 Kg/ha), *Bacillus subtilis* NBAIR (3575 Kg/ha), and *Pseudomonas fluorescens* NBAIR-PFDWD (3482 Kg/ha) were on par with the yield in Azoxystrobin (1ml/L) (3621 Kg/ha).

Table 14. Effect of bioagents against major diseases of rice

Treatments	Blast*	Brown spot*	BLB*	Yield Kg/ ha**
T1: *Bacillus subtilis* TNAU BS1 (Seed treatment (10g/kg) + soil application @ 5 kg/ha+ Foliar spray @10 g/kg)	4.04 (11.54)[a]	15.25 (22.99)[a]	2.91 (9.79)[a]	3810 (61.74)[a]
T2: *Bacillus subtilis* NBAIR BS1 (Seed treatment (10g/kg) + soil application @ 5 kg/ha+ Foliar spray @10 g/kg)	4.28 (11.83)[b]	15.39 (23.09)[a]	3.15 (10.21)[a]	3575 (59.81)[a]
T3: *Pseudomonas flourescens* NBAIR - PFDWD (Seed treatment (10g/kg) + soil application @ 5 kg/ha+ Foliar spray @10 g/kg)	4.89 (11.99)[bc]	14.58 (22.36)[a]	3.32 (10.15)[a]	3482 (59.01)[a]
T4: Azoxystrobin @ 0.1% 1ml/L	4.98 (12.01)[c]	19.76 (26.18)[ab]	3.12 (10.20)[a]	3621 (60.18)[a]
T5: Control	11.38 (21.68)[d]	30.55 (32.55)[c]	6.65 (14.94)[b]	2682 (51.79)[b]
CD (P = 0.05)	1.164	3.181	1.003	3.822
SEd	0.395	1.499	0.323	1.881

Figures in parentheses are arcsine transformed values* / square root transformed values**
In a column means followed by same letter(s) are not significantly different (p=0.05) by LSD
Values are mean of four replications.

III. 2. Biological Control of Maize Diseases

III. 2. 1. Field evaluation of ICAR-NBAIR antagonistic organisms against Maize Turcicum leaf blight (*Exserohilum turcicum*)

Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu

Table 15. Percent maize Turcicum leaf blight index in response to the application of various antagonistic organisms

Treatments	Plant Height (gm)	Percent disease index		Biomass (gm/ plant)	Yield (q/ha)
		3 DAS	7 DAS		
T_1- NBAIR-PFDWD strain *Pseudomonas fluorescens* (1%)	195.43	26.56	23.40	143.56	30.05
T_2 - NBAIR-TATP strain *Trichoderma asperellum* (1%)	197.55	22.78	19.80	148.44	32.36
T_3 - Carbendazim @ 2 g/L	181.56	20.60	18.21	136.08	28.18
T_4 – Untreated control	178.30	36.22	38.45	122.87	22.10
C.D. at 5%	**11.37**	**2.13**	**2.52**	**4.21**	**1.43**

Two antagonistic organisms *Pseudomonas fluorescens* and *Trichoderma asperellum* (NBAIR strain) along with recommended fungicide (Carbendazim @ 2 g/L), were assessed against Maize Turcicum leaf blight (*Exserohilum turcicum*).Carbendazim spray recorded lowest percent disease index (18.21%), that was comparable to NBAIR-TATP strain *T. asperellum* T_2 (19.80%). However, grain yield was significantly highest in T_2 (32.36 q/ha) and T_1 (30.05 q/ha). The grain yield was lowest in T_4 control (22.10 q/ha). Other growth and yield attributes (plant height and biomass) also corresponded respectively with the grain yield.

Biological Control of Pulse Diseases

III. 3. Biological Control of Chickpea Diseases

III. 3. 1. Biological suppression of chickpea pod borer, *Helicoverpa armigera* and soil borne disease of chickpea (*Fusarium* wilt, *Macrophomina* Dry root rot and Collar rot)

Anand Agricultural University, Anand

Results: Evaluation of entomopathogens against *H. armigera*, wilt-root rot incidence and yield of chickpea is presented in the Table 16. The significantly lowest larval population was documented in the treatment T_4 - POP recommendation (Carbendazim 12% + Mancozeb 63% WP(SA) and Quinalphos 25EC (FS)) (2.63 larvae/plant) as compared to treatment T_2 -*T. asperellum* NBAIR TATP (ST+SA) and *B. thuringiensis* NIBSM*Bt*18 1% (FS) (3.22 larvae/plant)which was statistically at par with the treatment T_1 - *T. harzianum* NBAIR strain (ST+SA) and *B. thuringiensis* NIBSM *Bt* 18 1% (FS) (3.38 larvae/plant). The highest pest reduction over control was found in the treatment T_4 - POP recommendation (Carbendazim 12% + Mancozeb 63% WP (SA) and Quinalphos 25EC (FS)) (47.19%).

The significantly lowest wilt-root rot incidence was recorded in the treatment T_4 - POP recommendation (Carbendazim 12% + Mancozeb 63% WP(SA) and Quinalphos 25EC (FS)) (8.70%) as compared to treatment T_2 -*T. asperellum* NBAIR TATP (ST+SA) and *B. thuringiensis* NIBSM *Bt* 18 1% (FS) (15.77%) which was statistically at par with the treatment T_1 - *T. harzianum* NBAIR strain (ST+SA) and *B. thuringiensis* NIBSM *Bt* 18 1% (FS) (17.78%). The highest disease reduction over control was found in the treatment T_4 - POP recommendation (Carbendazim 12% + Mancozeb 63% WP (SA) and Quinalphos 25 EC (FS)) (75.89%).

Further, treatment T_4 - POP recommendation (Carbendazim 12% + Mancozeb 63% WP (SA) and Quinalphos 25 EC (FS)) recorded significantly highest yield (13.20 q/ha) as compared to treatment T_2 -*T. asperellum* NBAIR TATP (ST+SA) and *B. thuringiensis* NIBSM *Bt* 18 1% (FS) (10.80 q/ha) which was statistically at par with the treatment T_1 - *T. harzianum* NBAIR strain (ST+SA) and *B. thuringiensis* NIBSM *Bt* 18 1% (FS) (10.60 q/ha).The highest (65.00%) increase in yield over untreated control was obtained in the treatment T_4 - POP recommendation (Carbendazim 12% + Mancozeb 63% WP(SA) and Quinalphos 25EC (FS)).

Table 16. Evaluation of entomopathogens against *Helicoverpa armigera*, wilt-root rot incidence and yield of chickpea (2023-24)

Treatments	No. of larvae/ plant		Pest reduction over control (%)	Wilt-root rot incidence (%)	Disease reduction over control (%)	Yield (q/ha)	Yield increase over control (%)	B:C Ratio
	BS	Pooled over Sprays						
T_1 Seed treatment with @ 10g/kg and soil application twice @ 5 kg/ha of *Trichoderma harzianum* NBAIR strain at 25 & 50 days after sowing + Spraying of *Bacillus thuringiensis* NIBSM *Bt* 18 1% @ 10 ml/L two sprays at pod initiation and pod formation stage	1.86* (2.96)	1.97^b (3.38)	32.13	24.94**^{b} (17.78)	50.72	10.60^b	32.5	1.03
T2 Seed treatment with @ 10g/kg and soil application twice @ 5 kg/ha of *Trichoderma asperellum* NBAIR TATP at 25 & 50 days after sowing + Spraying of *Bacillus thuringiensis* NIBSM *Bt* 18 1% @ 10 ml/L two sprays at pod initiation and pod formation stage	2.21 (4.38)	1.93^b (3.22)	35.34	23.40^b (15.77)	56.29	10.80^b	35.00	1.05
T3 Pheromone traps @ 25/ ha (NBAIR product)	1.91 (3.15)	2.26^c (4.61)	7.43	36.79^c (35.87)	0.58	8.40^c	5.0	1.08
T4 POP recommendation (Carbendazim 12% + Mancozeb 63% WP soil drenching @ 1 g/L at 25 & 50 days after sowing and Quinalphos 25 EC @ 250g a.i/ha (2ml/L) first spray at initiation of pest and second spray at 15 days interval	2.16 (4.17)	1.77^a (2.63)	47.19	17.15^a (8.70)	75.89	13.20^a	65.00	1.67
T5 Untreated control	2.00 (3.50)	2.34^c (4.98)	-	36.92^c (36.08)	-	8.00^c	-	-
S. Em.± (T)	0.10	0.03	-	0.95	-	0.60	-	-
C.D. at 5% T	NS	0.10	-	2.71	-	1.81	-	-
C. V. (%)	11.47	9.97	-	10.81	-	13.24	-	-

IGKV, Raipur

Minimum larval population/meter row length during 1st spray was observed in T2 (Seed treatment with @10g/Kg *Trichoderma asperellum* NBAIR strain) 1.87 larval/meter row length. Maximum larval population was observed during 1st spray in T5 (control plot) with (2.325) larval population. During 2nd spray T2 (Seed treatment with @ 10g/Kg *Trichoderma asperellum* NBAIR strain) was observed minimum larval population 1.06 larval population and T1(Seed treatment with @10g/Kg

Trichoderma harzianum NBAIR strain) was observed 1.86 larval population. Maximum larval was recorded in control plot T5 (Untreated control) with 5.40 larval/meter row length. During 1st spray percent reduction over control was recorded from 61.04% to 45.83% it was maximum in T2 (Seed treatment with Seed treatment with @ 10g/Kg *Trichoderma asperellum*) 61.04% and minimum in T4 (Quinalphos 25EC + Carbendazim +Mencozeb) 45.83%. During 2nd spray – percent reduction over control recorded from 65.55% to 80.37% most effective treatment was found T2 (Seed treatment with Seed treatment with @ 10g/Kg *Trichoderma asperellum*) with 80.37 reductions over control and lowest effective was T1 (Seed treatment with @10g/Kg *Trichoderma harzianum*) 65.55%.

Maximum grain yield per plot was observed in T2 (Seed treatment with @ 10g/Kg *Trichoderma asperellum* NBAIR Strain) with 8.16 kg/plot and minimum grain yield was recorded on T5 (Untreated control) 2.10 kg/plot. T2 (Seed treatment with @ 10g/Kg *Trichoderma asperellum* NBAIR Strain) was better over treatment T1 (Seed treatment with @ 10g/Kg *Trichoderma harzianum* NBAIR Strain*)* resulted depicted significant higher grain yield (21.30 kg/ha) as compared to (18.85kg/ha) in T1 (Seed treatment with @ 10g/Kg *Trichoderma harzianum* NBAIR Strain*)* percent increase in yield over control ranged from (47.07% to 55.02%) result indicated that highest percent increase in yield over control was significantly higher in treatment T2 (Seed treatment with @ 10g/Kg *Trichoderma asperellum* NBAIR Strain) (55.02%) and it was lowest in treatment T4 (Quinalphos 25EC +Carbendazim +Mencozeb (soil drenching) (47.07%).

Table 17. Mean number of chickpea pea pod borer *Helicoverpa armigera* larvae in different treatments

Treatments	Mean larval population/ meter row length during 1st spray				Mean	% ROC	Mean larval population/ meter row length during 2nd spray				Mean	% ROC
	Pre Treat-ment	3 DAS	7 DAS	10 DAS			Pre Treat-ment	3 DAS	7 DAS	10 DAS		
T1: Seed treatment with @10g/ Kg *T. harzianum* + NIBSM *Bt* 18%@10m/L	3.20 (2.00)	2.00 (1.67)	1.80 (1.85)	1.60 (1.57)	2.32	51.66	4.40 (2.29)	2.20 (1.74)	1.60 (1.55)	1.80 (1.60)	1.86	65.55
T2: Seed treatment with @10g/ Kg *T. asperellum* NIBSM *Bt* 18%@10m/L	3.00 (1.99)	1.60 (1.57)	1.50 (1.52)	1.40 (1.51)	1.87	61.04	3.80 (2.18)	1.00 (1.39)	1.40 (1.51)	0.80 (1.31)	1.06	80.37
T3: Pheromone trap (NBAIR) @ 25/ha	4.80 (2.40)	2.00 (1.70)	1.80 (1.65)	1.60 (1.57)	2.55	46.87	4.20 (2.25)	2.20 (1.75)	2.20 (1.74)	1.00 (1.36)	1.80	66.66
T4: Quinalphos25EC @ 250g a.i./ ha and Carbendazim+Mencozeb soil drenching @ lg/L	4.00 (2.21)	2.20 (1.77)	2.60 (1.84)	1.60 (1.55)	2.60	45.83	5.20 (2.48)	1.60 (1.60)	1.40 (1.49)	1.00 (1.39)	1.33	75.37
T5: Untreated control	3.40 (2.08)	5.00 (2.44)	5.20 (2.47)	5.60 (2.56)	4.80	-	5.40 (2.52)	5.20 (2.48)	5.40 (2.51)	5.60 (2.55)	5.40	-
SEM	0.13	0.09	0.11	0.09	-	-	0.13	0.13	0.10	0.11	-	-
CD	N/A	0.29	0.35	0.13	-	-	N/A	0.41	0.33	0.36	-	-

Table 18. Mean pod damage, grain damage of *H. armigera* and grain yield of gram (*C. aritenum*)

Treatments	Mean pod damage/5 plant before spray	Mean pod damage/5 plant after 1st spray	Mean pod damage/5 plant after 2nd spray	Mean pod damage at harvest per plot	Mean grain yield per kg/ha	Mean grain yield per/ha	Per cent increase in yield over control (%)
T1: Seed treatment with @10g/ Kg *T. harzianum* + NIBSM *Bt* 18%@10m/L	14.62 (3.91)	5.48 (2.52)	4.70 (2.37)	21.00 (4.63)	5.98	18.85	49.27
T2: Seed treatment with @10g/ Kg *T. asperellum* NIBSM *Bt* 18%@10m/L	12.40 (3.61)	3.20 (1.95)	1.66 (1.58)	11.66 (3.49)	8.16	21.30	55.02
T3: Pheromon trap (NBAIR) @ 25/ha	10.62 (3.40)	5.05 (2.44)	3.30 (2.03)	13.50 (3.75)	6.22	18.18	47.30
T4: Quinalphos 25 EC @ 250 g a.i./ha and Carbendazim+Mencozeb soil drenching @ lg/L	12.16 (3.57)	5.40 (2.52)	2.96 (1.93)	16.46 (4.13)	4.66	18.10	47.07
T5: Untreated control.	13.26 (3.73)	14.60 (3.92)	14.82 (3.93)	34.96 (5.97)	2.10	9.58	-
SEM	0.26	0.20	0.20	0.34	0.34	1.47	-
CD	N/A	0.61	0.60	1.04	1.02	4.25	-

Table 19. Disease incidence of chickpea soil born diseases (per cent mortality) in different treatments

Treatments	% mortality								
	Fusarium wilt			Dry root rot			Collar rot		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T1: Seed treatment with @10g/ Kg *T. harzianum* + NIBSM *Bt* 18%@10m/L	4.13 (10.46)	5.07 (12.52)	6.10 (13.90)	0.30 (1.40)	0.89 (3.38)	2.05 (6.19)	3.75 (10.86)	4.61 (12.17)	4.57 (11.96)
T2: Seed treatment with @ 10g/Kg *T. asperellum* NIBSM *Bt* 18%@10m/L	**2.85** (8.48)	**3.94** (10.04)	**5.35** (12.89)	**0.25** (1.28)	**0.57** (1.94)	**1.56** (5.47)	**2.75** (7.11)	**3.47** (9.12)	**3.69** (9.51)
T3: Pheromon trap (NBAIR) @ 25/ ha	3.95 (10.09)	5.11 (12.57)	6.72 (14.73)	0.50 (2.55)	0.74 (3.13)	1.47 (5.34)	3.62 (9.79)	4.36 (10.76)	5.36 (12.97)
T4: Quinalphos25EC @250g a.i./ ha and Carbendazim+Mencozeb soil drenching @ lg/L	6.10 (12.60)	8.50 (16.23)	9.57 (17.54)	0.75 (3.14)	1.47 (5.34)	3.34 (9.17)	8.50 (16.23)	9.48 (17.34)	10.05 (18.20)
T5: Untreated control.	11.45 (19.61)	14.00 (21.78)	15.43 (22.93)	1.94 7.93	4.29 (11.72)	7.38 15.58	13.80 (21.58)	15.24 (22.79)	16.92 (24.12)
SEM	2.47	1.98	1.65	1.47	1.93	2.47	2.20	2.18	1.90
CD	7.49	5.98	5.00	4.44	5.86	7.46	6.67	6.61	5.76

***Figures in parentheses are angular transformation values**

The minimum percent mortality and fewer incidences recorded in T2 (Seed treatment with @ 10g/ Kg *Trichoderma asperellum* NBAIR strain) as compare to other treatment in case of *Fusarium* wilt, dry root rot and collar rot disease respectively.

Fig 13. Chickpea field evaluation against *Helicoverpa armigera* and soil borne disease **(***Fusarium* wilt**,** *Macrophomina* Dry root rot and Collar rot)

III. 4. Biological Control of Cowpea Diseases

III. 4. 1. Demonstration of the bioefficacy of *Trichoderma asperullum* KAU strain for the management *Fusarium* wilt in cowpea

Kerala Agricultural University, Vellayani

The experiment was carried out during September 2023 to December 2023 at Thumba, under Kadinamkulam Krishi bhavan in an area of 50 cents (0.2 ha) using hybrid cowpea variety Polo. Experiment was laid out in RBD with 2 treatments replicated 14 times. Unit plot size was 80 m^2. Treatments evaluated were T1- talc - based formulation of the *Trichoderma asperullum* KAU strain 2×10^6 spores mL^{-1} @ 20 g kg^{-1} of seed + basal application (cowdung + neemcake 9:1 ratio) @ 250 g /plant and soil drenching @ 20 g/L at 20, 40 and 60 DAS and T2- seed treatment with carbendazim @ 2g kg^{-1} of seed followed by soil drenching @ 0.2 per cent at 15 DAS. During 2022 -23 and 23-24 (2 years) the incidence of *Fusarium* wilt was very less. The hybrid variety Polo was again proved to be tolerant to wilt. A lesser extend of infection (0.25%) was noted in *Trichoderma* treated plots and therefore, the disease incidence percentage could not be statistically analysed. The yield recorded was significantly high in *Trichoderma* treated plot (54.64 kg/plot) compared to carbendazim treatment (46.84 kg /plot).

Table 20. Efficacy of microbial agents in managing *Fusarium* with of cowpea (Pooled data of two years)

Treatments	Disease incidence (%)		Yield (kg/ha)
	After first application	After second application	
Talc based formulation of the *Trichoderma asperullum* KAU strain 2×10^6 spores @ 20g/L of seed + basal application (multiplied in cowdung + neemcake 9:1 ratio) @ 250g / plant and soil drenching @ 20 g/L	0	0.25	54.64

Seed treatment with carbendazim @ 2g kg^{-1} of seed followed by soil drenching @ 0.2 per cent	0	0	46.84
CD (0.05%)			5.87

During 2022 -23 and 23-24 (2 years) the incidence of *Fusarium* wilt was very less. The hybrid variety Polo was again proved to be tolerant to wilt. A lesser extend of infection (0.25%) was noted in *Trichoderma* treated plots and therefore, the disease incidence percentage could not be statistically analysed. However, the yield recorded was significantly high in *Trichoderma* treated plot (54.64 kg/plot) compared to carbendazim treatment (46.84 kg /plot) (Table 20)

Kerala Agricultural University, Kumarakom

Table 21. Demonstration of the bioefficacy of *Trichoderma asperellum* KAU strain application for the management *Fusarium* wilt in cowpea (Season 1) :Variety Vellyani Jyothika

Treatments	Germination (%)	Root length (cm)	Shoot Length (cm)	Disease incidence (%)			Reduction over control (%)	Yield (Kg/ha)	Yield increase over control (%)
				30 DAS	45 DAS	60 DAS			
T. asperellum	100	14	245 cm	2	5	12.5	-	6250.00	25
Carbendazim	100	11	207 cm	0	0	0	-	5000.00	

Table 22. Demonstration of the bioefficacy of *Trichoderma asperellum* KAU strain application for the management *Fusarium* wilt in cowpea (Season 2): Variety KAU Mithra

Treatments	Germination (%)	Root length (cm)	Shoot Length (cm)	Disease incidence (%)			Reduction over control (%)	Yield (Kg/ha)	Yield increase over control (%)
				30 DAS	45 DAS	60 DAS			
T. asperellum	100	15	300cm	2	3.5	5.1	-	5900.00	22.9
Carbendazim	100	12.2	279cm	0	0	0	-	4800.00	

In both the seasons, *Fusarium* wilt disease incidence was noted in *T. asperellum* treated plants, but their incidence was significantly less. Disease incidence was comparatively low in KAU Mithra compared to Vellayani Jyothika. Moreover *T. asperellum* treated plants (T1) showed promising results like good vegetative growth (plant height and root growth) as well as yield compared to the chemical check (T2). No disease symptoms were observed in chemical (Carbendazim 50 WP) treated plants in both seasons.

Fig 14. Management of *Fusarium* wilt in cowpea field using *Trichoderma asperullum* KAU strain

III. 5. Biological Control of Pea Diseases

III. 5. 1. Demonstration on management of *Fusarium* wilt/root rot of pea through biological control agents (UHFTa1)

Yashwant Singh Parmar University of Horticulture and Forestry, Solan

Field demonstration on management of *Fusarium* wilt/ root rot of pea through biological control agents revealed that the *Fusarium* wilt incidence in the pea crop differed non-significantly in both the treatments. There were non-significant differences between root length and plant height in both the treatments (Table 23). Significantly higher yield of pea (140.8q/ha) was recorded with the application of UHFTa1 as compare to 96.80 q/ha with recommended package of practices.

Table 23. Effect of *Trichoderma asperullum* (UHFTa1) on pea wilt

Treatment	Mean Incidence of *Fusarium* wilt (%)	Root length (cm)	Height (cm)	Yield (q/ha)	B:C
T1(UHFTa1)	1.73 ±0.15	10.90 ±0.62	60.30 ±2.70	140.80 ±4.10	1.36
T2 (POP)	2.03 ±0.14	9.80 ±0.72	55.10 ±2.45	96.80 ±2.53	1.21
t- value	-1.41325	1.0969	1.3542	8.6674	
P=0.5	.087322	0.1435	0.0962	0.0001	

III. 5. 2. Large scale demonstration of Pant Bioagent (PBAT-3) for the management of *Fusarial* wilt of pea

Field demonstration on management of *Fusarium* wilt/root rot of pea revealed that the *Fusarium* wilt incidence in the pea crop with application of PBAT-3 was significantly superior over chemical treatment. Whereas, the root length and plant height was significantly similar in both the treatments (Table 24). Significantly higher yield of pea (138.4 q/ha) was recorded with the application of PBAT-3 as compared to 98.4 q/ha with recommended package of practices.

Table 24. Effect of Pant Bioagent *Trichoderma asperullum* (PBAT-3) *Fusarium* wilt of pea

Treatment	Mean Incidence of *Fusarium* wilt (%)	Root length (cm)	Height (cm)	Yield (q/ha)	B:C
T1 (PBAT-3)	1.43 ±0.13	11.10 ±0.62	61.20 ±2.70	138.40 ±5.35	1.34
T2 (POP)	1.87 ±0.14	10.20 ±0.72	57.60 ±2.45	98.40 ±4.05	1.23
t- value	-2.16333	0.8975	0.9309	5.6597	
P=0.5	.022108	0.19064	0.18211	0.0001	

Fig 15. Management of *Fusarium* wilt/root rot in pea field through biological control agents (UHFTa1)

Govind Ballabh Pant University of Agriculture and Technology, Pantnagar

Table 25. Effect of Pant Bioagent (PBAT-3) for the management of *Fusarium* wilt of Pea

Treatments	Seed germination (%)	Root length (cm)	Shoot length (cm)	Disease incidence (%)	Percentage disease reduction over control	Yield (q/ha)	Percentage yield increase over control	C:B
T1: (PBAT-3)	75.66 (60.45)	11.33 (19.99)	62.33 (54.54)	11.33 (11.65)	56.97	92.67 (74.43)	24.46	1.86
T2: (POP)	75.33 (60.25)	10.66 (19.36)	62.66 (53.89)	12.00 (20.26)	54.42	92.00 (73.65)	23.91	1.84
T3: (Untreated Control)	60.00 (50.77)	9.00 (18.47)	58.66 (50.03)	26.33 (30.87)	-	70.00 (56.79)	-	1.26
SEm	0.63	0.74	1.01	0.51	-	1.22	-	-
CD (0.05%)	4.44	4.91	5.98	5.99	-	4.76	-	-

Data in parenthesis are angular transformed value

The results of the field demonstration on management of fusarium wilt of pea using PBAT 3 revealed that the root rot incidence was at par in T1 (PBAT3) (11.33%) and T2(POP) (12.00%) but significantly high in control (26.33%) accordingly seed germination percentage (75.66 & 75.33%), root length (11.33 & 10.66 cm), shooth length (62.33 & 62.66 cm) and yield (92.67 & 92.00qt/ha) was recorded at par in T1 and T2 but significantly different as compare to control (Table 25).

III. 5. 3. Demonstration of the bioefficacy of *Trichoderma asperullum* (UHF) for the management of *Fusarium* wilt of Pea

Table 26. Effect of *Trichoderma asperullum* (UHF) for the management of *Fusarium* wilt of Pea

Treatments	Seed germination (%)	Root length (cm)	Shoot length (cm)	Disease incidence (%)	Percentage disease reduction over control	Yield (q/ha)	Percentage yield increase over control	B:C
T1 (UHFTal)	74.22 (59.78)	10.66 (19.03)	63.63 (52.74)	11.43 (20.65)	58.68	91.33 (72.44)	31.73	1.83
T2 (POP)	74.12 (59.34)	10.53 (19.05)	62.33 (52.34)	12.33 (21.26)	55.42	91.22 (72.33)	31.57	1.82
T3 (Untreated Control)	62.23 (56.79)	8.33 (17.75)	58.33 (49.79)	27.66 (31.88)	-	69.33 (54.66)	-	1.24
SEm	1.42	1.83	1.93	0.68	-	1.11	-	-
CD (0.05%)	5.52	3.27	4.54	4.50	-	5.20	-	-

Data in parenthesis are angular transformed value

The results of the field demonstration on management of *Fusarium* wilt of pea using *Trichoderma asperullum* (UHFTal) revealed that the root rot incidence was at par in T1 (UHFTal) (11.43%) and T2 (PoP) (12.33%) but significantly high in control (27.66%) accordingly seed germination percentage (74.22 & 74.12%), root length (10.66 & 10.53 cm), shooth length (63.63 & 62.33 cm) and yield (91.33 & 91.22 q/ha) was recorded at par in T1 and T2 but significantly different as compare to control (Table 26).

Biological Control of Commercial Crops Diseases

III. 6. Biological Control of Sugarcane Diseases

III. 6. 1. Evaluation of biocontrol agents against sugarcane redrot

Sugarcane Breeding Institute, Coimbatore

In continuation of pot culture studies with bioagents against major fungal diseases viz., red rot, smut and wilt of sugarcane, three field experiments were laid out with fungal and bacterial bioagents against all the 3 diseases. In which, fungal (*Trichoderma asperellum*) and bacterial (*Paenibacillus alvei*) bioagents were selected and treated the setts individually and in combination. These biological treatments were compared with the recently CIB recommended fungicide Azoxystrobin and combination of this fungicide with bacterial antagonist *P. alvei*. Invariably all the treatments were imposed by mechanized means of sett treatment using sett Treatment Device (STD). Here, wilt infected planting material of V1 – CoC 671, V2 – Co 86032, V3 – Co 11015 were selected for evaluating wilt management and Co 97009 were smut management. While for red rot management, the susceptible variety CoC 671 along with red rot inoculum were used. Besides, FYM enriched with *T. harzianum* and *T. asperellum* was applied @ 1kg/ 10 row invariably to all the treatments.

Results of the study on the management of all the three diseases revealed that, the treatment with combination of azoxystrobin and *P. alvei* as sett treatment stands first in improving germination, yield attributes with significant reduction in disease incidence which was followed by fungicide alone and thereafter by biocontrol agents. Efficacy of treatments on the improvement of germination along with reduced red rot incidence is depicted in the figure below. Application of bioformulation invariably improves crop stand in all the treatments as compared to infected and healthy control. Hence it is suggested to follow the sett treatment with fungicide and bacterial bioaget or fungicide alone along with soil application of bioformulation as integrated approach for the management of fungal diseases in sugarcane.

T1 - Sett treatment with liquid formulation of 1% *T.asperellum* in STD+FYM

T2 - Sett treatment with liquid formulation of 1% *P. alvei* in STD+FYM

T3-*T.asperellum*+*P.alvei* in STD (each 0.5%)+FYM

T4-Sett treatment with 50 ppm Azoxystrobin + 0.05% *P.alvei* in STD+FYM

T5-Sett treatment with 100 ppm Azoxystrobin+FYM

T6-Infected control

T7-Infected control

Fig 16. Efficacy of mechanized sett treatment fungal and bacterial antagonists individually and in combination with fungicide against red rot incidence

Biological Control of Spice Crops Diseases

III. 7. Biological Control of Ginger Diseases

III. 7. 1. Evaluation of microbial antagonists for the management of ginger rhizome rot

Kerala Agricultural University, Kumarakom

The microshoots of the KAU ginger variety Aswathy treated with talc based formulation of *T. asperellum* was used for the experiment. At the time of planting 100 g *Trichoderma* enriched cowdung neem cake mixure was added to the base of the plant. Bioagent application was repeated as 2 % soil drenching at 10, 20 and 40 days after planting. Copper hydroxide (0.2%), given as soil drench at 10, 20 and 40 DAP served as chemical check. No disease incidence was observed in both bio agent treated plants and chemical fungicide applied plants during 2023-24. Moreover, *Trichoderma harzianum* AAU MC2 treated plants showed good vegetative growth and yield compared to chemical fungicide

Table 27. Evaluation of microbial antagonists for the management of ginger rhizome rot

Treatments	Germination (%)	No of tillers per plant	Shoot Length (cm)	Disease incidence (%)			Reduction over control (%)	Yield ((Kg/ha)	Yield increase over control
				10 DAP	20 DAP	40 DAP			
Powder formulation of *Trichoderma harzianum* AAU-MC2 as rhizome treatment @ 20 g kg^{-1}+basal application (multiplied in cowdung + neemcake 9:1 ratio) @ 100 g /plant and soil drenching @ 20 g/L at 10,20 and 40 DAP	95	9	33	0	0	0	-	5850	8.33 %
POP Recommendation (Copper hydroxide soil drenching @ 2g/L)	90	8	30	0	0	0	-	5400	

Fig 17. Management of ginger rhizome rot in ginger field

Assam Agricultural University, Jorhat

Results: Highest disease incidence was observed in control (68.60%) at 6 months after sowing (in Oct.) and lowest in T1 (14.30%) followed by T2 (18.00%). Similar trend was observed after harvest also. However, no significant difference of yield was observed in between T1 (6.24 t/ha) and T2 (6.02 t/ha), but significantly lower yield was observed in control (1.34 t/ha). The B:C ratio was 2.90 and 2.64 in T1 and T2 respectively.

Table 28. Efficacy of microbial antagonists for the management of ginger rhizome rot

Treatments	Disease incidence (%)		Yield data (t/ha)	B:C
	Cropping Stage (6 Month AS)	After harvest		
T1: Powder formulation of *T. harzianum* AAU-MC2:Rhizome treatment (@ 20 g kg^{-1}+basal application (multiplied in cowdung + neemcake 9:1 ratio) @ 100 g /plant and soil drenching @20 g/L at 10, 20 and 40 DAP	14.30	4.00	6.24	2.90
T2: POP Recommendation (Copper hydroxide soil drenching @ 2g/L)	18.00	8.60	6.02	2.64

T3: Control	68.60	30.5	1.34	
CD (0.05)	3.24	1.40	1.57	

*** Price of ginger Rs. 100/kg**

Fig 18. Time of transplanting

Fig 19. Vegetative stage

Fig 20. yield

Central Agricultural University, Pasighat

Table 29. Field efficacy of microbial antagonists for the management of ginger rhizome rot

Treatments	Germination (%)	Tillering (%)	Percent Disease Incidence (%)	Percentage disease reduction over control (%)	Yield (t/ha)	Percentage yield increase over control (%)
T_1: *Trichoderma harzianum* AAU-MC2: Rhizome treatment (@ 20 g/ kg+basal application (cow dung + neem cake 9:1 ratio) @ 100 g/plant and soil drenching @20 g/L at 10, 20 and 40 DAP	88.03 (70.15)	14.30 (22.20)	15.52 (23.17)	57.06	15.46	80.60
T_2:Copper hydroxide soil drenching @ 2g/L water	87.40 (69.38)	15.56 (23.23)	14.91 (22.68)	58.75	16.04	87.38
T_3:Untreated Control	76.95 (61.39)	9.56 (17.97)	36.15 (36.93)	-	8.56	-
SEm	1.27	0.37	0.67		0.59	
CD (0.05%)	3.93	1.13	1.54		0.83	

***Figures in the parenthesis are Arc sine transformed values**

Results: The *Trichoderma harzianum* (AAU-MC2 Strain) reduced Ginger rhizome rot incidence to 15.52 % which is 57.06 % lesser occurrence than control and found statistically at par with the chemical Copper oxy chloride. Similar trend was also recorded with respect rhizome yield *i.e.,*15.46 t/ha from *T. harzianum* and 16.04 t/ha COC treated plots, respectively.

Biological Control of Vegetable Diseases

III. 8. Biological Control of Tomato Diseases

III. 8. 1. Large scale demonstration of Pant Bioagent (PBAT-3) for the management of root rot complex disease of tomato

Govind Ballabh Pant University of Agriculture and Technology, Pantnagar

Table 30. Effect of Pant Bioagent (PBAT-3) for the management of root rot complex disease of tomato

Treatments	Seed germination (%)	Root length (cm)	Shoot length (cm)	Disease incidence (%)	Percentage disease reduction over control	Yield (qt/ha)	Percentage yield increase over control	C:B
T1: (PBAT-3)	88.33 (70.69)	6.10	33.06	11.67 (20.25)	52.03	257.67	23.97	2.33
T2: (POP)	84.66 (66.42)	5.98	33.08	11.33 (20.25)	53.43	254.33	22.93	2.16
T3: (Untreated Control)	79.30 (62.96)	5.21	32.17	24.33 (29.55)	-	196.00	-	1.68
SEm	1.32	0.97	0.98	1.62	-	1.17	-	-
CD (0.05%)	4.24	3.64	3.59	3.12	-	5.88	-	-

Data in parenthesis are angular transformed value

The results of the field demonstration on management of root rot complex in tomato using PBAT 3 revealed that the root rot incidence was at par in T1 (PBAT3) (11.67%) and T2 (PoP) (11.33%) but significantly high in control (24.33%) accordingly seed germination percentage (88.33 & 84.66%), root length (6.10 & 5.98cm), shooth length (33.06 & 33.08cm) and yield (257.67 & 254.33qt/ha) was recorded at par in T1 and T2 but significantly different as compare to control (Table 30).

Biological Control of Crop Pests

CEREALS

IV. 1. Biological control of insect pests of Maize

IV. 1. 1. Evaluation of native isolates of entomopathogens against maize fall armyworm during 2023-24

UAS, Raichur

Results: Among the treatments larval population ranged from 2.24 to 2.36 larvae per plant which was statistically non-significant. Ten days after third spray, *B. thuringiensis* NBAIR *Bt* @ 10 ml/L recorded 0.36 larva per plant and it was at par with *B. thuringiensis* RARS TPT – C33 1% @ 10 ml/L (0.52 larva/plant). Highest grain yield of 53.25 q/ha was noticed in *B. thuringiensis* NBAIR Bt @ 10 ml/L and it was at par with *B. thuringiensis* RARS TPT –C33 1% @ 10 ml/L (52.55 q/ha) while it was 47.25 q/ha in untreated control (Table 31).

Table 31. Evaluation of native isolates of entomopathogens against maize fall armyworm during 2023-24

Sl. No.	Treatment Details	Dosage (g/l)	Number of larvae per plant*				Plant damage (%) #	Microbial infection (%) #	Grain yield (q/ha)
			IDBS	10 days after each spray					
				I Spray	II Spray	III Spray			
1	*Bacillus thuringiensis* RARS TPT –C33 1% @ 10 ml/L	10.0	2.24 (1.66)	1.16 (1.29)	0.84 (1.16)	0.52 (1.01)	3.26 (10.40)	5.18 (13.16)	52.55
2	*Bacillus thuringiensis* NBAIR *Bt* @ 10 ml/L)	10.0	2.18 (1.64)	1.04 (1.24)	0.68 (1.09)	0.36 (0.93)	2.84 (9.70)	8.78 (17.24)	53.25
3	POP: Azadirachtin 1500 ppm @ 2 ml/lt at 15 days after sowing + Chlorantraniliprole 18.5 SC @ 0.4 ml/L at 25 days after sowing +Emamectin benzoate 5 SG @ 0.4 g /L at 35 days after sowing	2+0.4+ 0.4	2.36 (1.69)	0.48 (0.99)	0.24 (0.86)	0.18 (0.82)	0.86 (5.32)	0.75 (4.97)	58.85
4	Untreated control	0.40	2.28 (1.67)	2.32 (1.68)	2.06 (1.60)	1.84 (1.53)	12.68 (20.86)	1.54 (7.13)	47.25
S Em ±			**0.11**	**0.03**	**0.05**	**0.02**	**1.05**	**0.41**	**1.23**
CD (P=0.05)			**NS**	**0.11**	**0.16**	**0.07**	**3.45**	**1.24**	**3.71**

*** Figures in parentheses are square root transformed values**

 # Figures in parentheses are arcsine transformed values

ANGRAU, Anakapalle

Among the native isolates of entomopathogens, *Metarhizium rileyi* (Anakapalle strain AKP-Nr-1) as three sprays was found effective against fall armyworm with significantly low fall armyworm incidence (30.33%) followed by *Bacillus thuringiensis* (RARS TPT–C33) with 31.66% damage. However, least damage was observed in emamectin benzoate (29.49%) up to 60 days crop age. Significantly high crop yield was recorded in *M. rileyi* (Anakapalle strain AKP-Nr-1) (50.88 q/ha) and *Bacillus thuringiensis* (RARS TPT–C33) (47.58 q/ha) next to emamectin benzoate (51.11 q/ha) and low in untreated control (26.56 q/ha).

Table 32. Evaluation of native isolates of entomopathogens against maize fall armyworm

Treatment	FAW damage %				Dead larvae per plot*	FAW damage upto 60 days crop age	Percent reduction in FAW damage over control	Cob yield Q/ha	Percent increase in yield over control
	Before spraying	After 1st spraying	After 2nd spraying*	After 3rd Spraying*					
T1: *Bacillus thuringiensis* RARS TPT –C33 1% @ 10 g/L	28.2	21.4	9.10 (17.53)	3.4 (10.51)	25 (29.92)	31.66	32.09	47.58	79.14
T2: *Metarhizium rileyi* (Anakapalle strain AKP Nr-1) concentration 1x10^8 spores/ml@ 5 g/L	28.44	20.47	8.59 (17.01)	1.88 (7.73)	28.25 (32.08)	30.33	34.94	50.88	91.57
T3: *Bacillus thuringiensis* NBAIR *Bt* 25 -1% @ 10 ml/L	28.93	22.77	10.99 (19.23)	3.93 (11.42)	23.0 (27.46)	32.86	29.52	46.92	76.66
T4:Emamectin benzoate 5SD @ 0.4 g/L	29.49	20.12	0.58 (3.76)	0.0 (0.641)	32.5 (34.72)	29.49	36.74	51.11	92.43
T5 : Untreated control	30.72	42.07	66.41 (54.68)	15.9 (23.50)	0.0 (0.641)	46.62	-	26.56	
CD (0.05)	NS	4.06	5.22	1.81	4.26	6.68		8.59	
CV%	18.14	10.15	15.08	10.94	11.17	12.54		12.62	

Three sprays at 20, 35,50 days after sowing

*** Values in parenthesis are arc sin transformed values**

IV. 1. 2. Large scale demonstration of bioefficacy of multiple insecticide tolerant *Trichogramma chilonis* NBAIR MITS for the management of fall armyworm in maize during 2023-24

UAS, Raichur

Results: One day before treatment imposition, the number of egg patches ranged from 3.04 to 3.18 per plant and ten days after release, the number of egg patches were low in T_1 (1.25 egg patches/plant) and 1.51 larvae per plant with highest egg parastisation of 26.50 per cent while in T_2 it was 0.22 larva per plant with 0.50 per cent parasitisation. The mutliple insecticide tolerant *T. chilonis* recorded 52.25 q/ha grain yield while the farmers practices recorded 61.50 q/ha (Table 33).

Table 33. Large scale demonstration of bioefficacy of multiple insecticide tolerant *Trichogramma chilonis* NBAIR MITS for the management of fall armyworm in maize during 2023-24

Sl. No.	Treatment Details	Egg patches per plant (No.)*		Larvae per plant (No.) *		Damaged plant (%)#	Parasitisation (%)#	Grain yield (q/ha)
		IDBS	10 DAS	IDBS	10 DAS			
T_1	Mutliple insecticide tolerant *Trichogramma chilonis* cards (1,00,000 eggs/ha) (2 releases , first release after one week of sowing & second release one week after first release)	3.04 (1.88)	1.25 (1.32)	2.24 (1.66)	1.51 (1.41)	6.75 (15.06)	26.50 (30.98)	52.25
T_2	POP Recommendation (Insecticidal check: Azadirachtin 1500 ppm @ 2 ml/lt at 15 days after sowing + chlorantraniliprole 18.5 SC@ 0.4 ml/L at 25 days after sowing +Emamectin benzoate 5 SG @ 0.4 g /L at 35 days after sowing)	3.18 (1.92)	2.75 (1.80)	3.18 (1.92)	0.22 (0.84)	0.75 (4.97)	0.50 (4.05)	61.50
S Em ±		**0.21**	**0.17**	**0.13**	**0.08**	**1.04**	**1.35**	**1.18**
CD (P=0.05)		**NS**	**0.53**	**0.40**	**0.25**	**3.13**	**4.06**	**3.55**

***Figures in parentheses are square root transformed values**
#Figures in parentheses are arcsine transformed values

ANGRAU, Anakapalle

Locations: 3 villages in Vizianagaram and Srikakulam districts, Andhra Pradesh ; Area covered : 11 acres ; Farmers benefitted: 3 farmers

ICAR-NBAIR multiple insecticide tolerant (MITS) cards of *Trichogramma chilonis* (1,00,000 eggs/ha) two releases at weekly interval from one week of sowing + spraying chlorantraniliprole 18.5 SC@ 0.4 ml/L at 35 days after sowing was found highly effective against fall armyworm with low fall armyworm damage (14.27%); good egg parasitism (11.94 %), higher cob yield (88.87 q/ha); increased yield (3.34%) and high incremental benefit cost ratio (29.58) compared to POP recommendation (Insecticidal check: Azadirachtin 1500 ppm @ 2 ml/lt at 15 days after sowing + chlorantraniliprole 18.5 SC @ 0.4 ml/L at 25 days after sowing + emamectin benzoate 5 SG @ 0.4 g /L at 35 days after sowing (FAW damage : 20.47%; Yield : 86.0q/ha; Incremental benefit cost ratio: 20.93) (Table 34).

Table 34. Bioefficacy of ICAR-NBAIR multiple insecticide tolerant strain (MITS) of *Trichogramma chilonis* for the management of fall armyworm in maize

Treatment	FAW damage upto 60 DAS		Percent Reduction in FAW damage	Egg parasitism %	Cob yield Q/ha	Percent increase in yield	Incremental Benefit cost ratio
	Damaged plants /25 m ² plot	Damage %					
T1: Mutliple insecticide tolerant *Trichogramma chilonis* cards (1,00,000 eggs/ha) (2 releases, first release after one week of sowing & second release one week after first release)	11.19	14.27	30.27	11.94	88.87	3.34	29.58
T2: POP Recommendation (Insecticidal check: Azadirachtin 1500 ppm @ 2 ml/lt at 15 days after sowing + chlorantraniliprole 18.5 SC@ 0.4 ml/L at 25 days after sowing +emamectin benzoate 5 SG @ 0.4 g /L at 35 days after sowing)	15.91	20.47	-	0.0	86.0	-	20.93

*Spraying chlorantraniliprole 18.5 SC@ 0.4 ml/L at 35 days after sowing in T1

Table 35. Yield and cost economics of bioefficacy of multiple insecticide tolerant strain of *Trichogramma chilonis* against fall armyworm in maize

Treatment	Yield Q/ha	Gross returns Rs./ ha	Cost of Plant Protection Rs./ha	Net returns Rs./ ha	Incremental Benefit cost ratio
T1 : MITS TC	88.876	1,95,514/-	6393/-	1,89,121/-	29.58
T2 : POP	86.0	1,89,200/-	8628/-	1,80,572/-	20.93

IV. 1. 3. Field Demonstration of Eco-friendly management of fall armyworm in maize. Rabi-2023-24.

PJTSAU, Hyderabad

T1: BIPM module

Installation of pheromone trap @ 10 traps/acre

Release of *Trichogramma chilonis* (1,00,000 eggs/ ha) (2 releases, first release after one week of sowing & second one after one week of first release)

NBAIR Bt-25 @ 2ml/L (two sprays -first spray after 20 days after sowing to target early instars of FAW larvae)

ICAR-NBAIR *Metarhizium anisopliae* (Ma-35) @ 5g/L (2 sprays), first spray 10 days after first spray of *Bt*-25 to target late instars of FAW larvae

Table 36. Eco-friendly Management of fall armyworm in Maize

Treat-ments	Percent damaged plants/plot		reduction over control (%)	No. of Dead Larvae /plot		No.of predators/ plant (spiders/ coccinellids)		Percent Egg Mass/ plot	Percent Egg parasit-isation/ Plot	Yield (q/ha.)	%yield increase over control
	Pre-treat count	Post-treat count		Pre-treat count	Post-treat count	Pre-treat count	Post-treat count	Pre-treat count	Post-treat count		
T1	45.75 (36.45)	9.51 (17.82)	77.20	0.38 (0.94)	3.94 (2.02)	3.35 (1.90)	4.65 (2.23)	8.94 (17.31)	4.79 (12.34)	6125	41.00
T2	46.55 (36.77)	13.87 (21.81)	69.62	0.28 (0.89)	4.08 (2.12)	3.41 (1.94)	0.52 (1.00)	9.58 (17.87)	0.58 (4.32)	6500	49.942
T3	47.46 (37.29)	46.94 (43.21)		0.42 (0.87)	0.95 (1.18)	3.94 (1.97)	4.95 (2.28)	12.08 (20.27)	3.36 (10.52)	4335	-
SEM	2.43	1.62		0.07	0.17	0.21	0.18	0.89	0.67	-	-
CD (0.05%)	7.5	5		0.23	0.54	0.66	0.56	2.77	2.07	-	-
CV	17.36	15.45		11.93	14.1	15.76	14.11	12.78	19.51	-	-

The results in the given table 36. revealed that between BIPM practices and farmers practice there is no significant difference in terms of reduction of number of damaged plants percentage (77.20% & 69.62%) and dead larvae per plot (3.94 & 4.08) and they both were significantly differed with untreated control (100% & 0.95). However, BIPM package recorded highest predator (coccinellids & Spiders) 4.65/plant and egg parasitization 4.79/plot when compared with farmers practice 0.52 and 0.58 respectively. In terms of percent yields increase, BIPM practice recorded 41.00 and farmers practice recorded 49.94 per cent more yield compared to untreated check (4335 kg/ha.).

AAU, Jorhat

Number of larvae per plant and percent plant damage was more in BIPM plots compared to chemical treatment. However, the number of predators per plant and percent egg parasitism was significantly higher in BIPM plots. The yield was comparatively higher in chemical control (31.62 qt/ha) than BIPM plots (30.92 qt/ha) but no significant difference in yield and cob damage.

Table 37. Evaluation of BIPM module in comparison with farmers practice against the incidence of FAW on Maize

Treatment	No. of larvae/ plant		% plant damage				*Trichogramma* parasitism (%)	Number of predators per plant	Yield (Q/ha)
	Pre treat-ment	Post treat-ment	Pre-treatment		Post-treatment				
			Leaf	Cob	Leaf	Cob			
BIPM plot	3.88	2.14	6.87 (15.19)	3.86 (11.33)	3.70 (11.09)	2.12 (8.37)	5.25 (13.24)	2.16	30.92

Chemical	4.12	1.30	6.40 (14.65)	3.72 (11.12)	2.28 (8.68)	1.91 (7.94)	1.40 (6.79)	1.02	31.62
"t" value	0.624	1.26	0.304	0.245	2.034	0.134	3.40	2.283	0.407
Remarks	NS	S	NS	NS	S	S	S	S	NS

Fig 21. Fall armyworm

Fig 22. Maize at harvesting in field

Fig 23. Fall armyworm infestation

IV. 1. 4. Large scale demonstration of *Trichogramma chilonis* against maize stem borer *Chilo partellus and* fall armyworm *Spodoptera furgiperda* (5 ha)

MPUAT, Udaipur

The dead heart incidence in fields with the releases of *T. chilonis* was 16.58 per cent in comparison to the farmers practice, where it was recorded 10.24 per cent incidence of *C. partellus*. The reduction in incidence over control was 26.13 and 54.49 per cent in T_1 and T_2, respectively. While the dead heart incidence in fields with the releases of *T. chilonis* was 14.95 per cent and in farmers practice, it was 7.24 per cent against the incidence of FAW. The reduction in incidence over control was 35.28 and 68.48 per cent in T_1 and T_2, respectively.

Table 38. Effect of *T. chilonis* release on incidence of *C. partellus* and yield in *Kharif* maize during 2023-24.

S. No.	Treatments	Dead hearts (%)	Incidence (Per cent reduction in over control)	Parasitisa-tion (%)	Yield (q/ha)	Yield (Per cent increase over control)
1.	*T. chilonis* @ 1,00,000/ha	16.58 (24.02)*	26.19 (30.68)	30.14	25.41	27.00
2.	Spinosad 45 SC @ 1.0 ml/ 3 lit (farmers practice)	10.24 (18.65)	54.49 (47.58)	-	32.15	60.24
3.	Untreated control	22.48 (28.30)	-	-	20.14	-
	CD(at 5 %)	1.047	4.435		2.638	14.79

IV. 1. 5. Large scale demonstration of BIPM module for the management of maize FAW during 2023-24

UAS, Raichur

Results: The BIPM module recorded lowest of 1.03 egg patches per plant after two releases of parasitoid while in POP it was 1.75 egg patches per plant. In BIPM module recorded highest of 25.50 and 15.75 per cent parastisation and mycosis, respectively while in POP module it was 1.14 and 0.16 per cent parastisation and mycosis. BIPM module recorded 53.50 q/ha grain yield while in POP module it was 59.50 q/ha (Table 39).

Table 39. Large scale demonstration of BIPM module for the management of maize FAW during 2023-24

Sl. No.	Treatment Details	Egg patches per plant (No.)*		Larvae per plant (No.) *		Damaged plant (%)#	Parasitisation (%)#	Mycosis (%)#	Grain yield (q/ha)
		IDBS	10 DAS	IDBS	10 DAS				
T_1	BIPM Installation of pheromone trap @ 10 acre • Release of *Trichogramma chilonis* (1,00,000 eggs / ha) (2 releases, first release after one week of sowing & second one after one week of first release • ICAR- NBAIR *Metarhizium anisopliae* (NBAIR Ma35) @ 5 g/L (2 sprays, at 25, 35 days after sowing)	2.53 (1.73)	1.03 (1.22)	2.75 (1.80)	1.55 (1.43)	8.25 (16.69)	25.50 (30.33)	15.75 (23.38)	53.50
T_2	POP Recommendation Insecticidal check • Azadirachtin 1500 ppm @ 2 ml/lt at 15 days after sowing • Chlorantraniliprole 18.5 SC @ 0.4 ml/L at 25 days after sowing • Emamectin benzoate 5 SG @ 0.4 g /L at 35 days after sowing	2.25 (1.66)	1.75 (1.50)	2.25 (1.66)	0.51 (1.00)	2.53 (9.10)	1.54 (7.03)	0.16 (1.81)	59.50
S Em ±		0.05	0.06	0.04	0.08	1.36	1.13	1.06	1.25
CD (P=0.05)		NS	0.19	0.13	0.25	4.08	3.40	3.15	3.76

***Figures in parentheses are square root transformed values**

#Figures in parentheses are arcsine transformed values

MPUAT, Udaipur

BIPM Module shows a 39.14 per cent egg parasitisam and farmers practice (POP recommendation) shows 3.46 per cent egg parasitisam. Yield of 37.10 (q/ha) was obtained from BIPM module while a yield of 30.61 was observed in farmers practice.

Table 40. Large scale demonstration of BIPM module for the management of maize FAW during 2023-24

S. No	Treatments	Egg Masses / Plant		Damaged Plant / Plot (%)		No. of dead larvae / Plot		% Egg Par-asitisam	No. of Predetor / Plant	Yield (q/ha)
		Pre-Count	Post-count	Pre-Count	Post-count	Pre-Count	Post-count			
1.	BIPM	1.11	0.29	57.36	8.97	1.69	0.59	39.14	0.91	37.10
2.	POP recommendation spraying (Chlorantra-nilipr-ole 18.5 SC @ 0.5 ml/L @ 25 DAS + Emamectin Benzoate 5 SG @ 0.5 gm/L @ 35 DAS)	1.01	0.64	58.12	14.98	1.24	0.29	3.46	0.34	30.61
3.	t-value	0.12	0.18	1.47	1.58	0.12	0.10	2.49	0.15	1.91

ANGRAU, Anakapalle

Area covered : 12 acres

BIPM module (Installation of pheromone trap @ 10 /acre + release of *Trichogramma chilonis* (1,00,000 eggs /ha) two weekly releases from one week after sowing + Spraying ICAR- NBAIR *Metarhizium anisopliae* (NBAIR Ma35) @ 5 g/L two times at 25, 35 days after sowing) was found effective against maize fall armyworm with low plant damage (11.67%) and 41.65% reduction in FAW damage over insecticidal check. Egg parasitism was notice in BIPM moule (9.36%). High cob yield (92.67q/ha) with high incremental benefit cost ratio (30.09) compared to insecticidal check (Cob yield: 79.33q/ha; Incremental benefit cost ratio as 19.23) was recorded in BIPM module (Table 41).

Table 41. Evaluation of BIPM module for the management of maize fall armyworm in kharif, 2023

Treatment	FAW damage upto 60 DAS		Percent Reduc-tion in FAW damage	Egg parasitism %	Cob yield Q/ha	Percent increase in yield	Incremental Benefit cost ratio
	Damaged plants /25m^2 plot	Dam-age %					
T1: BIPM module	9.01	11.67	41.65	9.36	92.67	16.82	30.09
T2: POP Recommendation Insec-ticidal check Azadirachtin 1500 ppm @ 2 ml/lt at 15 days after sowing Chlorantraniliprole 18.5 SC @ 0.4 ml/L at 25 days after sowing Emamectin benzoate 5 SG @ 0.4 g /L at 35 days after sowing	15.65	20.0		0.0	79.33		19.23

IV. 1. 6. Adoption of BIPM Module in maize against fall armyworm in farmers fields

Fig 24. Spraying ICAR- NBAIR *Metarhizium anisopliae* (NBAIR Ma35) in maize field

Fig 25. release of *Trichogramma chilonis* (1,00,000 eggs /ha) in maize field

MPKV, Pune

Results: The data presented in the Table 42, revealed that the fall armyworm incidence was moderate during the growth period. FAW attack was observed within one week after germination.

Plant damage: The lowest mean per cent of plant damage/plot (7.56%), highest dead larva/plot (0.43), significant high egg parasitisation (34.93 %) and highest yield (34.54 qt./ha.) was recorded in the BIPM plot compared to POP recommended spraying

Table 42. Effect of BIPM against fall armyworm *Spodoptera frugiperda* in maize

Treatment details	Egg masses/ plant		Damaged plants/ plot (%)		No. of dead larvae/plot		Egg para-sitism (%)	No. of Pred-ators/ plant	Yield (qt/ha)
	Pre count	Post count	Pre count	Post count	Pre-count	Post count			
BIPM module (T1)	0.87 (1.17)*	0.11 (0.78)	54.36 (47.50)**	7.56 (15.96)	1.47 (1.40)	0.43 (0.96)	34.93 (36.23)	0.87 (1.17)	34.54
POP recommendation (T2)	1.03 (1.23)	0.87 (1.17)	55.03 (47.89)	11.27 (19.62)	1.40 (1.38)	0.67 (1.09)	2.67 (9.40)	0.30 (0.89)	30.68
"t" value	0.13	0.09	1.78	1.21	0.26	0.07	1.87	0.067	1.21
Remarks	N.S.	Sig.	N.S.	Sig.	N.S.	Sig.	Sig.	Sig.	Sig.

*Figures in parenthesis $\sqrt{x+0.5}$ transformed values.

**Figures in parenthesis are arc sin valu

AAU, Anand

BIPM module: Installation of pheromone trap @ 10 traps/acre; Release of *Trichogramma chilonis* (1,00,000 eggs/ ha) (2 releases, first release after one week of sowing & second one after one week of first release); NBAIR *Bt*-25 @ 10 ml/L (1-2 sprays depending on pest incidence), first spray after 20 days after sowing to target early instars of FAW larvae; ICAR-NBAIR *Metarhizium anisopliae* (Ma-35) @ 5 g/L (1-2 sprays depending on pest incidence), first spray 10 days after first spray of *Bt*-25 to target late instars of FAW larvae and collection and destruction of egg masses of fall armyworm at regular interval for the management of maize FAW

POP recommendation: Spraying Azadirachtin 1500 ppm @ 2 ml/L at 15 days after sowing + Chlorantraniliprole 18.5 SC @ 0.4 ml/L at 25 days after sowing + Emamectin benzoate 5 SG @ 0.4 gm/L at 35 days after sowing

Large scale demonstration of BIPM module was carried out in Panchmahal district during *kharif* 2023-24 and results revealed that significantly highest number of damaged plants (6.90/plot) were recorded in treatment T_2 - POP recommendation as compared to T_2 - POP recommendation(3.87/plot). The highest population (1.27 coccinellids/plant) and (3.38 spiders/plant) were documented in T_1 - BIPM module as compared to T_2 -POP recommendation (0.56 coccinellids/plant) and (1.40 spiders/plant).

Among the two modules evaluated, T_2 - POP recommendation was found promising in getting higher grain and fodder yield. Highest grain and fodder yield of 42.40 and 60.20 q/ha was recorded in the treatment T_2 - POP recommendation as compared to T_1 - BIPM module 37.50 and 51.40 q/ha.

Table 43. Effect of different modules on insect pests and natural enemies in maize (2023-24)

Treatments	No. of damaged plants/plot		No. of dead larvae (due to bacteria/virus/fungus) /plot	No. of coccinellids per plant		No. of spiders per plant	
	BS	Pooled over period and spray	Pooled over period and spray	BS	Pooled over period and spray	BS	Pooled over period and spray
BIPM module	3.45* (11.40)	3.20[b] (9.74)	3.33[a] (10.59)	1.40 (1.46)	1.33[a] (1.27)	1.81 (2.78)	1.97[a] (3.38)
POP recommendation	3.75 (13.56)	2.72[a] (6.90)	2.09[b] (3.87)	1.37 (1.38)	1.03[b] (0.56)	1.96 (3.34)	1.38[b] (1.40)
S. Em.± (T)	0.14	0.06	0.07	0.06	0.04	0.07	0.09
C.D. at 5% T	NS	0.17	0.26	NS	0.11	NS	0.33
C. V. (%)	11.89	11.54	13.13	13.42	17.36	12.16	12.04

Note: *Figures are $\sqrt{x + 0.5}$ transformed values whereas those in parentheses are retransformed values; NS: Non-significant; BS: Before spray

Table 44. Effect of different modules on yield in maize (2023-24)

Treatments	Grain Yield (q/ha)	Fodder Yield (q/ha)
BIPM module	37.50[b]	51.40[b]
POP recommendation	42.40[a]	60.20[a]
S. Em ± (T)	1.40	2.47
C.D. at 5 % T	4.16	7.33
C. V. (%)	11.08	13.98

SKUAST-Jammu

Large plot trial (2.0 ha) on the effectiveness of BIPM module (Treatment 1); POP recommendation Treatment 2 and untreated control (Treatment 3) - was conducted at the farmer's field. Number of *S. frugiperda* dead larvae /m^2 area was significantly highest in BIPM package (18.67 *S. frugiperda* dead larvae per m^2) followed by Treatment 2 (15.17 dead larvae per m^2). Plant damage (%) was accordingly lowest in BIPM package – 11.89% plant damage followed by Treatment 2 (13.54% plant damage). Grain yield was accordingly highest in BIPM package (40.05 q/ha).

Table 45. Effect of BIPM against fall armyworm *Spodoptera frugiperda* in maize

Treatments	Per cent plant damaged	No. of dead larvae per m^2	No. of predators (Spiders) per m^2	Grain Yield (q/ha)
Treatment 1 - Pheromone traps @ 10/acre + *Trichogramma chilonis* (1,00,000 adults/ha) (2 releases + NBAIR Bt-25 @ 10 ml/L 2 sprays + NBAIR *Metarhizium anisopliae* (Ma-35) @ 5g/L(2 sprays) + Collection and destruction of egg masses	11.89	18.67	2.14	40.05
Treatment 2 - POP recommendation (Spraying Azadirachtin 1500 ppm @ 2ml/L at 15 days after sowing + Chlorantraniliprole 18.5 @ 0.4 ml/L at 25 days after sowing + Emamectin benzoate 5SG @ 0.4 gm/L at 35 days after sowing	13.54	15.17	0.43	35.80
Treatment 3 - Untreated Control	52.33	1.12	2.32	16.30
CD @ 5%	5.65	2.45	0.46	5.72

PAU, Ludhiana

The demonstrations on the BIPM module for the management of fall armyworm, *Spodoptera frugiperda* were conducted at farmer's fields on an area of 4 acres in Hoshiarpur, Jalandhar and Ludhiana districts of Punjab in collaboration with Krishi Vigyan Kendra, Nurmahal (Jalandhar) and Farm Advisory Service Centre (Hoshiarpur).

Each demonstration area was divided into three blocks representing three treatments, *viz*. BIPM, chemical control and untreated control. Each block was further divided into 10 units (each unit representing one replication). The observations were recorded from 50 randomly selected plants from each unit at weekly interval and per cent damage was worked out

Based on the mean of three locations (Table 46), the plant infestation in BIPM module was 13.71 per cent and in chemical control, it was 3.98 per cent. However, both the treatments were significantly better than untreated control (31.19 %). Similarly, larval count BIPM (1.27/ 10 plants) and chemical control (0.29 / 10 plants) were significantly less than in untreated control (2.78 / 10 plants). The grain yield in BIPM and chemical control was 36.64 and 44.77 quintals per hectare, respectively. However, lowest grain yield was recorded in untreated control (30.33 q/ha).

Table 46. Large scale demonstrations of BIPM module for FAW in maize during 2023

Treatment	Plant infestation* (%)	Number of larvae/ 10 plants**	Yield (q/ha)
BIPM module	13.71 (21.54)	1.27 (1.50)	36.64
Chemical control	3.98 (11.19)	0.29 (1.13)	44.77
Untreated control	31.19 (33.79)	2.78 (1.92)	30.33
LSD (p=0.05)	(2.21)	(0.20)	3.86
CV (%)	10.00	13.20	10.38

 # Pooled mean of 3 locations; * Figures in parentheses are arc sine transformed values;
**** Figures in parentheses are square root transformed values**

TNAU, Coimbatore

In BIPM module and insecticide treated plots fall armyworm damage was 21.85 and 19.45 per cent respectively on 10 days after first spraying (DAFS). Plant with fall armyworm damage in newly emerged leaves was 7.34 per cent in insecticide treated plots which is significantly lower than the damage in BIPM module (10.23 %) on 10 days after Second Spraying (DASS). The number of dead larvae ranged between 0.35 and 0.46 per plant on 10 DAFS and 0.28 and 0.41 per plant 10 DASS . Significantly higher parasitisation by *Telenomus* sp. was observed in BIPM module (15.73 and 16.35 % 10 DAFS and 10 DASS respectively) than in insecticide treated plots (6.14 and 5.24 %). Similarly, the predator population was also found to be high in BIPM module compared to the POP recommendation. Though there was 10.15 per cent reduction in yield in BIPM module when compared to insecticide treated plot, a CB ratio of 1.66 was observed in BIPM module (Table 47).

Table 47. Efficacy of BIPM module on maize fall armyworm

Treatments	Damaged Plants* (%)			Dead Larvae** (Nos./Plant)		
	Pre treat-ment	10 DAFS (Newly emerged leaves)	10 DASS (Newly emerged leaves)	Pre treat-ment	10 DAFS	10 DASS
T1-BIPM Module	37.69 (37.43)	21.85 (27.85)[b]	10.23 (18.60)[b]	0.23 (0.45)	0.46 (0.68)[b]	0.41 (0.64)
T2 – POP recommendation	39.28 (38.46)	19.45 (26.11)[a]	7.34 (15.70)[a]	0.24 (0.47)	0.35 (0.59)[a]	0.28 (0.52)
SEd	NS	0.75	1.04	NS	0.026	0.035
CD (P=0.05)	NS	1.571	2.174	NS	0.056	0.073

DAFS- Days after First Spraying; DASS- Days after Second Spraying;
*** Figures in parentheses are arcsine transformed values**
**** Figures in parentheses are square root transformed values;**

In a column means followed by same letter(s) are not significantly different (p=0.05) by LSD

Table 48. Effect of BIPM module on natural enemies of maize fall army worm and yield of maize

Treatments	Egg Parasitism ** (%)			No. of Predators/plant* (Nos.)			Yield (kg/acre)	CB ratio
	Pre treat-ment	10 DAFS	10 DASS	Pre treat-ment	10 DAFS	10 DASS		
T1-BIPM Module	11.341 (19.16)	15.73 (23.33)[b]	16.35 (23.83)[b]	0.38 (0.61)	0.41 (0.64)[b]	0.44 (0.63)[b]	2854 (53.39)[b]	1.66
T2 – POP recom-men-dation	12.65 (20.45)	6.14 (14.27)[a]	5.24 (13.11)[a]	0.45 (0.64)	0.36 (0.59)[a]	0.34 (0.59)[a]	3144 (56.03)[a]	1.94
SEd	NS	0.84	0.96	NS	0.015	0.014	0.566	
CD (P=0.05)	NS	1.753	2.02	NS	0.031	0.030	1.819	

DAFS- Days After First Spraying; DASS- Days After Second Spraying

*** Figures in parentheses are arcsine transformed values**

**** Figures in parentheses are square root transformed values**

In a column means followed by same letter(s) are not significantly different (p=0.05) by LSD

IV. 2. Biological control of insect pests of Rice

IV. 2. 1. Evaluation of entomopathogens against sucking pests of rice

MPKV, Pune

Significantly less incidence of brown plant hopper was recorded in all the treated plots over untreated check (Table 49). Among the three entomopathogenic fungi, *M. anisopliae* @ 5g/l recorded low hopper population 13.52/25 hills and higher percentage reduction of hoppers (80.93%) followed by *B. bassiana* NBAIR Bb5a @ 5g/l (15.58/25hill) and were at par with each other. The next treatment was *L. saksenae* @ 5g/l which recorded hopper population as (15.96/25hills) and 77.48 per cent reduction over control.

All the treated plants produced significantly higher grain (40.41 to 45.24 qt/ha) yield over untreated check (35.46 qt/ha). Among the entomopathogens, the higher grain yield was achieved in *M. anisopliae* (42.63 qt/ha) followed by *B. bassina* (41.62 qt/ha) and *L. saksenae* (40.41 qt/ha) and on par with each other.

Table 49. Evaluation of entomopathogens against brown plant hopper of rice.

T. N.	Treatment	Dose (g/L.)	Population of BPH/25hills				Red. over control (%)	Yield (qt/ha)
			Pre count	7 DAS	15 DAS	Mean		
T1	*Lecanicillium saksenae* KAU ITCC7714 (1 × 10^8 Spores/g).	5	50.50 (7.12)	22.79 (4.80)	9.13 (3.16)	15.96 (3.98)	77.48	40.41
T2	*Beauveria bassiana* NBAIR Bb 5a (1 × 10^8 Spores/g)	5	56.25 (7.56)	20.79 (4.62)	10.37 (3.35)	15.58 (3.98)	78.03	41.62
T3	*Metarhizium anisopliae* (1 × 10^8 Spores/g)	5	53.25 (7.36)	17.04 (4.17)	10.00 (3.30)	13.52 (3.74)	80.93	42.63
T4	Thiamethoxam 25% WDG	0.2	55.00 (7.48)	2.91 (1.97)	4.83 (2.41)	3.87 (2.19)	94.54	45.24
T5	Untreated Control		55.25 (7.50)	71.33 (8.50)	70.46 (8.45)	70.90 (8.47)		35.46
	SE +/-		0.25	0.76	0.30	0.34		1.31
	CD @ 5%		N.S.	2.15	0.87	1.06		4.48

***Figures in parenthesis are $\sqrt{x+1}$ transformed value**

IV. 2. 2. Field evaluation of ICAR-NBAIR entomopathogenic strains against rice stem borer (*Scirpophaga incertulas*), rice leaf-folder (*Cnaphalocrosis medinalis*) and rice brown plant hopper (*Nilaparvata lugens*)

SKAUST, Jammu

Two entomopathogenic strains, NBAIR-PEOWN *Pseudomonas entomophila* and NBAIR-BATP *Bacillus albus* were assessed against rice stem borer and rice leaf folder along with the recommended insecticide. NBAIR-BATP *Bacillus albus* and the insecticide treatment recorded significantly lowest number of dead heart / white ears per square meter (12.67 and 12.43 respectively in *B. albus* and insecticidal treatment). Mean number of rolled leaves also corresponded with it (9.79 and 9.12 in *B. albus* and insecticidal treatment respectively). However, the predators population per square meter was significantly lowest in the insecticide treatment (3.67). Grain yield was highest in the insecticide treatment (4012.33 kg/ha), but was at par with the *B. albus* treatment (4001.67 kg/ha).

Table 50. Evaluation of entomopathogens against brown plant hopper of rice.

Treatments	Mean no. of dead heart / white ear / sq m	Mean no. of rolled leaves / sq m	Predators (Spiders, dragonflies, damselflies / sq m	Grain yield (kg / ha)
T1 – NBAIR-PEOWN *Pseudomonas entomophila*	14.80 (22.63)	10.93 (19.30)	6.00	3916.33
T2 – NBAIR-BATP *Bacillus albus*	12.67 (20.85)	9.79 (18.23)	5.67	4001.67
T3 – Cartap hydrochloride 50 WP @ 30 g /kanal and Betacyfluthrin @ 0.04%	12.43 (20.64)	9.12 (17.58)	3.67	4012.33
T4 – Untreated control	21.56 (27.67)	19.37 (26.11)	6.33	3260.00
C.D. at 5%	(1.23)	(1.42)	0.33	81.56

IV. 2. 3. Comparative efficacy of entomopathogenic fungi against sucking pests of rice, *Leptocorisa acuta* (Through AICRIP Entomology programme, ICAR- IIRR)

During kharif 2023, the trial was taken up at nine locations *viz*., Brahmavar, Chatha, Coimbatore, Gangavati, Karjat, Mandya, Moncompu, Navasari and Raipur with a susceptible variety of the location. Three entomopathogens viz., *Lecanicillium saksenae* (1x10^8 spores/g) @ 5 g/l), *Beauveria bassiana* (1x10^8 spores/g) @ 5 g/l and *Metarhizium anisopliae* (1x10^8 spores/g) @ 5 g/l) were compared with Thiamethoxam 0.2 g/l and untreated Control.

1. ***Brahmavar***

At 15 days after first spray, the least number of ear head bugs were observed in *L. saksenae* sprayed plots (0.50/ 5 hills). Seven days after second spray, all the treatments showed significantly lesser number of ear head bugs compared to control (3.40), the least being observed with *L. saksenae* (0.70/5 hills). *Metarhizium anisopliae* with a population of 1.60 and 2.40/5 hills 15 days after first and second spray was the least effective among the bioagents tested Overall, *L. saksenae* was the most effective treatment.

Overall, the natural enemy count viz. mirids, spiders and coccinellids was significantly higher in control followed by *L. saksenae*, *B. bassiana* and *M. anisopliae* treatments. Thiamethoxam registered lowest number of natural enemies. The highest yield was observed with *L. saksenae* treatment (4635.73 kg/ha) followed by thiamethoxam (4600.15 kg/ha. The least yield was observed in the control plot with 4199.05 kg/ha.

2. ***Chatha***

Population of gundhi bugs ranged from 1-2 individuals per sweep in all treatments. The yield was 2768.00, 2644.25, 2673.75, 2788.50, and 2686.00 in *L. saksenae, B. bassiana*, *Metarhizium anisopliae,* thiamethoxamand control plots respectively.

3. ***Coimbatore***

The number of earhead bugs at seven days after first spray was significantly lower in thiamethoxam (5.25/25 hills) while among bioagents, *M. anisopliae and L. saksenae* treatments (10.25 and11.25/ 25 hills) had the lowest population (Table 51). Overall, *M. anisopliae* was the most effective treatment among bioagents. Overall, the natural enemy count was significantly higher in control followed by *L. saksenae*, *B. bassiana* and *M. anisopliae* treatments which were all on par. Thiamethoxam registered lowest number of natural enemies (Table 52). The highest yield was observed in thiamethoxam treated plots (6032kg/ha) though statistically on par with other treatments.

4. *Gangavathi*

The population of hoppers was lowest thiamethoxam (22.58/ 25 hills) and on par with *L. saksanae* (29.03/25 hills) 7 days after first spray as compared to 44.42/ 25 hills in untreated control (Table 53). Chemical control was the most effective 15 days after second spray though all bioagents could bring down the population significantly. The number of earhead bugs after first spray was significantly lower in all treatments as compared to untreated control, but the chemical thiamethoxam recorded significantly lowest population of bugs (2.99 and 2.14/ 25 hills) at 7 and 15 days after first spray. The population of mirids, spiders and coccinellids were significantly lower in thiamethoxam treated plots while they were on par in all other treatments including untreated control. The yields were significantly lower in control plot (2698.50 kg/ ha) while it was significantly higher in *L. saksanae* treatment (7512.75 kg/ ha) (Table 53).

5. ***Karjat***

At fifteen days after second spray, the least number of ear head bugs were observed in *L. saksenae* sprayed plots(1.50 / 25 hills) while it reached nil population in thiamethoxam treated plots. The other two bio-agents *B. bassiana* and *M. anisopliae* were also effective in reducing pest population (4.75 and 6.75/ 25 hills) as compared to control (80.50). The natural enemy count was significantly higher in control followed by *L. saksenae*, *B. bassiana* and *M. anisopliae* treatments which were all on par. The highest yield was observed in thiamethoxam treated plots (4556.25 kg/ha) followed by *L. saksenae* treatment (4406 kg/ha).

6***. Ludhiana***

The most effective bioagent against hoppers was *L. saksanae* (73.50/25 hills) while the least effective was *B. bassiana* (107.00/ 25 hills) (Table 55). The spider count was significantly higher in control (14.25/ 10 hills) followed by *L. saksenae*, *B. bassiana* and *M. anisopliae* treatments which were all on par (10-10.5/ 10 hills). The highest yield was observed in thiamethoxam treated plots (7637.24 kg/ha) followed by *L. saksenae* treatment (7419.53 kg/ha).

7***. Moncompu***

Population of planthoppers was on par and significantly lower in thiamethoxam and *L. saksanae* treated plots seven days after (85.25 and 84.25/ 25 hills respectively) and fifteen days after (45.00 and 54.5 / 25 hills) first spray.

The population of earhead bugs ranged from 20.75 – 29.75/ 25 hills in untreated control. Population of bugs was significantly lower in thiamethoxam (14.75/ 25 hills) followed by *L. saksanae* treated plots (16.00 / 25 hills) seven days after first spray (Table 57). The spiders and mirid population were on par in all treatments while coccinellids were higher in untreated control. The highest yield was observed in thiamethoxam treated plots (4900 kg/ha) followed by *L. saksenae* treatment (4800 kg/ ha).

*8**. Mandya***

At 15 days after first spray, the least number of ear head bugs were observed in thiamethoxam sprayed plots(1.98/ 25 hills) followed by *L. saksenae* treated plots (2.26/25 hills). The highest yield was observed with thiamethoxam treatment (7716 kg/ha), but the treatment *L. saksenae* was on par with chemical control (7032 kg/ha respectively). The least yield was observed in the control plot with 2168 kg/ha.

9. ***Navsari***

All treatments were significantly more effective than untreated control which recorded 13.25 – 19.75 bugs per 10 hills. The number of earhead bugs was significantly lower with thiamethoxam treatment (4.00 – 7.00/ 10 hills) after first and second spray. The three bioagents did not differ significantly in their effectiveness after two sprays (Table 60).

The three bioagent treatments were on par, with the highest population recorded in *L. saksanae* treatment with 9.75, 7.75 and 2.25 mirids, spiders and coccinellids per plot. The highest yield was observed in thiamethoxam treatment (5392 kg/ha) but was statistically on par with other treatments (Table 59).

10. ***Raipur***

All treatments were significantly more effective than untreated control which recorded 9.00 – 11.75 earhead bugs per 25 hills. Nevertheless, *L. saksenae* treated plots reached3.0/ 25 hills fifteen days after second spray which was on par with 2.50/25 hills in thiamethoxam (Table 60).

Natural enemy population did not differ significantly among the treatments. The lowest yield was observed in the control plot with 5687 kg/ha, while all other were on par with a yield range of 6100 – 6518.75 kg/ha (Table 60).

Table 51. Effect of entomopathogens on sucking pests and their natural enemies at Brahmavar, EESP, *kharif* 2023

Treatment	No. of Ear head bugs / 5 hills						Natural enemies No./ plot			Yield (kg/ ha) *
	I SPRAY			II SPRAY						
	PC	7DAS	15 DAS	21 DAS/ PC	7 DAS	15 DAS	Mirid	Spi- der	Cocci- nellid	
Lecanicillium saksenae @ 1 x 10^7 cfu ml $^{-1}$ KAU 7714 (20 g talc formulation/ L)	2.90	0.85 (1.16)	0.50 (0.99)	0.90 (1.18)	0.70 (1.09)	0.45 (0.99)	3.25 (1.90)	4.25 (2.17)	3.00 (1.86)	4635.73
Beauveria bassiana @ 1 x 10^8 cfu ml^{-1} NBAIR Bb 5 (20 g talc formulation / L)	2.60	1.00 (1.22)	0.80 (1.14)	1.20 (1.38)	1.00 (1.22)	0.60 (1.05)	5.00 (2.34)	5.00 (2.34)	3.00 (1.86)	4396.28
Metarhizium anisopliae @ 1 x 10^8 cfu ml $^{-1}$ NBAIR Ma 4 (20 g talc formulation / L)	3.00	1.40 (1.37)	1.60 (1.45)	2.20 (1.64)	2.00 (1.58)	2.40 (1.70)	4.00 (2.12)	3.00 (1.86)	2.00 (1.56)	4355.20
Thiamethoxam	3.00	1.20 (1.38)	0.80 (1.14)	1.40 (1.38)	1.00 (1.22)	0.80 (1.14)	2.75 (1.79)	3.00 (1.86)	2.00 (1.56)	4600.15
Control	3.00	3.60 (2.03)	3.40 (1.98)	4.00 (2.12)	3.40 (1.98)	3.20 (4.09)	2.00 (1.56)	5.00 (2.34)	2.00 (1.56)	4199.05
SED		0.02	0.04	0.03	0.03	0.02	0.12	0.08	0.07	20.58
CD (0.05)	NS	0.05**	0.11**	0.09**	0.09**	0.07**	0.38**	0.23**	0.23**	62.87**

Table 52. Effect of entomopathogens on sucking pests and their natural enemies at Coimbatore, EESP, *kharif* 2023

Treatment	No. of Ear head bugs / 5 hills					Natural enemies No./ plot			Yield (kg/ ha) *
	I SPRAY			II SPRAY					
	PC	7 DAS	15 DAS	7 DAS	15 DAS	Mirid	Spider	Cocci- nellid	

Lecanicillium saksenae @ 1 x 107 cfu ml -1 KAU 7714 (20 g talc formulation/ L)	18.75	11.25 (3.41)	11.75 (3.49)	7.25 (2.78)	4.75 (2.29)	7.25 (2.76)	12.00 (3.53)	15.00 (3.92)	5772
Beauveria bassiana @1 x 108 cfu ml-1 NBAIR Bb 5 (20 g talc formulation / L)	24.75	19.50 (4.43)	18.50 (4.34)	9.25 (3.11)	6.25 (2.59)	6.75 (2.66)	13.00 (3.65)	14.00 (3.79)	5531
Metarhizium anisopliae @ 1 x 108 cfu ml -1 NBAIR Ma 4 (20 g talc formulation / L)	22.00	10.25 (3.24)	8.50 (2.99)	5.00 (2.33)	1.75 (1.40)	7.00 (2.71)	13.75 (3.76)	14.50 (3.83)	5820
Thiamethoxam	25.50	5.25 (2.38)	5.75 (2.50)	1.50 (1.34)	0.00 (0.71)	1.50 (1.34)	4.00 (2.11)	6.25 (2.59)	6032
Control	24.50	27.00 (5.23)	23.25 (4.87)	9.00 (3.07)	7.00 (2.74)	7.25 (2.76)	14.25 (3.83)	15.50 (13.98)	5615
SED	0.54	0.38	0.13	0.22	0.20	0.31	0.23	0.30	133.0
CD (0.05)	NS	1.17	0.39**	0.68**	0.62**	0.93**	0.66**	0.85**	NS

Figures in parenthesis are square root transformed; PC- pre-count; DAS- days after spraying; *extrapolated

Table 53. Effect of entomopathogens on sucking pests and their natural enemies at Gangavathi, EESP, *kharif* 2023

Treatment	No. of Ear head bugs / 25 hills					NO. of hoppers/ 25 hills					No. of natural enemies/m²			Yield (kg/ha)
		I SPRAY		II SPRAY			I SPRAY		II SPRAY					
	PC	7 DAS	15 DAS	7 DAS	15 DAS	PC	7 DAS	15 DAS	7 DAS	15 DAS	Mirid	Spider	Coccinellid	
Lecanicillium saksenae @ 1 x 10^7 cfu ml^{-1} KAU 7714 (20 g talc formulation/ L)	4.61	3.94 (2.10)	3.10 (1.89)	2.40 (1.70)	4.75 (2.29)	41.34	29.03	23.22	18.527	11.74	10.90	4.91	3.07 (1.89)	7512.75
Beauveria bassiana @1 x 10^8 cfu ml^{-1} NBAIR Bb 5 (20 g talc formulation / L)	4.57	4.38 (2.21)	3.53 (2.00)	3.06 (1.88)	6.25 (2.59)	40.71	33.29	28.03	23.08	15.04	10.26	4.30	2.95 (1.86)	6368.25
Metarhizium anisopliae @ 1 x 10^8 cfu ml^{-1} NBAIR Ma 4 (20 g talc formulation / L)	4.58	3.63 (2.03)	2.88 (1.83)	2.35 (1.69)	1.75 (1.40)	40.07	28.11	22.80	18.33	11.32	11.14	4.93	3.02 (1.87)	7281.75
Thiamethoxam	4.62	2.99 (1.86)	2.14 (1.62)	1.82 (1.52)	0.00 (0.71)	40.46	22.58	15.53	10.53	8.57	3.23	1.12	0.66 (1.07)	6137.25
Control	4.53	5.31 (2.41)	5.82 (2.51)	6.29 (2.60)	6.29 (2.60)	40.97	44.42	47.84	54.87	59.11	12.17	5.34	3.32 (1.95)	2698.50
SED	0.08	0.07	0.07	0.05	0.08		3.51	2.69	4.26	1.89	0.33	0.57	0.53	399.99
CD (0.05)	NS	0.16*	0.22	0.10	0.24	NS	7.64*	8.21**	13.02**	5.76**	1.00**	0.80**	0.16**	1221.80**

Figures in parenthesis are square root transformed; PC- pre-count; DAS- days after spraying; *extrapolated

Table 54. Effect of entomopathogens on sucking pests and their natural enemies at Karjat, EESP, *kharif* 2023

Treatment	No. of Ear head bugs / 25 hills					Spiders No./ plot	Yield Kg/ha
	I SPRAY			II SPRAY			
	PC	7 DAS	15 DAS	7 DAS	15 DAS		
Lecanicillium saksenae @ 1 x 10^7 cfu ml^{-1} KAU 7714 (20 g talc formulation/ L)	54.00	17.50 (4.23)	9.50 (3.15)	3.50 (2.29)	1.50 (1.35)	7.75 (2.86)	4406.25
Beauveria bassiana @1 x 10^8 cfu ml^{-1} NBAIR Bb 5 (20 g talc formulation / L)	56.00	26.00 (5.13)	17.25 (4.22)	6.25 (2.59)	4.75 (2.24)	6.50 (2.64)	4178.13
Metarhizium anisopliae @ 1 x 10^8 cfu ml^{-1} NBAIR Ma 4 (20 g talc formulation / L)	54.00	30.50 (5.55)	22.00 (4.73)	9.75 (3.19)	6.75 (2.69)	7.00 (2.72)	4084.38
Thiamethoxam	57.25	8.75 (3.02)	3.00 (1.84)	1.25 (1.27)	0.00 (0.71)	5.50 (2.43)	4556.25
Control	55.50	64.25 (8.05)	67.00 (8.21)	78.75 (8.90)	80.50 (8.99)	8.50 (2.99)	3734.38
SED	0.35	0.28	0.30	0.30	0.21	0.17	53.19
CD (0.05)	NS	0.24**	0.91**	0.92**	0.64**	0.51*	162.46**

Table 55. Effect of entomopathogens on sucking pests and their natural enemies at Ludhiana, EESP, *kharif* 2023

Treatment	No. of hoppers / 25 hills						Spiders No./ plot	Yield Kg/ha
	I SPRAY			II SPRAY				
	PC	7 DAS	15 DAS	PC	7 DAS	15 DAS		
Lecanicillium saksenae @ 1 x 10^7 cfu ml^{-1} KAU 7714 (20 g talc formulation/ L)	177.75	99.25	90.25	103.25	78.50	73.50	10.00	7419.53
Beauveria bassiana @ 1 x 10^8 cfu ml^{-1} NBAIR Bb 5 (20 g talc formulation / L)	180.75	120.00	113.50	152.75	111.00	107.00	10.00	6890.98
Metarhizium anisopliae @ 1 x 10^8 cfu ml^{-1} NBAIR Ma 4 (20 g talc formulation / L)	185.75	108.25	104.00	121.00	96.50	92.00	10.50	7187.50
Thiamethoxam	177.75	46.50	37.50	49.75	22.50	20.50	6.75	7637.24
Control	180.75	199.75	219.50	226.25	232.50	248.00	14.25	6818.23
SED	3.74	3.27	4.44	2.62	3.12	3.05	0.60	75.58
CD (0.05)	NS	9.99**	13.56**	8.02**	9.51**	9.32**	1.84**	230.87

Table 56. Effect of entomopathogens on hoppers at Moncompu, EESP, *kharif* 2023

Treatment	No. of GLH / 25 hills						NO. of BPH/ 25 hills					
	I SPRAY			II SPRAY			I SPRAY			II SPRAY		
	PC	7 DAS	15 DAS	PC	7 DAS	15 DAS	PC	7 DAS	15 DAS	PC	7 DAS	15 DAS
Lecanicillium saksenae @ 1 x 10^7 cfu ml^{-1} KAU 7714 (20 g talc formulation/ L)	34.75	15.75 (4.02)	8.00 (2.89)	15.00 (3.92)	9.50 (3.16)	5.00 (2.34)	239.75 (15.47)	85.25 (9.25)	54.50 (2.10)	162.25 (12.64)	68.50 (8.29)	54.00 (7.36)

Beauveria bassiana @1 x 10^8 cfu ml^{-1} NBAIR Bb 5 (20 g talc formulation / L)	34.25	21.75 (4.69)	11.75 (3.47)	13.75 (3.77)	10.00 (3.23)	7.00 (2.72)	218.25 (14.78)	95.25 (9.78)	76.50 (8.76)	132.75 (11.53)	71.75 (8.49)	60.00 (7.76)
Metarhizium anisopliae @ 1 x 10^8 cfu ml^{-1} NBAIR Ma 4 (20 g talc formulation / L)	36.50	27.50 (5.28)	14.75 (3.90)	17.00 (4.16)	12.50 (3.58)	8.75 (3.02)	235.50 (15.35)	115.75 (10.75)	84.75 (9.23)	134.75 (11.61)	78.50 (8.87)	68.00 (8.24)
Thiamethoxam	42.50	15.00 (3.92)	7.50 (2.81)	13.50 (3.73)	6.50 (2.63)	2.00 (1.50)	230.50 (15.19)	84.25 (9.20)	45.00 (6.70)	121.25 (11.00)	47.50 (6.91)	16.50 (4.04)
Control	34.25	40.50 (6.39)	44.50 (6.70)	35.25 (5.97)	37.25 (6.13)	37.25 (6.14)	242.50 (15.57)	295.00 (17.16)	346.50 (18.61)	264.25 (16.24)	312.00 (17.67)	324.00 (18.00)
SED	0.07	0.32	0.26	0.30	0.28	0.26	0.58	0.48	0.48	0.86	0.37	0.46
CD (0.05)	NS	0.70*	0.78**	0.90**	0.87**	0.80**	NS	1.46**	1.46*	1.87**	1.13**	1.42**

Table 57. Effect of entomopathogens on hoppers at Moncompu, EESP, *kharif* 2023

Treatment	No. of Ear head bugs / 25 hills					Natural enemies No./ plot			Yield (kg/ha) *
	I SPRAY			II SPRAY		Mirid	Spi-der	Cocci-nellid	
	PC	7 DAS	15 DAS	7 DAS	15 DAS				
Lecanicillium saksenae @ 1 x 107 cfu ml^{-1} KAU 7714 (20 g talc formulation/ L)	26.50	16.00 (4.05)	11.25 (3.42)	5.50 (2.44)	4.00 (2.12)	38.75 (6.23)	38.75 (6.23)	29.50 (5.47)	4800.00
Beauveria bassiana @1 x 108 cfu ml^{-1} NBAIR Bb 5 (20 g talc formulation / L)	29.25	18.25 (4.31)	10.50 (3.29)	7.25 (2.75)	6.75 (2.67)	43.25 (6.61)	43.25 (6.61)	27.25 (5.26)	4625.00
Metarhizium anisopliae @ 1 x 10^8 cfu ml^{-1} NBAIR Ma 4 (20 g talc formulation / L)	26.25	18.00 (4.27)	12.25 (3.57)	7.75 (2.85)	6.25 (2.57)	34.50 (5.90)	34.50 (5.90)	22.75 (4.80)	4306.25
Thiamethoxam	30.50	14.75 (3.89)	11.50 (3.45)	8.25 (2.94)	7.25 (2.76)	40.25 (6.38)	40.25 (6.38)	24.50 (4.99)	4900.00
Control	29.75	28.50 (5.38)	27.00 (5.23)	20.75 (4.59)	21.75 (4.69)	44.75 (6.70)	44.75 (6.70)	32.50 (5.74)	4137.50
SED	0.22	0.33	0.26	0.28	0.30	0.32	0.32	0.23	95.68
CD (0.05)	NS	0.72*	0.78**	0.85**	0.92**	NS	NS	0.50*	292.28**

Figures in parenthesis are square root transformed; PC- pre-count; DAS- days after spraying; GLH- green leafhopper; BPH- brown planthopper *extrapolated

Table 58. Effect of entomopathogens on sucking pests and their natural enemies at Mandya, EESP, *kharif* 2023

Treatment	No. of Ear head bugs / 25 hills						Natural enemies No./ plot		Yield (kg/ha) *
	I SPRAY			II SPRAY			Spider	Cocci-nellid	
	PC	7 DAS	15 DAS	21DAS/ PC	7 DAS	15 DAS			
Lecanicillium saksenae @ 1 x 10^7 cfu ml^{-1} KAU 7714 (20 g talc for-mulation/ L)	3.47	2.74 (1.79)	2.26 (1.65)	2.85 (1.82)	2.05 (1.56)	1.42 (1.37)	19.00 (4.28)	14.75 (3.74)	7032.00

Beauveria bassiana @1 x 10^8 cfu ml^{-1} NBAIR Bb 5 (20 g talc formulation / L)	4.63	3.86 (2.07)	3.59 (2.02)	4.74 (2.29)	3.92 (2.09)	3.04 (1.86)	29.50 (5.36)	11.00 (3.31)	4060.00
Metarhizium anisopliae @ 1 x 10^8 cfu ml^{-1} NBAIR Ma 4 (20 g talc formulation / L)	3.35	3.27 (1.93)	3.05 (1.88)	3.48 (1.99)	3.12 (1.89)	2.78 (1.81)	25.25 (4.96)	18.75 (4.23)	5852.00
Thiamethoxam	4.16	2.14 (1.60)	1.98 (1.57)	2.23 (1.63)	1.47 (1.40)	0.96 (1.20)	11.50 (3.38)	4.25 (1.99)	7716.00
Control	3.81	4.45 (2.22)	5.12 (2.37)	5.36 (2.42)	5.70 (2.49)	6.14 (2.57)	42.75 (6.51)	27.00 (5.20)	2168.00
SED	0.21	0.17	0.10	0.13	0.19	0.17	0.88	0.79	848.34
CD (0.05)	NS	0.39*	0.22*	0.27*	0.41*	0.37*	1.91*	1.72*	1848.38*

Table 59. Effect of entomopathogens on sucking pests and their natural enemies at Navsari, EESP, *kharif* 2023

Treatment	No. of Ear head bugs / 25 hills					Natural enemies No./ plot			Yield (kg/ha) *	Straw yield kg/ha
	I SPRAY			II SPRAY		Mirid	Spider	Coccinellid		
	PC	7 DAS	15 DAS	7DAS	15 DAS					
Lecanicillium saksenae @ 1 x 10^7 cfu ml^{-1} KAU 7714 (20 g talc formulation/ L)	9.77	8.00 (2.90)	10.00 (3.23)	10.25 (3.28)	12.00 (3.53)	9.25 (3.12)	6.25 (2.60)	2.00	4871.32	7092.53
Beauveria bassiana @1 x 10^8 cfu ml^{-1} NBAIR Bb 5 (20 g talc formulation / L)	9.21	8.25 (2.95)	13.00 (3.67)	11.25 (3.42)	12.25 (3.56)	9.00 (3.08)	6.00 (2.55)	2.25	4883.58	7184.44
Metarhizium anisopliae @ 1 x 10^8 cfu ml^{-1} NBAIR Ma 4 (20 g talc formulation / L)	8.90	6.75 (2.69)	8.25 (2.95)	9.75 (3.20)	12.50 (3.59)	8.50 (2.99)	6.75 (2.69)	3.00	5147.06	7153.80
Thiamethoxam	8.96	4.00 (2.11)	6.75 (2.68)	5.75 (2.49)	7.00 (2.73)	4.25 (2.18)	3.00 (1.86)	1.00	5392.16	7261.03
Control	8.92	13.25 (3.70)	12.00 (3.53)	20.93 (4.62)	19.75 (4.50)	9.75 (3.20)	7.75 (2.87)	2.25	5208.33	7383.58
SED	0.11	0.16	0.16	0.17	0.21	0.13	0.10	0.21	152.77	102.00
CD (0.05)	NS	0.49**	0.35*	0.52*	0.45*	0.28*	0.30*	NS	NS	NS

Figures in parenthesis are square root transformed; PC- pre-count; DAS- days after spraying; *extrapolated

Table 60. Effect of entomopathogens on sucking pests and their natural enemies at Raipur, EESP, *kharif* 2023

Treatment	No. of Ear head bugs / 25 hills					Natural enemies No./ plot			Rove beetle	Yield (kg/ha) *
	I SPRAY			II SPRAY		Spider	Ground beetle	Coccinellid		
	PC	7DAS	15DAS	7DAS	15DAS					
Lecanicillium saksenae @ 1 x 10^7 cfu ml^{-1} KAU 7714 (20 g talc formulation/ L)	4.75	4.50 (2.22)	2.00 (1.58)	6.25 (2.59)	3.00 (1.86)	3.00	3.25	3.75	3.25	6268.75

Beauveria bassiana @1 x 10^8 cfu ml^{-1} NBAIR Bb 5 (20 g talc formulation / L)	4.50	3.75 (2.06)	2.75 (1.80)	7.75 (2.87)	5.75 (2.49)	2.50	3.00	3.50	3.75	6100.00
Metarhizium anisopliae @ 1 x 10^8 cfu ml^{-1} NBAIR Ma 4 (20 g talc formulation / L)	5.00	4.50 (2.22)	2.25 (1.65)	6.25 (2.59)	4.75 (2.28)	2.75	4.25	3.75	4.25	6162.50
Thiamethoxam	5.00	3.00 (1.86)	1.25 (1.27)	6.25 (2.56)	2.50 (1.73)	2.25	3.50	4.00	4.00	6518.75
Control	4.50	9.00 (3.07)	10.00 (3.23)	11.00 (3.37)	11.75 (3.48)	3.25	4.75	4.75	5.25	5687.50
SED	0.12	0.19	0.18	0.187	0.16	0.12	0.17	0.20	0.30	132.57
CD (0.05)	NS	0.42*	0.55**	0.41*	0.49**	NS	NS	NS	NS	288.85*

Figures in parenthesis are square root transformed; PC- pre-count; DAS- days after spraying; *extrapolated

IV. 2. 4. Testing of BIPM trial on paddy along with farmers practice and control.

IGKV, Raipur

Minimum percent of dead heart (4.28%); white ear head (7.44%), leaf folder damage (1.46%), minimum caseworm damage (0.49%) and maximum grain yield (115.25 kg/acre) was obtained in BIPM treatment.

Table 61. Evaluation of BIPM package against insect pests in Rice

Treatments	Stem borer			leaf folder		Case worm		Hispa		Gundhi bug		Mean grain yield Q/acre	Increase yield %
	Pre-treatment	Dead Heart (%)	White ear head (%)	Pre-treatment	Post treatment	Pre-treatment	Post treatment	Pre-treatment	Post treatment	Pre-treatment	Post treatment		
T1 BIPM	1.30 (6.53)	4.28 (11.94)	7.44 (15.82)	0.64 (4.21)	1.46 (6.94)	0.45 (3.850)	0.49 (4.02)	3.76 (11.18)	1.96 (8.03)	0.00 (0.00)	1.10 (1.45)	115.25	29.29
T2 Farmer's Practice	1.80 (7.70)	7.60 (15.98)	13.09 (21.21)	0.89 (5.39)	2.56 (9.20)	0.50 (4.06)	0.60 (4.46)	5.59 (13.67)	2.66 (9.38)	0.00 (0.00)	1.89 (1.70)	105.12	17.92
T3 Control	2.00 (8.10)	10.11 (18.52)	15.55 (23.21)	0.98 (5.69)	3.21 (10.32)	0.64 (4.59)	0.75 (4.96)	6.45 (14.70)	3.12 (10.17)	0.00 (0.00)	2.25 (1.80)	89.14	-
CD	NS	0.36	0.12	NS	0.198	NS	0.113	0.334	0.283	NS	0.016	0.12	-
SEm+	0.178	0.118	0.039	0.415	0.065	0.092	0.037	0.109	0.092	-	0.005	2.973	-

IV. 2. 5. Large scale bio-intensive pest management in rice

OUAT, Bhubaneshwar

The dead heart (DH), white earhead (WEH) and leaf folder (LF), incidence in BIPM demonstrated plots were 4.48, 3.12 and 4.20 %, respectively as compared to 3.53, 2.31 and 3.51% infestation in farmers practice (FP) with the use of chemical pesticides. Highest yield (40.34q/ha) was recorded in FP which was at par with BIPM plot (38.35 q/ha). The benefit cost ratio in BIPM treated plots was found (1.39 as against 1.48 in FP and 1.21 and untreated control, respectively (Table 62).

Table 62. BIPM demonstration in paddy at Koska and Jharapada village of Nayagarh district

Treatments	DH (%)	WEH (%)	LF (%)	Yield (q/ha)	B:C ratio
BIPM package	4.48 (2.12)	3.12 (1.77)	4.20 (2.04)	38.35	1. 39
Farmer's Practice Chlorantraniliprole 18.5% SC 200ml/ha	3.53 (1.88)	2.31 (1.52)	3.51 (1.87)	40.34	1.48
Untreated Control	8.79 (2.97)	8.64 (2.93)	10.07 (3.17)	30.59	1.21
S.E. (m) ±	(0.07)	(0.06)	(0.07)	1.19	
C.D. (0.05)	0.22	0.19	0.21	3.63	

figures in the parentheses are square root transformation values

IV. 2. 6. Large scale validation of BIPM in rice was carried out over an area of 200 ha at Alathur in Palakkad district.

KAU, Thrissur

Adoption of BIPM practices led to substantial reduction in infestation by major pests. The dead heart as well as white ear head symptoms in BIPM plots was 49.0 and 20.0 per cent lower as compared to non BIPM plots. Similarly, leaf folder damage was approximately 50.0 per cent lower as compared to conventionally managed plots, while the rice bug population was nearly 54.0 per cent of what was reported from farmer's field.

The population of natural enemies too was higher in BIPM plots. The yield obtained from BIPM plots, at 7320 kg/ha was approximately 42 per cent more than that obtained from non BIPM plots (4216 kg/ha). The cost of cultivation also was nearly six per cent lower in the former. The cost benefit ratio, at 2.17 for BIPM fields compared quite favorably with 1.17 for non BIPM fields.

Table 63. Comparison between BIPM and non BIPM plots at Alathur Panchayat

Sl. No.	Particulars	BIPM plot (Mean no/m^2)	Non BIPM plot (mean no/m^2)
1.	Dead hearts	2.55	5.0
2.	White ear heads	4.0	5.0
3.	Leaf folder damage	3.0	6.0
4.	Rice bug	6.5	14.0
5.	Spiders	6.5	2.0
6.	Other predators	11.75	4.0
7.	Parasitoids	4.75	2.0
8.	Yield (kg/ha)	7320	4216
9.	Bacterial leaf blight	Mild	Mild

10.	Returns per ha (@Rs. 28.12/kg)	Rs. 205838/-	Rs. 118554/-
11.	Cost of cultivation (Rs/ha)	Rs. 94825/-	Rs. 101100/-
12.	Net return per ha	Rs. 111013/-	Rs. 17454/-
13.	Benefit cost ratio	2.17	1.17

IIRR, Hyderabad

There were significant differences between the BIPM plots and farmers practice (FP) plots. Hopper population was recorded under the ETL (3-5 / 5 hill) in BIPM plots. Besides this, in BIPM plots stem borer damage ranged from 2.27-3.21% well below ETL. The yield due to good management practices in BIPM plots was an average of6200 kg /ha while in that of Farmers practices it was 5950 kg/ha.

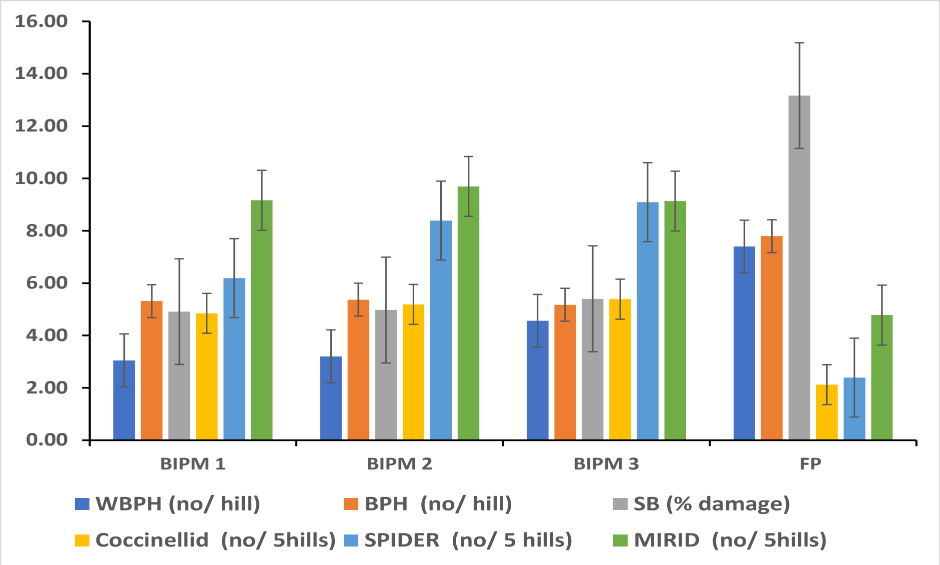

Fig 26. Pest and natural enemie's incidence at Ibrahimpatnam, Telangana, *Kharif* 2023

BIPM 1 with *Trichoderma asperellum* Strain TAIK1; BIPM 2 with *Bacillus cabrialesii* BIK3; BIPM with *Pseudomonas fluorescens; FP- farmer's practice with no intervention*

AAU, Jorhat: No significant difference was observed between BIPM and chemical control in terms of Dead heart (%), WEH (%) LFDL (%) and Yield. BIPM and chemical control plots recorded 4650.00 kg/ha yield and 4740.00 kg/ha yield which were 26.11 % and 27.52 % more yield than control.

Table 64. Evaluation of BIPM module against insect pests of rice

Treatments	Dead heart (%)		WEH (%)	LFDL (%)		Grain yield (kg/ha)	Pest reduction over control (%)		Yield increase over control (%)
	45 DAT	60 DAT	100 DAT	45 DAT	60 DAT		WEH %	LFD %	
BIPM Package	7.49 (15.88)	3.75 (11.16)	2.34 (8.79)	5.38 (13.41)	3.02 (10.00)	4650.00	56.82	41.35	26.11

Chemical control	5.07 (13.01)	2.36 (8.83)	2.16 (8.45)	4.28 (11.93)	2.27 (8.66)	4740.00	60.14	55.92	27.52
Untreated control	6.57 (14.85)	6.92 (15.25)	5.42 (13.46)	7.68 (16.08)	5.15 (13.11)	3435.50			
CD = 0.05	NS	2.07	3.23	2.18	2.47	526.90			

Table 65. Evaluation of BIPM module against insect pests of rice

Treatments	Post count (spider/ m^2)		Post count coccinellids /m^2	
	45 DAT	60 DAT	45 DAT	60 DAT
IPM package	1.32	2.48	0.84	1.26
Farmer's practice	1.12	0.72	0.34	0.31
Untreated control	1.07	2.65	0.76	1.25
CD = 0.05	NS	0.487	NS	0.85

PAU, Ludhiana

Large scale demonstrations on the bio-suppression of yellow stem borer and leaf folder, were conducted in collaboration with KVKs and Regional Station (Gurdaspur). The demonstrations were conducted in areas of Amritsar, Bathinda, Fatehgarh Sahib, Gurdaspur, Jalandhar, Ludhiana, Mansa, Moga, Muktsar, Patiala, Ropar and Sangrur districts in organic *basmati* rice over an area of 342 acres. BIPM package includes seed bio-priming with *Trichoderma harzianum* @ 15g/ kg of seeds, mechanical control (passing the 20-30 m long coir/jute rope before flowering, forwards and then backwards, both ways while touching the crop canopy for leaf folder) and augmentative releases of *T. chilonis* and *T. japonicum* each @ 1,00,000 parasitoids/ha (5-6 times at weekly interval starting from 30 days after transplanting). The data were recorded on dead hearts (stem borer) and leaf damage (leaf folder) at vegetative stage (45 and 60 DAT).

The mean dead heart incidence in biocontrol fields was 1.58 and 1.65 per cent at 45 and 60 DAT, respectively (Table 66). The corresponding figures in untreated control were 3.30 and 4.16 per cent. Similarly, leaf folder damage was significantly lower in BIPM fields as compared to untreated control. The damage was 2.38 and 2.26 per cent at 45 and 60 DAT, respectively as compared to 6.42 and 6.20 per cent in untreated control. Grain yield in biocontrol field (28.01 q/ha) was significantly better as compared to 25.33 q/ha in untreated control, respectively. It is concluded that BIPM package involving 5-6 releases of *T. chilonis* and *T. japonicum* each @ 1,00,000/ha resulted in lowering incidence of rice insect pests and higher grain yield in organic *basmati* rice with an additional benefit of Rs. 7148/- per hectare over untreated control with benefit cost ratio of 2.86.

Table 66. Large scale demonstrations of biocontrol of rice pests in organic *basmati* rice during 2023

Treatments	Dead hearts (%)			Leaf folder damaged leaves (%)		
	45 DAT	60 DAT	Mean	45 DAT	60 DAT	Mean
BIPM*	1.58[a]	1.65[a]	1.62[a]	2.38[a]	2.26[a]	2.32[a]
Untreated control	3.30[b]	4.16[b]	3.73[b]	6.42[b]	6.20[b]	6.31[b]

DAT – days after transplanting; *5-6 releases of *T. chilonis* and *T. japonicum* each @ 1,00,000/ha at weekly interval starting from 30 DAT

Table 67. Large scale demonstrations of biocontrol of rice pests and yield of organic *basmati* rice during 2023

Treatments	White ears incidence (%)	Paddy yield (q/ha)	Net returns over control (Rs./ha)	Benefit Cost ratio
BIPM*	2.37[a]	28.01[a]	7148.00	2.86
Untreated control	5.35[b]	25.33[b]	-	-

DAT – days after transplanting; *5-6 releases of *T. chilonis* and *T. japonicum* each @ 1,00,000/ha at weekly interval starting from 30 DAT

NCIPM:

Large scale demonstration of bio-intensive pest management (BIPM) in basmati rice was carried out at farmer's field in the village Bambawar (GPS 28.618599, 77.552171), District GB Nagar (UP) in two ha area with variety Pusa Basmati-1847 and compared with farmers practice (FP). The infestation of stem borer at tillering stage was low with 2.06 % dead heart. However, at the time of ear emergence, YSB infestation was high and crossed ETL with 5.53 % white ear in BIPM and 12.84 % in FP fields. Leaf folder attack was also moderate with 5-10 % leaf damage in both BIPM and FP. Average yield was 45q/ha in BIPM and 42.5 q/ha in FP. Economic analysis revealed significant increase in yield (5.9 %) along with a reduction in the cost of cultivation (11.3 %) and increase in net return (17.7 %) and BC ratio in BIPM (2.93) over FP (2.46). Overall BIPM strategy proved successful in managing pest problems in basmati rice with a higher benefit-cost ratio and the conservation of natural enemies without the application of chemical pesticides.

Table 68. Plant growth parameters of BIPM and FP rice fields at Gautambuddh Nagar, UP

Plant growth parameters	BIPM	FP	*t Test P value	% Change in BIPM over FP
25 days old seedlings				
Root length (cm)	8.2	4.93	0.00004	66.32
Shoot length (cm)	26.11	24.79	0.63	5.32

Seedling Fresh Weight (g)	2.17	2.13	0.83	1.87
Seedling Dry Weight (g)	0.558	0.550	0.91	1.45
Main field				
No. of tillers/hill	21.51	18.61	0.02	15.58
Number of panicle bearing tillers/hill	18.66	17	0.049	9.76
Yield q/ha	45	42.5	0.006	5.88

Table 69. Scenario of pests and natural enemies in BIPM and FP fields of basmati rice (PB1847) at Gautambuddh Nagar, UP

	45 DAT			60 DAT			100 DAT		
Pest	**BIPM**	**FP**	***t-Test P value**	**BIPM**	**FP**	***t-Test P value**	**BIPM**	**FP**	***t-Test P value**
YSB (% Dead heart/White ear)	2.06	4.74	0.03	1.40	4.50	0.017	5.53	12.84	0.011
Leaf folder (% leaf damage)	7.43	7.83	0.88	9.17	8.33	0.812	-	-	-
BPH (no/hill)	0.00	0.00	-	0.03	0.17	0.0048	1.43	6.75	0.0003
Spider (No/hill)	1.03	1.05	0.96	3.01	0.5	0.00003	2.0	0.98	0.0001
Sheath Blight (% incidence)	0.00	00	-	0.00	00	-	2.36	5.75	0.044
Bakane (% incidence)	0.00	0.1	-	0.00	0.14	-	0.05	0.20	0.003

***Two tail t-Test: Two-Sample Assuming equal Variances**

Table 70. Economics of BIPM and farmers practice in basmati rice (PB1847) at Gautambuddh Nagar, UP

Parameters	BIPM	FP	% Change in BIPM over FP
Cost (Rs/ha)	56800	64050	-11.3
Yield (Qt/ha)	45	42.5	5.9
Gross return (Rs/ha)	166500	157250	5.9
Net return (Rs/ha)	109700	93200	17.7
BC Ratio	2.93	2.46	

Market price of paddy @ Rs 3700/q

UBKV: The result of the experiments revealed that dead heart and rice leaf folder incidence in BIPM fields was 3.43 and 3.29 per cent, respectively. In case of stem borer infestation, the BIPM field showed 70.35% per cent reduction over control whereas in leaf folder infestation the BIPM field showed 74.41% reduction over control. The highest yield was recorded from university POP (Chlorantraniliprole 18.5 SC and Validamycin 3 %) treated field (4506.71 Kg/ha) followed by BIPM field (3420.43 Kg/ha). The BIPM field registered 36.34 % yield increase over untreated control plots.

Table 71. Large scale demonstration of bio-intensive pest management in rice

Treatments	Stem borer (% Dead heart)			Leaf Folder (% leaf infested)			Blast (PDI)			Natural enemies (Spider/ Lady bird beetle/ Carabids) (No./m²)		Yield (Kg/ha)	% yield increase over control
	Pre treatment	Post treatment	% reduction over control	Pre treatment	Post treat	% reduction over control	Pre treatment	Post treat	% reduction over control	Pre treatment	Post treat		
T1- BIPM	11.29 (6.48)[1]	3.43 (1.96)	70.35	10.71 (6.15)	3.29 (1.88)	74.41	12.14 (6.97)[1]	9.10 (5.22)	35.96	14.29 (3.77)[2]	9.14 (3.02)	3420.43 (8.13)[3]	36.34
T2-Chlorantraniliprole 18.5 SC @ 30 g a.i/ha & Validamycin 3% L	11.14 (6.40)	1.00 (0.57)	91.35	11.00 (6.32)	0.71 (0.41)	94.47	12.23 (7.02)	3.96 (2.27)	72.13	13.86 (3.72)	1.14 (0.89)	4506.71 (8.41)	79.65
T3- Untreated control	10.86 (6.23)	11.57 (6.65)	-	11.14 (6.40)	12.86 (7.39)	-	12.31 (7.07)	14.21 (8.17)	-	10.86 (3.28)	13.71 (3.70)	2508.57 (7.82)	-
SEm (±)	-	0.33	-	-	0.21	-	-	0.43	-	0.17	0.28	0.06	-
CD (0.05%)	N.S.	1.03	-	N.S.	0.67	-	N.S.	1.34	-	0.52	0.88	0.21	-
CV (%)	-	15.42	-	-	9.52	-	-	11.79	-	6.70	15.83	1.18	-

[1]: Angular transformation; [2]: Square root transformation; [3]: Log transformation

IV. 3. Biological control of insect pests of Sorghum

IV. 3. 1. Studies on abundance of natural enemies of borers in Millets (2023-24)

IIMR, Hyderabad

In Sorghum during Kharif season, Spotted stem borer, *Chilo partellus* was predominant (8 - 10 %) in comparison to Pink borer, *Sesamia inferens* (5-7 %) in Sorghum. About 18 % of Spotted stem borer larvae were parasitizated by *Cotesia flavipes*. The incidence of Pink borer was 15-20 % in Rabi while Spotted stem borer infestation <10%.

In finger millet during Kharif Pink borer infestation was moderate, 15 – 18 % dead hearts and 10 – 12 % white ear heads

In Proso and Little millets the incidence of shoot fly was 10 – 15% dead hearts and at panicle stage there was severe infestation (20- 25 % white earheads)

Egg parasitoid *Trichogrammatoidea* (10 %); larval parasitoid, *Neotrichoporoides nyemitawus* (17 %) and pupal parasitoid, *Spalangia endius* (8 %) were found parasitizing shoot flies across species and millets.

Management of FAW in Sorghum using biocontrol agents (ICAR-IIMR, Warangal) – Rabi 2023-24

There was significant reduction in egg patches in T2 (0.28 nos) followed by T1 (0.75 nos) as compared to T3, control (1.25 nos). There was 53.6 and 40 % reduction in oviposition in T1 and T2 respectively over control (T3). There was significant reduction in larvae in T2 (0.28 nos) followed by T1 (0.75 nos) as compared to T3, control (2.0 nos). There was 86.0 and 62.5 % reduction in larval population in T1 and T2 respectively over control (T3).

There was significant reduction in foliar damage in T2 (1.3) and T1 (1.7) in terms of damage score over the control (2.6). The whorl damage was significantly least in T1 (11.66 %) followed by T2 (15.55 %). There was 54.9 and 39.8 % reduction in whorl damage caused by *S. frugiperda* over untreated control (T3).

Statistically there was no differences between treatments T1 and T2 for grain and fodder yields, though yield penalty of 6.82 and 2.01 % was observed in the biocontrol module (T1) in comparison to the Standard practice (T2), respectively (Table 72). The control plot yielded 2.8 and 5.93 tons/ha. of grain and fodder yield.

Table 72. Validation of bio-control module for management of fall armyworm in Sorghum (Rabi, 2023-24), Warangal, Telangana.

Treatment	Egg patches/ 20 Plants (30 DAE)ǂ	Larvae/20 Plants (45 DAE)ǂ	FAW (1-9)ǂ	Whorl damage % (45 DAE) **	Grain Yield (t/ha.)	Fodder yield(t/ha)
T1- Release of *Trichogramma pretiosum* @ 1 card/ acre, twice (first release one week of planting & second one after one week of first release + spray of *Metarhizium anisopliae (*Ma 35) 0.5 % at 20, 35 DAE	0.75 (1.31)[b]	0.75 (1.31)[b]	1.7 (1.65)[b]	11.66 (19.87)[a]	3.13[a]	6.55[a]
T2- Standard Plant protection practice (Seed treatment with Fortanzaduo 5ml/kg seed) + application of Chlorantraniprole (18.5% SL) @ 0.3 ml/L (30 DAE of this experiment)	0.58 (1.24)[a]	0.58 (1.24)[a]	1.3 (1.49)[a]	15.55 (23.00)[b]	3.35[a]	6.69[a]
T3 - Control	1.25 (1.49)[c]	2.0 (1.73)[c]	2.6 (1.88)[c]	25.86 (30.24)[c]	2.80[b]	5.93[b]
CD (0.05)	0.168	0.157	0.144	2.79	0.26	0.64
P = (0.05)	0.00	0.00	0.014	0.00	0.001	0.04
CV (%)	14.65	12.88	10.08	13.44	10.07	11.84

ǂ Figures in parentheses are square root transformed values
***** Figures in parentheses are Arc sine transformed values***
Means followed by same letter are significantly not different (p= 0.05) by LSD
DAE: Days after crop emergence

IV. 3. 2. Demonstration of BIPM module for the management of FAW on Sorghum during 2023-24

UAS, Raichur

Results: One day before treatment imposition the number of egg patches ranged from 0.84 to 0.92 per plant. Ten days after treatment imposition the BIPM module recorded 0.22 egg patches per plant, 0.68 larva per plant with 4.25 per cent plant damage while untreated control recorded 0.76 egg patches per plant, 1.02 larvae per plant with 7.51 per cent plant damage, respectively. The BIPM module recorded 11.50 q/ha grain yield while untreated control recorded 10.25 q/ha grain yield and these treatments were at par with each other (Table 73).

Table 73. Large scale demonstration of BIPM module for the management of sorghum FAW during 2023-24

Sl. No.	Treatment Details	Egg patches per plant (No.)*		Larvae per plant (No.) *		Damaged plant (%)#	Parasitisation (%)#	Grain yield (q/ha)
		IDBS	10 DAS	IDBS	10 DAS			
T_1	Biointensive module: Release of *Trichogramma chilonis* 1 lakh/ha (2 releases, first release one week of planting & second one after one week of release + spray of *Metarhizium anisopliae* NBAIR Ma 35 @ 5 ml/litre at 20 & 45 DAE	0.84 (1.16)	0.22 (0.85)	1.14 (1.28)	0.68 (1.09)	4.25 (11.90)	10.25 (18.67)	11.50
T_2	POP recommendation (Seed treatment with Fortanza duo @ 6 ml/kg of seed)	0.92 (1.19)	0.34 (0.92)	1.06 (1.25)	0.04 (0.73)	0.75 (4.97)	1.51 (7.03)	12.25
T_3	Untreated control	0.88 (1.17)	0.76 (1.12)	1.02 (1.23)	0.96 (1.21)	7.51 (15.89)	5.56 (13.56)	10.25
S Em ±		**0.08**	**0.04**	**0.03**	**0.02**	**1.18**	**1.04**	**1.15**
CD (P<0.05)		**NS**	**0.12**	**0.10**	**0.07**	**3.55**	**3.11**	**3.46**

PULSES

IV. 4. Biological control of insect pests of Chickpea

IV. 4. 1. Large scale demonstration of entomopathogenic fungi, *Metarhizium rileyi* against chickpea pod borer, *Helicoverpa armigera* during 2023-24

UAS, Raichur

Results: Ten days after spray, *M. rileyi* KK-Nr-1 (1×10^8 spores/g) @ 5 g/L recorded 0.75 larva per plant with 6.50 per cent pod damage while untreated control recorded 3.25 larvae per plant with 9.75 per cent pod damage. The treatment *M. rileyi* KK-Nr-1 KK-Nr-1 (1×10^8 spores/g) @ 5 g/L recorded 10.75 q/ha grain yield which was superior over untreated control (8.25 q/ha) grain yield (Table 74).

Table 74. Large scale demonstration of entomopathogenic fungi, *Metarhizium rileyi* against chickpea pod borer, *Helicoverpa armigera* during 2023-24

Sl. No.	Particulars	Pod borer, *H armigera* No. of larvae per plant *			Pod damage (%) #	Grain Yield (q/ha)
		1 DBS	7 DAS	10 DAS		
T_1	*Metarhizium rileyi* KK-Nr-1 (1×10^8 spores/g) @ 5 g/L	3.50 (2.00)	1.25 (1.32)	0.75 (1.12)	6.50 (14.77)	10.75
T_2	Emamectin benzoate 5 SG @ 0.2 gm/L	3.25 (1.94)	0.50 (1.00)	0.20 (0.84)	1.50 (7.03)	12.05
T_3	Untreated control	3.10 (1.89)	3.75 (2.06)	3.25 (1.94)	9.75 (18.19)	8.25
S Em ±		**0.15**	**0.04**	**0.06**	**1.01**	**0.43**
CD (P=0.05)		**NS**	**0.13**	**0.18**	**3.04**	**1.31**

*Figures in parentheses are square root transformed values

#Figures in parentheses are arcsine transformed values

IV. 4. 2. Biological suppression of chickpea pod borer *Helicoverpa armigera* and soil borne diseases of chickpea (*Fusarium* wilt, dry root rot and collar rot)

AAU, Jorhat

Results: The initial population of *Helicoverpa armigera* was varied from 4.14 -5.62 larvae/m row length. After 3 days population of *H. armigera* was not observed in chemical treatment (T3). The incidence of *Fusarium* wilt was varied from 0.028% to 0.044% and wilt symptom was observed after 30 days. The percent pod damage was significantly higher in control (42.65%) and lowest was observed in chemical control (8.17%). In treatment 2 we recorded 28.5% pod damage and in treatment 3 it was 26.18%. The number of coccinellids/5 plants were significantly higher (4/5 plants) in treatment T1 and lowest in T3. All the treatments registered significantly higher yield than control (806.5kg/ha). The maximum yield was observed in chemical control (1145.2 kg/ha) followed by seed treatment with @10g/Kg and soil application twice @5kg/ha of *Trichoderma harzianum* NBAIR strain + spraying of *Bacillus thuringiensis* NIBSM Bt 18 1% @10ml/ (1055.0 kg/ha) and pheromone traps treatment (979.5 kg/ha) with yield increase 23.55%, 29.57% and 17.66%, respectively, over control.

Table 75. Efficacy of different treatments against chickpea pod borer *Helicoverpa armigera* and soil borne diseases of chickpea

Treatments	Number of larvae/ m row length (DAT)					Disease incidence (%)			% pod damage	No. of coccinellids/5 plants	Yield (kg/ha)	Yield increase over control %)
	Pre treat count	3	7	10	15	30	60	90				
T2- Pheromones traps @ 25/ ha (NBAIR Product)	4.14	5.80	3.64	2.02	1.16	0.028	0	0	28.50	3.40	979.5	17.66
T4- Untreated control	5.44	6.72	7.20	7.8	6.36	0.042	0	0	42.65	3.80	806.5	-

T1-Seed treatment with @10g/Kg and soil application twice @5kg/ha of *Trichoderma harzianum* NBAIR strain at 25 & 50 days after sowing + Spraying of *Bacillus thuringiensis* NIBSM Bt 18 1% @10ml/L two sprays at pod initiation and pod formation stage at 15 days interval	4.78	5.06	3.28	1.64	1.08	0.044	0	0	26.18	4.00	1055	23.55
T3- POP recommendation (application of Chlorantraniliprole 18.5 SC@ 0.3 ml/L)	5.62	2.88	0	0	0	0.036	0	0	8.17	0,60	1145.2	29.57
CD (0.05)	NS	2.93	2.36	1.76	1.95	NS			3.17	3.43	123.82	

IV. 4. 3. Biological suppression of pod borer, *Helicoverpa armigera* infesting chickpea

MPUAT, Udaipur

Results: The maximum *H. armigera* population reduction was recorded in Novaluron treatment (2.0 larvae per plant) and the minimum reduction was observed with (3.21 larvae per plant) at ten days after spray; whereas, the untreated control recorded least reduction in larval population (5.95 larvae per plant) at ten days after spray. Minimum per cent pod damage was recorded in treatment of Novaluron (8.95 %) and maximum was in Pheromone traps @ 3-5/ ha (17.8%). The highest grain yield obtained in Novaluron treatment (19.10 t/ha) and lowest yield was recorded in untreated control (6.98 t/ha). It could be concluded that biopesticides had promising results in minimizing the pest damage with higher yield.

Table 76. Effect of different treatments on population of *H. armigera* and pod damage of chickpea during *Rabi*, 2023-24

Treatments	Larval count (mean no plant^{-1})					Pod damage (%)	Yield (qha^{-1})
	PTP	3 DAS	7 DAS	10 DAS	15 DAS		
Pheromone traps @ 3-5/ ha + Border crop + mustard, Intercrop Intercrop mustard (border crop)	4.25 (2.11)*	3.97 (2.11)	3.69 (2.05)	3.21 (1.93)	3.74 (2.06)	17.80 (22.63)	9.14
Beauveria bassiana NBAIR Bb5a @ 1×10^8 spore/gm @ 5gm/L/	4.10 (2.14)	3.92 (2.10)	3.5 (2.00)	3.1 (1.90)	3.8 (2.07)	16.24 (22.16)	9.71
Bacillus thuriengiensis NBAII *Bt*G4 2%) @ 2 ml/lit	3.80 (2.07)	3.52 (2.00)	3.21 (1.93)	2.7 (1.79)	3.21 (1.93)	13.16 (19.36)	12.12
Spray of HaNPV NBAIR1 (1.5 × 10^{12} OBs/ha)	3.95 (2.11)	3.39 (1.97)	3.10 (1.90)	2.5 (1.73)	3.50 (2.00)	10.95 (19.32)	12.59
Novaluron 10% EC @ 700ml/ha	4.95 (2.11)	3.0 (1.86)	2.5 (1.73)	2.0 (1.53)	3.12 (1.90)	8.95 (17.41)	19.10
Untreated control	5.10 (2.10)	4.95 (2.33)	5.41 (2.43)	5.95 (2.54)	6.84 (2.71)	30.58 (33.56)	6.98
CD(at 5 %)	NS	0.405	0.277	0.266	0.283	1.508	1.013

***Figures in parenthesis are square root transformed value**

KSNUAHS, Shivamogga

Table 77. Biological suppression of pod borer, *Helicoverpa armigera* infesting chickpea

Treatments	Mean number of larvae per meter row length							% Damage pod	No. of Coccinellids/5 plants	Yield (kg/ha)
	1st Spray				2nd Spray					
	Pre Treatment	3DAS	7 DAS	15 DAS	3 DAS	7 DAS	15 DAS			
T1: *Bacillus thuringiensis* NIBSM Bt 18 1% @10ml/L	6.4	5.2	3.6	0.8	4.6	2.4	0.6	22.46	4.6	1262.8
T2: Pheromones traps @ 25/ ha (NBAIR Product)	6.8	6.0	4.2	1.4	4.8	3.2	2.0	28.38	3.4	982.4
T3: POP recommendation (Quinalphos 25EC @250g a.i/ha – recommended newer generation biorational insecticide may be incorporated)	5.2	3.6	1.6	0.0	2.8	1.4	0.2	8.66	0.0	1364.2
T4:Untreatedd control	6.0	6.4	7.2	5.4	5.6	6.2	5.4	48.28	2.4	743.6
SEM	0.05	0.31	0.19	0.26	0.35	0.25	0.03	1.84	1.20	34.54
CD	NS	0.94	0.57	0.79	1.17	1.06	0.12	2.73	3.62	114.6

Results: The initial population of *Helicoverpa armigera* was varied from 5.2-6.8 larvae/m row length. After 15 days of treatment, population of *H. armigera* was significantly lower in all the treatments. In chemical treated plots, no larvae were observed at 15 days after application. The percent pod damage was significantly higher in control (48.28%) followed by pheromone traps @25 per ha (28.38%) and spraying of *Bacillus thuringiensis* NIBSM Bt 18 1% @10ml/L two sprays at pod initiation and pod formation stage at 15 days interval (22.46%) and lowest was observed in chemical treatment (8.66%) where as the number of coccinellids/5 plants were significantly higher (4/5 plants) in treatment T1 and lowest in T3. All the treatments showed significantly higher yield than control (743.6 kg/ha). The maximum yield was recorded in chemical control (1364.2 kg/ha) followed by spraying of *B. thuringiensis* NIBSM Bt18 1% @ 10ml/L (1262.8kg/ha) and pheromone traps treatment (982.4 kg/ha).

IV. 5. Biological control of insect pests of Cowpea

IV. 5. 1. Evaluation of entomopathogens against cowpea sucking pests

KAU, Vellayani

The experiment was carried out during September to December 2023 at Thumba, under Kadinamkulam Krishibhavan in an area of 50 cents (0.20 ha) using hybrid cowpea variety Polo. Experiment was laid out in RBD with 3 treatments replicated 7 times. Unit plot size was 80 m^{2}. Treatments evaluated werechitin enriched oil formulation of *L. saksenae* (KAU isolate), thiamethoxam 25 WDG 2g/10L and the untreated check.

Table 78. Effect of improved formulations of *Lecanicillium saksenae* in the management of sucking pests of cowpea (Results of two year experiment – Pooled mean of 22-23 and 23-24)

Treatments	No.of aphids/15 cm twig/plant			No.of pod bugs /plant		Per cent reduction over control	Yield (Kg/ha)	Percent yield increase over control
	Pre-treatment count	Post Treatment count	Per cent reduction over control	Pre treatment	Post treatment			
T1- Chitin enriched oil formulation of *L. saksenae*	59.21	0 (0.70)	100	5.71 (2.37)	0 (0.70)	100	75.18	36.69
T2-Thiamethoxam 25 WDG 2gm/10L	(6.64)	2.51 (1.08)	89.23	7.0 (2.62)	0.42 (0.91)	82.12	69.15	25.72
T3- Control	102.96	23.31 (4.61)	-	6.85 (2.56)	2.35 (1.59)	-	55.00	-
CD (0.05%)	(9.0)	0.82	-	**NS**	(0.30)	**-**	**5.86**	**-**
CV	98.2	49.39	-	13.92	37.11	-	11.36	

One week after the first spraying the mean population of aphids was on par in *L. saksenae* treated plot and thiamethoxam treated plots, (Table 78). Thereafter, chitin enriched oil formulation of *L. saksenae* was the best treatment to manage aphid population. Results were more or less similar in the population of pod bug, though thiamethoxam was the superior treatment after the first spraying, *L. saksenae* out performed it after the second application (Table 78). The mean population of natural enemies including coccinellids and spiders was found to be significantly high in *L. saksenae* treated plots (20.85) compared to that in thiamethoxam treated plots (13.42). More over the average yield per plot was significantly high (75.18 kg) in plots treated with chitin enriched *Lecanicllium* treatment compared to chemical treatment (69.15 kg)

Pooled analysis of data of two years was summarised and presented in Table 78. One week after the first spray the mean population of aphids was on par in *L. saksenae* treated plot and thiamethoxam treated plots**.** Thereafter, chitin enriched oil formulation of *L. saksenae* was the best treatment to manage aphid population. Results were more or less similar in the population of pod bug, though thiamethoxam was the superior treatment after the first spray, *L. saksenae* out performed it after the second application (The mean population of natural enemies including coccinellids and spiders was found to be significantly high in *L. saksenae* treated plots (20.85) compared to that in thiamethoxam treated plots (13.42). Moreover, the average yield per plot was significantly high (75.18 kg) in plots treated with chitin enriched *Lecanicllium* treatment compared to chemical treatment (69.15 kg)

KAU, Kumarakom

The mean observation of 2 sprays on number of pod bugs (**Table 79**) revealed that there is no significant difference in number of pod bugs among the three treatments at different intervals after first and second spray except 3rd day after first spray. Even though the variation in population of pod bug was not significantly different among the treatments, lowest count was noticed in plots treated with *Lecanicillium saksenae* at 7 days after second spray. Analysis of yield data revealed that, there was no significant difference in yield among the treatments, but highest yield was recorded in plot treated with Dimethoate 30 EC (5.06 kg/plot). **Table 80** reveals the effect of biopesticide on population of *A. craccivora* in cowpea. Significant reduction in population of cowpea aphids was noted one week after treatment, wherein maximum reduction in population of aphids was noted in Dimethoate 30 EC treated plots. The population of aphids in plots treated with *L. saksenae* and Dimethoate 30 EC were found to be on par but significantly superior over untreated plots on different intervals after first and second spraying.

Table 79. Evaluation of entomopathogens against cowpea pod bug

Treatment	No. of pod bugs (*Riptortus pedestris*) per plot							Yield (kg/ plot)	Yield increase over control (%)
	Pre-count	3 DAS1	7 DAS1	10 DAS1	3 DAS2	7 DAS2	10 DAS2		
T1: *Lecanicillium saksenae* KAU ITCC7714 (1×10^8cfu/ml) @5ml/L	4.00 (1.14)	2.71 (1.10)a	3.57 (1.12)	1.29 (1.04)	1.86 (1.07)	0.86 (1.03)	1.29 (1.04)	4.25	7.32
T2: Dimethoate 30 EC 2 ml/L (KAU recommendation) two sprays at 15 days interval when the pest reaches ET	4.43 (1.15)	0.86 (1.03)a	1.71 (1.06)	1.14 (1.04)	1.29 (1.04)	1.43 (1.05)	1.00 (1.03)	5.06	27.77
T3: Untreated control	5.14 (1.18)	3.29 (1.12)b	2.14 (1.08)	2.14 (1.08)	3.00 (1.114)	1.71 (1.06)	1.14 (1.04)	3.96	
CD (0.05%)	NS	0.03	NS	NS	NS	NS	NS	NS	
CV	3.72	2.38	6.40	5.46	4.92	3.35	4.13	33.81	

DAS – Days after spraying Figures in parentheses are logarithmic transformed values

Table 80. Evaluation of entomopathogens against cowpea aphids (*Aphis craccivora*)

Treatment	No. of cowpea aphids (*Aphis craccivora*) per plant							Yield (kg/ plot)	Yield increase over control (%)
	Precount	3 DAS1	7 DAS1	10 DAS1	3 DAS2	7 DAS2	10 DAS2		
T1: *Lecanicillium saksenae* KAU ITCC7714 (1×10^8cfu/ml) @5ml/L	298.29 (17.00)	222.55 (14.58)[a]	40.21 (5.85)[b]	5.51 (2.10)[c]	14.86 (3.34)[b]	5.51 (1.66)[b]	4.94 (1.78)[b]	4.25	7.32
T2: Dimethoate 30 EC 2 ml/L (KAU recommendation) two sprays at 15 days interval when the pest reaches ET	245.81 (15.43)	50.52 (6.63)[b]	17.68 (3.74)[b]	41.81 (5.09)[b]	10.01 (2.39)[b]	8.83 (2.64)[b]	14.60 (2.57)[b]	5.06	27.77
T3: Untreated control	297.78 (17.08)	295.66 (16.99)[a]	291.95 (16.84)[a]	264.2 (16.08)[a]	196.23 (13.71)[a]	179.73 (12.99)[a]	144.90 (11.88)[a]	3.96	
CD (0.05%)	NS	3.88	3.41	3.09	2.92	2.64	2.77	NS	

Treatment	No. of cowpea aphids (*Aphis craccivora*) per plant							Yield (kg/plot)	Yield increase over control (%)
CV	20.84	26.21	33.35	32.95	38.74	39.35	43.95	33.81	

DAS – Days after spraying; Figures in parentheses are square root transformed values

MPKV, Pune

The experiment was laid out at All India Coordinated Research on Biocontrol Farm, Entomology Section, College of Agriculture, Pune. The cowpea variety "PhuleVithai" was sown in plot size 5.00 × 4.00 m with 45 ×10 cm spacing in randomized block design with seven treatments replicated three times. Population of aphids recorded on five terminal shoots per plants, five plants were randomly selected per treatment. Pre count and post count at 10 days after spraying were recorded. Finally yield was recorded as kg/plot and expressed asqt/ha.

Table 81. Efficacy of entomopathogenes against cowpea aphids after two sparys

Treatment details	Dose (g or ml/lit)	No. of aphids/shoot/plant (Mean of 2 sprays)					Yield (Qt/ha)
		Pre count	3 DAS	7 DAS	10 DAS	Overall mean	
T1:*Beauveria bassiana* NBAII Bb5a @ 1×10^8 spores	5.00	46.06 (6.86)	46.61 (6.90)	48.89 (7.06)	46.89 (6.92)	47.46 (6.96)	9.24
T2: *Metarhizium anisopliae* NBAII Ma4 (1×10^8 spores/g)	5.00	50.42 (7.17)	40.52 (6.44)	36.87 (6.15)	30.65 (5.63)	36.01 (6.08)	10.89
T3: *Lecanicillium lecanii* NBAIIVl8 (1×10^8 cfu/ml)	5.00	49.86 (7.13)	35.24 (6.02)	31.48 (5.70)	24.84 (5.08)	29.86 (5.55)	11.78
T4: *Lecanicillium saksenae* KAU ITCC7714 (1×10^8 cfu/ml) @ 5ml/L	5.00	44.52 (6.75)	34.08 (5.92)	30.61 (5.62)	24.88 (5.09)	30.52 (5.61)	11.35
T5: Thiamethoxam 50 WP	0.20	51.32 (7.23)	27.93 (5.38)	20.81 (4.67)	16.28 (4.16)	21.68 (4.76)	13.68
T6: Azadirachtin 3000 PPM	2.00	50.39 (7.17)	41.04 (6.48)	35.15 (6.01)	30.96 (5.65)	35.71 (6.06)	10.24
T7: Untreated control	-	48.50 (7.04)	59.89 (7.80)	60.14 (7.82)	57.84 (7.67)	59.29 (7.76)	8.15
SE±		N.S.	0.15	0.11	0.17	0.09	1.01
CD at 5%		1.16	0.47	0.35	0.53	0.26	3.10
CV		9.30	4.15	7.47	12.15	5.65	16.19

***Figures in parenthesis are $\sqrt{x+1}$ transformed values**

Results: Data presented in the Table 81 revealed that precount population of aphids was statistically non-significant. While two sprays of *L. lecanii* NBAIIVl8 (1×10^8 cfu/ml) @ 5.00 g/L at fortnightly interval found superior in suppressing aphid population (29.86 aphids/shoot/plant) with 11.78 qt/ha yield and it was at par with *L. saksenae* KAU ITCC7714 (1×10^8 cfu/ml) @ 5ml/L (30.52 aphids/shoot/plant) and 11.35 qt/ha yield.

SKUAST, Jammu

Lecanicillium saksenae KAU (1 × 10^8 cfu/ml) @ 5 ml/L (Treatment 1) recorded significantly lowest aphid (36.23 aphids per 10 cm terminal shoot) and pod bug (3.18 bugs per 10 cm terminal shoot) incidence, that was comparable to Thiamethoxam 25 WG @ 1g/l Treatment 2 (37.18 aphids and 3.90 pod bugs per 10 cm terminal shoot, respectively). Grain yield was also comparable in both the treatments (9.24 q/ha and 9.37 q/ha, respectively in treatment 1 and 2) that was significantly higher as compared to control (7.46 q/ha).

Table 82. Pre and Post spray count of cowpea aphid nymphs and adults

Treatments	Pre spray count	Post spray count (mean no. per 10 cm terminal shoot)		
		3 DAS	7 DAS	10 DAS
T1 - *Lecanicillium saksenae* KAU (1 × 10^8 cfu/ml) @ 5 ml/L	75.62 (60.41)	67.81 (55.43)	49.37 (44.64)	36.23 (37.00)
T2 - Thiamethoxam 25 WG @ 1g/ L	78.91 (62.66)	32.37 (34.68)	30.16 (33.31)	37.18 (37.57)
T3 - Untreated Control	78.14 (62.12)	76.74 (61.17)	80.82 (64.03)	82.17 (65.02)
CD at 5%	(N.S.)	(1.673)	(1.896)	(2.09)

Figures in parenthesis are square root transformed values; DAS – Days After Spray

Table 83. Pre and Post spray count of cowpea pod bug nymphs and adults

Treatments	Pre spray count	Post spray count (mean no. per 10 cm terminal shoot)			Grain Yield (Q / ha)
		3 DAS	7 DAS	10 DAS	
T1 - *Lecanicillium saksenae* KAU (1 x 10^8cfu/ml) @ 5 ml/L	7.51	6.21	3.97	3.18	9.24
T2 - Thiamethoxam 25 WG @ 1g/ L	8.11	3.89	3.24	3.90	9.37
T3 - Untreated Control	6.98	7.17	7.32	7.66	7.46
CD at 5%	N.S.	1.49	1.81	1.16	1.01

DAS – Days After Spray

IV. 6. Biological control of insect pests of Grenngram

IV. 6. 1. Evaluation of different entomopathogens against spotted pod borer, *Maruca vitrata in* greengram

ANGRAU, Anakapalle

Spotted pod borer, *Maruca vitrata* incidence and pod damage was significantly low in *Bacillus thuringiensis* NBAIR Bt G4 2% @ 10 ml/ lit (0.74 larvae/plant and 9.6% pod damage) as three sprays from pre flowering resulted in higher grain yield (524.28 q/ha) compared to POP recommendation (Azadirachtin 1% 1500 ppm @ 2 ml/L+ Chlorpyriphos @ 2.5 ml/L+ Acephate @ 1.5 g/L) (0.54 larvae /plant, 8.6% pod damage and 544.11 q/ha yield) **(Table 84).**

Table 84. Evaluation of entomopathogens against spotted pod borer in greengram

Treatment	Number of larvae / plant	Pod damage %	Grain Yield kg/ha
T1: *Bacillus thuringiensis* NBAIR Bt G4 1% @ 10 ml/ lit	0.74 (4.877)	9.6	524.28
T2- POP recommendation (Azadirachtin 1% 1500 ppm @ 2 ml/L+ Chlorpyriphos @ 2.5 ml/ L+ Acephate @ 1.5 g/L)	0.54 (4.165)	8.6	544.11
T3-Untreated Control	1.2 (6.27)	25.8	347.82
CD (0.05)	1.004	4.056	121.33
CV%	13.486	18.96	17.63

Bt: *Bacillus thuringiensis;* Values in parenthesis are arc sin transformed values

AAU, Anand

Results: The significantly lowest larval population was documented in the treatment T_1- *Bacillus thuringiensis* NBAIR BtG4 2% (8.74 larvae/meter row length) which was statistically at par with the treatment T_2 - POP recommendation (Azadirachtin 1% 1500 ppm) (9.55 larvae/meter row length). The treatment T_1 -*Bacillus thuringiensis* NBAIR BtG4 2% showed highest per cent pest reduction over control (47.22%) as compared to treatment T_2 (42.33%). Further, treatment T_1 recorded the significantly lowest pod damage (3.64%) as compared to treatment T_2 5.64%. Due to significant low pod damage in T_1 recorded the significantly highest yield (18.57 q/ha) as compared to treatment T_2 (16.14 q/ha). The highest (96.92%) increase in yield over untreated control was obtained in the treatment T_1.

Table 85. Evaluation of different entomopathogens against spotted pod border, *Maruca vitrata* in green gram during 2023-24

Treatments	No. of larvae/ meter row length		Pest reduction over control (%)	Pod damage (%)	Yield (q/ha)	Yield increase over control (%)	B:C Ratio
	BS	Pooled over Sprays					
T1: *Bacillus thuringiensis* NBAIR *Bt*G4 2% @ 10 ml/lit	3.77* (13.71)	3.04[a] (8.74)	47.22	11.00**[a] (3.64)	18.57[a]	96.92	4.08
T2: POP recommendation (Azadirachtin 1% 1500 ppm) @ 2 ml/L	3.61 (12.53)	3.17[a] (9.55)	42.33	13.74[b] (5.64)	16.14[b]	71.16	3.78
T3: Untreated control	3.80 (13.94)	4.13[b] (16.56)	-	20.61[c] (12.39)	9.43[c]	-	-
S. Em.± (T)	0.22	0.07	-	0.43	0.70	-	-
C.D. at 5%	NS	0.20	-	1.25	2.14	-	-
C. V. (%)	15.26	13.73	-	11.04	12.51	-	-

Note: *Figures are $\sqrt{x + 0.5}$ transformed values whereas those in parentheses are retransformed values; **Figures outside the parentheses are arcsine transformed values, those inside are retransformed values, NS = Non –significant, BS: Before Spray

SKUAST, Jammu

Bacillus thuringiensis NBAIR-BtG4 2% @ 10 ml/L (treatment 1) recorded significantly lowest pod damage by spotted pod borer, *Maruca vitrata* (14.83%), while in untreated control it was 21.66%. Number of larvae per meter row length was also lowest in treatment 1 (2.19 larvae/m), that was at par with Azadirachtin1% 1500 ppm @ 2 ml/L (2.34). Accordingly, the grain yield was highest in treatment 1 (12.24 q/ha), while in control it was 8.42 q/ha.

Table 86. Percent pod damage, number of larvae and grain yield of greengram

Treatments	Pod damage (%)	No. of larvae / m row length	Grain Yield (q/ha)
T1 - *Bacillus thuringiensis* NBAIR-BtG4 2% @ 10 ml/L	14.83 (22.65)	2.19	12.24
T2 - Azadirachtin1% 1500 ppm @ 2 ml/L	16.92 (24.29)	2.34	10.86
T3 - Untreated Control	24.34 (29.56)	3.87	8.42
CD at 5%	(1.68)	0.32	1.13

Figures in parenthesis are arc-sine transformed values; DAS – Days After Spray

IV. 6. 2. Evaluation of entomopathogen and azadirachtin against spotted pod border, *Maruca vitrata* in greengram

Results: *Bacillus thuringensis* NBAIR *Bt*G4 2% @ 1 ml/litre was significantly better than Azadirachtin 1% 1500 ppm @ 2 ml/L throughout the period of observation (Table 87). Only 0.74 larva was observed in Bt plot compared to 0.97 in Azadiractin and 1.31 in control plots, 10 days after first spray. Reduction in pod damage was observed to the tune of 16.62 and 7.28% in *B. thuringensis* NBAIR *Bt*G4 2% @ 1 ml/litre and Azadirachtin 1% 1500 ppm @ 2 ml/L, respectively. Significantly higher yield was recorded in NBAIR BtG4 2% @ 1ml/litre treated plot (418.28 kg/ha) with a CB ratio of 1.33 (Table 87).

TNAU, Coimbatore

Table 87. Effect of entomopathogen and Azadirachtin on spotted pod borer, *Maruca vitrata*

Treatments	Population of Larva* (Nos./ meter row length)			Pod damage**		Yield (kg/ ha)	CB ratio
	Pre count	First Spray 10 DAS	Second Spray 10 DAS	Affected Pods (%)	% reduction over control		
T1: *Bacillus thuringiensis* NBAIR *Bt*G4 2% @ 1 ml/litre	1.06 (1.025)	1.03 (1.014)[a]	0.74 (0.86)[a]	7.62 (16.020[a]	16.62	418.28 (20.45)[a]	1.33
T2: Azadiractin 1% 1500 ppm @ 2 ml/litre	1.14 (1.023)	1.23 (1.11)[b]	0.97 (0.99)[b]	8.47 (16.92)[b]	7.28	404.22 (20.10)[b]	1.32
T3: Untreated control	0.86 (0.921)	1.34 (1.16)[c]	1.31 (1.15)[c]	9.14 (17.59)[c]		325.06 (18.03)[c]	1.25

CD (0.05)	NS	0.015	0.010	0.428		0.122	
SED		0.007	0.005	0.173		0.058	

DAS-Days After Spray
*** Figures in parentheses are square root transformed values**
**** Figures in parentheses are arcsine transformed values**
In a column means followed by same letter(s) are not significantly different (p=0.05) by LSD
Values are mean of 7 replications

IV. 7. Biological control of insect pests of Redgram

IV. 7. 1. Evaluation of bio-control agents against pod borers in redgram

KSNUAHS, Shivamogga

Results: The initial Population of pod borer was varied from 6.8-7.2, significantly minimum per cent pod damage of 6.2% in insecticidal sprays followed by the Bt treatment (T1) with 15.8% pod damage and both the treatments were significantly superior compared to untreated control 48.6% damage. Maximum yield (1742.36 kg/ha) was recorded in T2 followed by T1 (1658.28 kg/ha) and both treatments were at par with each other and significantly superior over untreated control.

Table 88. Evaluation of bio-control agents against pod borers in Redgram

Treatments	Mean number of larvae per meter row length										% Damage pod	Yield (kg/ha)
	1st Spray				2nd Spray			3rd Spray				
	Pre Treat-ment	3DAS	7DAS	15DAS	3DAS	7DAS	15DAS	3DAS	7DAS	15DAS		
T1: *Bacillus thuringiensis* (NBAIR BtG4 2%) @ 10 ml/L	7.2	4.8	3.2	1.2	4.2	2.6	0.4	3.8	1.8	0.4	15.8	1658.28
T2: POP recommendation (Chlorantraniliprole 18.5% SC@ 0.4 ml/lit)	6.8	3.6	1.4	0.2	2.8	0.6	0.0	2.2	0.8	0.0	6.2	1742.36
T3: Untreated control	7.0	5.6	6.4	5.8	6.4	7.6	5.2	5.0	5.8	4.0	48.6	948.32
SEM	0.08	0.05	0.03	0.11	0.08	0.51	0.41	0.05	0.37	0.44	1.20	43.23
CD @ 5%	NS	0.15	0.90	0.41	0.26	1.61	1.24	0.15	1.08	1.33	3.60	129.88

COMMERCIAL CROPS

IV. 8. Biological control of insect pests of Cotton

IV. 8. 1. Large scale evaluation of biointensive management of pink bollworm on *Bt* cotton during 2023-24

UAS, Raichur

Results: The per cent rosette flower in T_1 was 5.18 while in untreated control it was 9.28 per cent. The number of PBW larvae in T_1 was 6.24 larvae per 10 bolls while in untreated control it was 10.54. Good opened bolls and bad opened bolls in T_1 was 28.54 and 13.56 while in untreated control it was

20.04 and 17.36, respectively. Per cent locule damage in T_1 was 22.54 while in untreated control it was 29.62 per cent. Seed cotton yield 20.94 q/ha was noticed in T_1 while in untreated control it was 18.24 q/ha (Table 89).

Table 89. Large scale evaluation of biointensive management of pink bollworm on *Bt* cotton during 2023-24

Sl. No.	Treatment Details	Rosette flowers % *	PBW larvae per 10 bolls	GOB /plant	BOB /plant	Locule damage (%)	Seed cotton yield (q/ha)
1.	**T_1:** 1. Erection of Pheromone Traps (Funnel type) @ 20/acre 2. Release of *T. bactrae* @ 100000/ ha 6-8 releases from 55 DAS 3. Application of azadiractin 1500 ppm @ 2 ml/lit	5.18 (13.16)	6.24 (2.60)	28.54 (5.39)	13.56 (3.75)	22.54 (28.34)	20.94
2.	**T_2:** 1. Profenophos 50 EC @ 2.0 ml/lt at 70 DAS 2. Thiodicarb 75 wp @ 1.0 gm/lt at 90 DAS 3. Lamda cyhalothrin 5 EC @ 0.5 ml/lt @ 110 DAS	2.36 (8.84)	4.06 (2.14)	34.08 (5.88)	9.62 (3.18)	11.18 (19.53)	23.56
3.	**T_3:** Untreated Control	9.28 (17.74)	10.54 (3.32)	20.24 (4.55)	17.36 (4.23)	29.62 (32.97)	18.24
S Em ±		**0.35**	**0.13**	**0.18**	**0.15**	**0.41**	**0.68**
CD (P=0.05)		**1.06**	**0.31**	**0.65**	**0.46**	**1.24**	**2.05**

Figures in parentheses are square root transformed values

*Figures in parentheses are arcsine transformed values

PJTSAU, Hyderabad

The trial conducted in the farmers field of Cheryal village of Siddipeta District, Telangana State during Kharif 2023-24 in an area of 1200 sq.m., with 3 treatments (including unsprayed control) in three blocks (400 sq.m) and data collected from 15 randomly selected quadrates (served as replications) from each block subject to RBD on Bt Cotton crop var.BG II US seed 7067 sowed on 28-06-2023. Data collected after imposing the following BIPM package.

Table 90. Large scale evaluation of Bio-intensive Management of Pink Bollworm on Bt Cotton

Treatment	No.of rosette flowers/plant	Percent Reduction over control	Percent infested bolls Infested bolls /plot	Percent Reduction over control	Yield (q/ha.)	Percent Increase over control
BIPM	5.28 (12.7)	31.69	15.77 (26.0)	18.80	31.00	63.15
Farmers practice	5.03 (12.39)	34.93	15.48 (22.23)	20.29	34.50	81.57
Control	7.73 (15.59)	-	19.42 (22.43)	-	19.00	-
SEM	1.11	-	1.72	-	-	-
SED	1.57	-	2.44	-	-	-
CD (5%)	3.22	-	5.00	-	-	-
CV	11.61	-	10.37	-	-	-

The result depicted in the table 90 reveals that the BIPM practices recorded less rosette flowers 5.28 percent, infested bolls 15.27 percent and more yield 63.15 percent Q/ha. When compared with untreated control 7.73 percent, 19.42 percent and 19 Q/ha., respectively and there is no significant difference between farmers practice in terms of percent rosette flowers (5.03%) and infested bolls (15.48%).

PAU, Ludhiana

Each treatment plot was divided into 10 units (each unit representing one replication). The isolation distance of 100 m was kept between BIPM and control plots. The data on various parameters of pink bollworm damage was recorded based on rosette flowers (at weekly intervals), green boll damage (90, 120 and 150 DAS), open boll and locule damage (at harvest) and seed cotton yield (at harvest).

Overall, the damage of pink bollworm based on rosette flowers (Table 91) in BIPM (1.20 %) was significantly less than untreated control (3.00 %). Similarly, significantly lower green boll damage was recorded in BIPM field in all the observations recorded at 90, 120 and 150 DAS as compared to untreated control (Table 2). Both BIPM (2.40 %) and chemical control (1.30 %) fields recorded relatively less open boll damage than untreated control (4.90 %) Similar observations were recorded for locule damage also (Table 2). Significantly higher yield was recorded in chemical control (9.29 q/ha) followed by BIPM (8.60 q/ha). However, lowest yield was recorded in untreated control (7.11 q/ha).

Table 91. Effect of BIPM on rosette flower damage by pink bollworm in *Bt* cotton during 2023

Dates	Rosette flowers (%)		
	BIPM	Chemical control	Untreated control
6.7.2023	0.00	0.00	0.00
14.7.2023	0.00	0.00	0.00
21.7.2023	0.00	0.00	0.00
28.7.2023	1.74	0.00	3.66
3.8.2023	1.30	0.00	3.55
10.8.2023	1.96	0.00	3.49
17.8.2023	3.90	0.80	6.12
24.8.2023	2.20	0.90	5.90
31.8.2023	2.32	0.00	4.80
7.9.2023	0.00	0.66	4.56
14.9.2023	1.00	0.00	1.56
21.9.2023	0.00	0.00	2.40
Mean	1.20 (1.30)	0.20 (0.83)	3.00 (1.87)
LSD (p=0.05)	(0.22)		
CV %	16.34		

Table 92. Effect of BIPM on boll damage by pink bollworm and seed cotton yield of *Bt* cotton during 2023

Treatments	Green boll damage (%)			Open boll damage (%)	Loculi damage (%)	Seed cotton yield (q/ha)
	90 DAS	120 DAS	150 DAS			
BIPM module	1.00 (1.22)	2.30 (1.67)	1.90 (1.55)	2.40 (1.70)	1.40 (1.38)	8.60
Chemical control	0.70 (1.10)	1.30 (1.34)	1.00 (1.22)	1.30 (1.34)	0.80 (1.14)	9.29
Untreated control	3.00 (1.87)	3.90 (2.10)	3.80 (2.07)	4.90 (2.32)	2.80 (1.82)	7.11
LSD (p=0.05)	(0.26)	(0.33)	(0.24)	(0.27)	(0.20)	0.80
CV (%)	17.80	14.19	11.24	11.29	15.68	5.09

DAS- Days after sowing; Figures in parentheses are square root transformed values

Fig 27. Large scale evaluation of biointensive management of pink bollworm on *Bt* cotton at village Khiali Chahihanwali (District Mansa) during 2023-24

IV. 8. 2. Evaluation of efficacy of entomofungal pathogens and botanicals for the management of sucking pests in cotton (UAS Raichur; TNAU Coimbatore; AAU Anand, ANGRAU Anakapalle; PJTSAU Hyderabad; PDKV Akola)

UAS, Raichur

Results: The average leafhopper population ranged from 16.32 to 17.18 per plant at a day before spray. After final spray the population reduction in leafhopper over control was 59.84 per cent was noticed in *L. leccani* (ICAR-NBAIR-VL-8) 1×10^8 @ 5 gm/l. Similarly thrips and aphid population reduction over control was 55.92 and 64.94 per cent, respectively was noticed in *L. leccani* (ICAR-NBAIR-VL-15) 1×10^8 @ 5 gm/l. Highest seed cotton yield 18.42 q/ha was noticed in *L. leccani* (ICAR-NBAIR-VL-8) 1×10^8 @ 5 gm/l and it was superior over untreated control (Table 93).

Table 93. Evaluation of efficacy of entomofungal pathogens for the management of sucking pests in *Bt* cotton during 2023-24

Sl. No.	Treatment Details	Dosage (g/l)	No. of leafhoppers/plant				No. of thrips/plant				No. of aphids/plant				Seed cotton yield (q/ha)
			IDBS	3DAS	7 DAS	ROC (%)	IDBS	3DAS	7 DAS	ROC (%)	IDBS	3DAS	7 DAS	ROC (%)	
T_1	*Lecanicillium leccani* (ICAR-NBAIR-VL-8)	1×10^8 @ 5gm/l	16.32 (4.10)	8.04 (2.92	5.46 (2.44)	59.84 (50.67)	10.46 (3.31)	4.46 (2.23)	3.68 (2.04)	55.92 (48.40)	13.54 (3.75)	5.58 (2.47)	4.28 (2.19)	64.94 (53.69)	18.42
T_2	Spiromesifen 240 SC	0.3 ml/ lit	17.18 (4.20)	5.16 (2.38	3.28 (1.94)	74.89 (59.93)	11.28 (3.43)	3.14 (1.91)	2.84 (1.83)	67.62 (55.32)	12.82 (3.65)	4.16 (2.16)	3.76 (2.06)	71.83 (57.95)	21.68
T_3	Untreated control	-	16.86 (4.17)	17.24 (4.21	16.32 (4.10)	0.00 (0.00)	10.04 (3.25)	10.62 (3.33)	7.04 (2.75)	0.00 (0.00)	13.18 (3.70)	14.28 (3.84)	13.84 (3.79)	0.00 (0.00)	16.12
S Em ±			**0.18**	**0.03**	**0.05**	**-**	**0.34**	**0.08**	**0.04**	**-**	**0.15**	**0.07**	**0.03**	**-**	**0.63**
CD (P=0.05)			**NS**	**0.10**	**0.16**	**-**	**NS**	**0.25**	**0.13**	**-**	**NS**	**0.21**	**0.11**	**-**	**1.91**

***Figures in parentheses are square root transformed values**

#Figures in parentheses are arcsine transformed values

PJTSAU, Hyderabad

The trial conducted in the farmers field of Cheryal village of Siddipeta District, Telangana State during Kharif 2023-24 in an area of 800 sq.m., with 3 treatments (including unsprayed control) and 7 replications laid out in RBD (Randomized Block Design) on 26-06-2023 on Bt Cotton crop var.BG II Rasi-Magna. The following treatments were imposed twice with 7 days interval and data collected at every 3rd & 7th day after spraying.

Table 94. Evaluation of efficacy of Entomo-fungal pathogens and botanicals for the management of sucking pests in cotton

Treatment	Population of Hoppers / plant			Population of Aphids / plant			Population of Thrips/plant			Population of Whiteflies/plant			Yield Q/ha	Yield increase over control (%)
	Pre Treatment count	Post Treatment	% reduc. over control (%)	Pre Treatment count	Post Treatment	% reduc. over control (%)	Pre Treatment count	Post Treatment	% reduc. over control (%)	Pre Treatment count	Post Treatment	% reduc. over control (%)		
T1: *L. lecanii* VL 8 @5g/L	10.7 (3.3)	7.92 (2.89)	23.73	4.08 (2.09)	2.54 (1.73)	36.84	2.85 (1.77)	2.40 (1.70)	29.52	3.11 (1.94)	2.45 (1.70)	20.49	26.87	43.33
T2: Acetamiprid 20% SP @0.2G/L	10.8 (3.3)	5.45 (2.43)	45.21	3.77 (2.02)	1.80 (1.51)	47.12	2.82 (1.8)	1.89 (1.54)	14.28	2.91 (1.79)	1.65 (1.46)	39.13	28.12	50.00
CV	10.2	13.64		11.68	16.88	-	10.91	17.63	-	10.05	18.04	-	-	-

T3: Untreat. Control	11.3 (3.4)	12.01 (3.52)		3.85 (2.05)	4.18 (2.15)	-	3.14 (1.87)	3.15 (1.90)	-	3.22 (1.9)	2.88 (1.82)	-	18.75	-
CD (0.05%)	0.5	0.84		0.52	0.64	-	0.43	0.64	-	0.41	0.63	--	-	-
SEM	0.16	0.27		0.17	0.21	-	0.14	0.2	-	0.13	0.2	-	-	-

Results: In the given table 94, application of *L. lecanii* VI 8 @ 5 g/L of water and Acetamiprid 20% SP at rate of 0.2 g/Lof water twice with 7 days interval resulted lower incidence of sucking pest complex (Grean Leaf Hoppers, Aphids, Thrips and Whiteflies) and significantly differed with untreated check. Whereas in terms of yields, application of *L. lecanii* VI 8 has recorded 43.33% more yield (26.87 Q/ha) and Acetamiprid has recorded 50% more yield (28.12 Q/ha.) when compared with untreated check (18.75 Q/ha.).

TNAU, Coimbatore

The effect of entomopathogens on the aphids in cotton was summarised in Table 95. Spiromesifen 240SC @ 7 ml/10 L recorded the lowest population of 22.87/3 plant followed by Azadirachtin 1500 ppm @ 2 ml/L (33.27), *Beauveria bassiana* NBAIR Bb5a ($1x10^{8}$ spores /g) @ 5 g/ l (34.47) and *Lecanicillium lecanii* NBAIR Vl 8 ($1x10^{8}$ spores /g) @ 5 g/l (36.53) on 7 days after first spray. The same trend was observed after second spraying also (Table 95).

Whiteflies population was significantly reduced compared to other treatments both after first and second round of spray. Significantly less population of observed in the entomopathogen applied plots compared to the untreated control (Table 96). Among the entomopathogens, *Lecanicillium lecanii* NBAIR VL 8 ($1x10^{8}$ spores /g) @ 5 g/l (1.68/3 leaves) followed by *Beauveria bassiana* NBAIR Bb5a ($1x10^{8}$ spores /g) @ 5 g/ l (1.98/3 leaves) on 7 days after second spraying (Table 96).

Table 95. Effect of entomofungal pathogens and botanicals on aphids in cotton

Treatments	Population of Aphids / 3 plants				
	First spray			Second spray	
	Pre count	3 DAS	7 DAS	3 DAS	7 DAS
T1: *Lecanicillium lecanii*	53.58 (7.319)	42.37 (6.509)^{b}	36.53 (6.044)^{d}	23.06 (4.802)^{c}	19.58 (4.425)^{c}
T2: *Beauveria bassiana*	51.97 (7.209)	44.13 (6.643)^{c}	34.47 (5.870)^{c}	23.68 (4.866)^{d}	19.16 (4.377)^{c}
T3: Azadirachtin 1500 ppm	52.99 (7.279)	46.33 (6.806)^{d}	33.27 (5.768)^{b}	20.23 (4.498)^{b}	17.49 (4.182)^{b}
T4: Spiromesifen 240 SC	52.05 (7.214)	21.73 (4.662)^{a}	22.87 (4.782)^{a}	18.73 (4.327)^{a}	13.03 (3.610)^{a}
T5: Absolute control	52.58 (7.251)	48.33 (6.951)^{e}	48.93 (7.022)^{e}	30.67 (5.629)^{e}	34.29 (5.898)^{d}
CD (0.05)	NS	0.096	0.076	0.052	0.084
SEd		0.046	0.036	0.025	0.040

Figures in parentheses are square root transformed values

In a column means followed by same letter(s) are not significantly different (p=0.05) by LSD

Values are mean of four replications.

Table 96. Efect of entomofungal pathogens and botanicals on whiteflies in cotton

Treatments	Population of whiteflies / 3 leaves				
	First spray			Second spray	
	Pre count	3 DAS	7 DAS	3 DAS	7 DAS
T1: *Lecanicillium lecanii*	6.89 (2.624)	5.13 (2.266)[d]	4.83 (2.198)[d]	2.76 (1.662)[b]	1.68 (1.295)[c]
T2: *Beauveria bassiana*	7.60 (2.752)	3.54 (1.880)[c]	3.42 (1.850)[c]	2.89 (1.701)[c]	1.98 (1.408)[d]
T3: Azadirachtin 1500 ppm	7.22 (2.678)	2.93 (1.712)[b]	2.66 (1.631)[b]	2.77 (1.663)[b]	1.43 (1.196)[b]
T4: Spiromesifen 240 SC	7.21 (2.680)	2.68 (1.636)[a]	2.34 (1.530)[a]	2.13 (1.461)[a]	1.35 (1.161)[a]
T5: Absolute control	6.88 (2.584)	5.14 (2.447)[e]	4.82 (2.447)[e]	3.67 (2.042)[d]	3.47 (1.989)[e]
CD (0.05)	NS	0.035	0.028	0.015	0.020
SEd		0.017	0.013	0.007	0.010

Figures in parentheses are square root transformed values

In a column means followed by same letter(s) are not significantly different (p=0.05) by LSD

Values are mean of four replications.

Table 97. Effect of entomofungal pathogens and botanicals on thrips in cotton

Treatments	Population of thrips / 3 leaves				
	First spray			Second spray	
	Pre count	3 DAS	7 DAS	3 DAS	7 DAS
T1: *Lecanicillium lecanii*	3.24 (1.798)	3.12 (1.767)[d]	3.52 (1.877)[d]	2.07 (1.438)[d]	2.03 (1.426)[d]
T2: *Beauveria bassiana*	3.12 (1.764)	2.99 (1.728)[c]	3.12 (1.767)[c]	1.58 (1.258)[b]	1.47 (1.211)[c]
T3: Azadirachtin 1500 ppm	3.18 (1.782)	2.71 (1.642)[b]	2.75 (1.657)[b]	1.66 (1.291)[c]	1.33 (1.151)[b]
T4: Spiromesifen 240 SC	3.25 (1.800)	2.43 (1.559)[a]	2.43 (1.559)[a]	1.43 (1.192)[a]	1.25 (1.118)[a]
T5: Absolute control	3.18 (1.783)	3.98 (1.997)[e]	3.79 (1.947)[e]	2.12 (1.460)[e]	2.42 (1.558)[e]
CD (0.05)	NS	0.033	0.019	0.023	0.22
SEd		0.016	0.009	0.011	0.011

Figures in parentheses are square root transformed values

In a column means followed by same letter(s) are not significantly different (p=0.05) by LSD Values are mean of four replications.

Table 98. Effect of entomofungal pathogens and botanicals on cotton leafhopper and yield of cotton

Treatments	Population of leafhopper/ 3 leaves					Yield Qtl/ha
	First spray			Second spray		
	Pre count	3 DAS	7 DAS	3 DAS	7 DAS	
T1: *Lecanicillium lecanii*	5.15 (2.269)	3.21 (1.793)[b]	3.54 (1.880)[c]	8.76 (2.959)[c]	6.62 (2.573)[d]	15.89 (3.986)[b]

T2: *Beauveria bassiana*	5.16 (2.272)	4.23 (2.057)^{c}	4.49 (2.119)^{d}	8.62 (2.935)^{c}	5.42 (2.328)^{b}	15.86 (3.999)^{ab}
T3: Azadirachtin 1500 ppm	5.13 (2.264)	3.14 (1.771)^{b}	3.36 (1.834)^{b}	7.42 (2.724)^{b}	5.69 (2.385)^{c}	16.07 (4.008)^{a}
T4: Spiromesifen 240 SC	5.25 (2.291)	2.17 (1.473)^{a}	2.73 (1.653)^{a}	6.51 (2.552)^{a}	4.31 (2.076)^{a}	16.10 (4.013)^{a}
T5: Absolute control	5.05 (2.248)	4.89 (2.212)^{d}	4.99 (2.236)^{e}	9.87 (3.142)^{d}	8.94 (3.075)^{e}	13.99 (3.742)^{c}
CD (0.05)	NS	0.022	0.014	0.041	0.040	0.016
SEd		0.011	0.006	0.021	0.019	0.008

Figures in parentheses are square root transformed values. In a column means followed by same letter(s) are not significantly different (p=0.05) by LSD Values are mean of four replications

Spiromesifen 240 SC @ 7 ml/10 L recorded less no. of thrips (1.25) followed by Azadirachtin (1.33) and *Beauveria bassiana* NBAIR Bb5a (1x10^{8} spores /g) @ 5 g/ l (1.47), and *Lecanicillium lecanii* NBAIR VL 8 (1x10^{8} spores /g) @ 5 g/l (2.03) on 7days after second spraying (Table 97). Leaf hopper population was less (4.31) in Spiromesifen 240 SC @ 7 ml/10 L treated plots followed by *Beauveria bassiana* NBAIR Bb5a (1x10^{8} spores /g) @ 5 g/ l (5.42), Azadirachtin 1500ppm @ 2 ml/L (5.69) and *Lecanicillium lecanii* NBAIR Vl8 (1x10^{8} spores /g) @ 5 g/l (6.62) on 7 days after second spraying. Yield was maximum in Spiromesifen 240 SC @ 7 ml/10 L (6.10 Qtl/ha) followed by Azadirachtin (16.07) and *Lecanicillium lecanii* NBAIR Vl 8 (1x10^{8} spores /g) @ 5 g/l (15.89) (Table 98).

IV. 8. 3. Large scale evaluation of biointensive management of pink bollworm on *Bt* cotton (UAS Raichur; TNAU Coimbatore; AAU Anand, ANGRAU Anakapalle; PJTSAU Hyderabad; PAU Ludhiana)

In the demonstration trial conducted in farmer's field rosette flowers due to pink boll worm was 2.28 per cent in BIPM plots while it was 2.43 per cent in the insecticide treated plots and 3.74 in the control plot on 110 Days After Sowing (DAS). On 110 DAS, green boll damage due to pink boll worm was 7.04 per cent in BIPM plots while it was 11.84 per cent in the control plot. Observations on bad open bolls were taken on 130, 140 and 150 DAS. There was 23.58 per cent reduction in the bad open bolls in BIPM module as against 28.93 per cent reduction in bad open bolls in insecticides treated plots. The yield was maximum in insecticide sprayed plots (1727 Kg/ha) followed by 1654 Kg/ha in BIPM and 1467 Kg/ha and control plots. CB ratio was higher in insecticide treated plots (2.07) than in BIPM plot (1.98) (Table 99).

Table 99. Bio – intensive management of Pink bollworm on *Bt* Cotton

Treatments	Rosette flowers (%)* 110 DAS	Green boll damage (%)* 110 DAS	Bad open bolls (%) *	Mean Bad open bolls (%) *	Yield Kg/ ha**	Increase over control (%)	CB ratio
			150 DAS				
T1:BPIM module	2.28 (8.684)^{a}	7.04 (15.386)^{b}	15.46 (23.153)^{b}	13.99	1654 (40.66)^{b}	12.67	1.98
T2: Insecticides spray	2.43 (8.968)^{b}	6.26 (14.489)^{a}	14.89 (22.697)^{a}	12.83	1727 (41.54)^{a}	17.63	2.07
T3: Control	3.74 (11.151)^{c}	11.84 (20.125)^{c}	19.04 (25.871)^{c}	18.31	1467 (38.30)^{c}	-	1.76

SEd	0.041	0.087	0.084	-	0.145	-	-
CD (P=0.05)	0.086	0.182	0.176	-	0.304	-	-

DAS – Days after sowing

Figures in parentheses are arcsine transformed values*

Figures in parentheses are square root transformed values. Means followed by a common letter in a column are not significantly different. Values are mean of ten replications.**

IV. 9. Biological control of insect pests of Sugarcane

IV. 9. 1. Large scale demonstrations of *Trichogramma* sp. (ICAR-NBAIR HTTS) against borers (early shoot borer) in sugarcane during 2023-24

UAS, Raichur

Results: The per cent dead heart due to early shoot borer ranged from 14.25 to 15.75 at a month after the establishment of ratoon crop. At final release of the trichocards the observations indicated that the per cent deadheart was 4.50 in *T. chilonis* (TTS) released plot while in untreated control plot it was 14.25 per cent. The *T. chilonis* (TTS) release plot recorded 108.75 t/ha cane yield and it was superior over untreated control 101.50 t/ha (Table 100).

Table 100. Large scale demonstrations of *Trichogramma* sp. (ICAR-NBAIR HTTS) against borers (early shoot borer) in sugarcane during 2023-24

Sl. No.	Particulars	Dead hearts (%)* Before release	Dead hearts (%)* After final release	Cane yield (t/ha)
T_1	Releases of *T. chilonis* (TTS)	15.75 (23.38)	4.50 (12.25)	106.75
T_2	Farmers' practice	14.25 (22.18)	1.75 (7.60)	115.50
T_3	Untreated control	15.50 (23.18)	14.25 (22.18)	101.50
S Em ±		**0.15**	**0.35**	**1.37**
CD (P=0.05)		**NS**	**1.06**	**4.10**

***Figures in parentheses are square root transformed values**

#Figures in parentheses are arcsine transformed values

IV. 9. 2. Field evaluation of ICAR-NBAIR endophytic entomopathogenic strains against shoot borers (*Chilo infuscatellus* and *Chilo sacchariphagus indicus*) in sugarcane

ANGRAU, Anakapalle

Sugarcane Early shoot borer, *Chilo infuscatellus* incidence upto 120 days after planting wassignificantly low in Cholorantraniliprole as sett treatment + three sprays from 25 days after planting at 14-day interval (4.98 %DH) and was on par with the entomopathogenic fungi, *Metarhizium anisopliae* NBAIR Ma35 (9.52 %DH) and high early shoot borer incidence recorded in untreated control (21.6%). Internode borer incidence and Internode borer intensity was significantly low in Cholorantraniliprole (58.3 % and 5.57 %) with highercane yield (67.7 t/ha) at par with *Metarhizium anisopliae* NBAIR Ma35 (66.67% and 6.23%) recorded cane yield (59.27 t/ha) (Table 101).

Sett treatment at planting and Three sprays from 25 DAP at 14 days interval

Fig 28. Efficacy of endophytic entomopathogens in the management of shoot borers in sugarcane

Table 101. Field evaluation of ICAR-NBAIR endophytic entomopathogenic strains in sugarcane

Treatment	ESB incidence (%DH)					Internode borer incidence %	Internode borer intensity %	Single cane weight (Kg)	Cane Yield (t/ha)
	45 DAP	60 DAP*	90 DAP *	120 DAP*	Upto 120 DAP				
T1- *Metarhizium anisopliae* NBAIR Ma35 (Sett Treatment + 3 sprays)	7.39 (0.83)	1.45 (1.20)	0.44 (0.97)	0.22 (0.84)	9.52	66.67 (1.813)	6.23 (0.755)	1.49	59.27
T2 : Chlorantraniliprole (Sett Treatment +3 sprays)	4.24 (0.61)	0.61 (0.78)	0.6 (0.75)	0.055 (0.74)	4.98	58.3 (1.76)	5.57 (0.736)	1.63	67.70
T3 – Control	7.80 (0.89)	11.67 (3.53)	0.81 (1.14)	0.47 (0.99)	21.6	80.0 (1.90)	7.55 (0.91)	1.13	44.32
CD(0.05)	0.107	0.176	0.081	0.119	3.1	0.081	0.127	0.19	11.15
CV%	10.66	7.426	6.59	10.79	21.6	3.428	12.285	10.40	15.18

Values in parenthesis are logarithmic transformed values

*** Values in parenthesis are square root transformed values**

IV. 9. 3. Field evaluation of *Metarhizium anisopliae* against Sugarcane White grub *Holotrichia serrata*during Kharif-2023-24

PJTSAU, Telangana

The Experiment was implemented in sugarcane farmers field at Mastipur village of Wanaparthy District, Telangana State during Kharif 2023-2024, with 3 treatments (including unsprayed control) in three blocks (each one acre) on 2[nd] year ratoon sugarcane crop var.2003 V 46 and data collected from 13 randomly selected 10 m row length canes (served as replications) from each block subjected to RBD. The following treatments imposed on 07-06-2023 and data collected 60 days after treatment.

Table 102. Field evaluation of *Metarhizium anisopliae* against Sugarcane White grub *Holotrichia serrata*

Treatments	Damaged plants (%)			No.of grubs/10m row length			Cane Yield t/ acre	Percent yield increase over control (%)
	Pre treatment counts	Post Treatment counts (60 DAT)	Percent reduction over control (%)	Pre treatment counts	Post Treatment counts (60 DAT)	Percent pest reduction over control (%)		
T1: *Metarhizium anisopliae* SBI Ma 16 @ 5ml/L	28.88 (32.44)	18.71 (25.30)	36.15	7.13 (2.71)	4.2 (2.08)	40.92	87.5	27.27
T2: Check (Immidachloprd 40% @ Fipronil 40% (80WG) 5ml/L)	29.34 (32.75)	12.92 (20.77)	58.37	7.20 (2.66)	2.48 (1.66)	65.92	112.5	63.63
T3 Untreated check	28.13 (30.77)	27.51 (31.40)	-	8.06 (3.67)	7.16 (2.69)	-	68.75	-
SEM	1.64	1.31	-	0.19	0.15	-	-	-
CD (0.05%)	4.77	3.79	-	0.56	0.45	-	--	-
CV	10.19	10.05	-	10.25	10.3	-	-	-

Fig 29. NSL Krishnaveni Sugars, Ramkrishnapuram, Kothakota of Mahabubnagar Dt. Officials at Mastipur village with sugarcane farmers.

Results: The result in the table 102 indicates that soil drenching with Lesenta (Immidachloprd 40% @ Fipronil 40% (80 WG) 1g/L) @ 1.0 ml/L of water resulted in reduction of 58.37 percent cane damage and 65.92 percent grub incidence and 63.63 percent cane yield realized when compared with untreated control. Whereas soil drench with *Metarhizium anisopliae* SBI Ma 16 @ 5 ml/L has resulted reduction of 36.15 percent cane damage and 40.92 percent grub incidence and 27.27 percent cane yield was realized when compared with untreated control.

IV. 9. 4. Large scale demonstration of EPN against white grubs in sugarcane ecosystem

MPKV, Pune

The experiment was laid out on the farmer's field of Shri. Shon Kokare Mobile Mobile No. 9511181800 at A/p. Sonkaswadi, Tal. Baramati of Pune district. The planting of sugarcane variety CoM. 265 was done on 20.04.2023 with 90 x 60 cm spacing in plot size of 5 ha. Two applications of *Heterorhabditis indica* NBAIR WP formulation, *Metarhizium anisopliae* (1 X10^8 CFU/g) and insecticide were given on 20.9.2023 and 22.10.2023. The yield data will be available after harvesting of sugarcane.

Method of recording observations:

The observations on sugarcane clump mortality were recorded at 5 spots and the number of damaged and healty clumps were counted before application of treatment as precount and also after 30 and 60 days after treatment application as post count. The sugarcane clump mortality data were calculated in percentage and it was angularly transformed and subjected to analysis of variance.

Results

The data on efficacy of EPN against white grubs in sugarcane indiacted that the clump mortality due to white grub was observed statistically non significant and it was in the range of 27.81 to 34.40 per cent before imposing the treatments. Two applications of entomopathogenic nematodes, *H. indica* NBAIR WP @ 10 kg/ha was found superior with 24.48 and 16.64 per cent clump mortality and which was followed by *M. anisoplae* @ 2.50 kg/ha with 30.09 and 21.17 per cent clump mortality after 30 days of first and second application, respectively. But chemical applications of Imidacloprid 40% + Fipronil 40% WG @ 500 g/ha was superior as with 20.36 and 11.09 percent clump mortality after 30 days of first and second application, respectively.

Table 103. Efficacy of entomopathogenic nematodes against white grub in sugarcane

Tr. No.	Treatment	Dose/ha	Sugarcane clump Mortality due to white grub (%)		
			Pre-count	30 Days after application	
				First	Second
1	*Heterorhabditis indica* NBAIR WP	10 kg	27.81 (31.82)	24.48 (29.65)	16.64 (24.07)
2	POP recommendation (Imidacloprid 40 %+ Fipronil 40%WG	500 g	28.91 (32.52)	20.36 (26.82)	11.09 (19.45)
3	*Metarhizium anisoplae*	2.50 kg	34.40 (35.91)	30.09 (33.27)	21.17 (27.40)
4	Control	-	29.63 (32.98)	33.29 (35.24)	35.96 (36.85)
	SE±		N.S.	1.81	1.45
	CD at 5%		4.43	5.57	4.46
	CV		9.65	13.06	11.89

*Figures in parenthesis are arc sin transformed values

Maintainance of stock cultures of natural enemies and their host insects

Following cultures of bioagents and host insects were maintained in the laboratory and used for experimental purposes, demonstrations and also supplied to Govt and pivate Biocontrol laboratories in the state. Moreover, *Trichogramma* spp., *Cryptolaemus montrouzieri, Lecanicillium lecanii* and *Metarhizium anisopliae* were mass cultured and distributed to farmers.

Parasitoids:
Trichogramma chilonis Ishii
Trichogramma chilonis TTS
Trichogramma pretiosum Rileyi
Goniozus nephantidis

Predators:	*Apertochrysa auster* *Chrysoperla zastrowi sillemi* (Esben-Petersen) *Cryptoleumus montroizeuri*
Microbial agents:	*Metarhizium anisopliae* *Lecanicillium lecanii*
Laboratory host insects:	*Maconellicoccus hirsutus* Green *Corcyra cephalonica*

Fig 30. Sugarcane Experiment

IV. 9. 5. Large scale demonstrations of proven biocontrol technologies against sugarcane stalk borer, *Chilo auricilius*

PAU, Ludhiana

Large scale demonstrations on the effectiveness of *T. chilonis* against stalk borer, *Chilo auricilius* were carried out over an area of 5658 acres in collaboration with Krishi Vigyan Kendras (KVKs), Regional Station (Gurdaspur) and four sugar mills of the state i.e. Nawanshahr Co-operative Sugar Mills Ltd. Nawanshahr (SBS Nagar), Morinda Co-operative Sugar Mills Ltd. Morinda (Roop Nagar), Nahar Sugar Mills Pvt. Ltd. Amloh (Fatehgarh Sahib) and Rana Sugar Mills Ltd. Buttar Seviyan (Amritsar). The demonstrations were conducted in 14 districts of Punjab, i.e. Patiala, Hoshiarpur, Jalandhar, Kapurthala, Gurdaspur, SBS Nagar, Fatehgarh Sahib, Barnala, Rupnagar, Moga, Mohali, Muktsar Sahib, Amritsar and Ludhiana districts. The egg parasitoid, *T. chilonis* was released 10-12 times from July to October at 10 days interval @ 50,000/ha and was compared with untreated control. Tricho-cards each having approximately 20,000 parasitized eggs were cut into 40 strips (each strip having 500 eggs) and were stapled uniformly per acre to the underside of the sugarcane leaves.

The incidence of stalk borer in biocontrol fields (2.90 %) was significantly less as compared to untreated control (7.78 %) (Table 104). Further, the yield was also relatively more in bioagent released fields (740.80 q/ha) than in untreated control fields (660.40 q/ha). It is concluded that in large scale demonstrations, 10-12 releases of *T. chilonis* @ 50,000 per ha at 10 days internal during July to October proved effective for the management of stalk borer in sugarcane. The benefit cost ratio was also higher in biocontrol fields (1.65) as compared to 1.50 in untreated control (Table 105).

Table 104. Large-scale demonstrations using *T. chilonis* against *Chilo auricilius* in sugarcane during 2023

Treatments	Incidence (%)	Yield (q/ha)
Biocontrol*	2.90[a]	740.80[a]
Untreated control	7.78[b]	660.40[b]

***10-12 releases of *T. chilonis* @ 50,000 per ha at 10 days interval during July to October**

Table 105. Benefit-Cost analysis (2023)

Treatments	Yield (q/ha)	Additional yield over control (q/ha)	Gross returns (Rs)	Cost of cultiva-tion (Rs/ha)	Benefit Cost ratio
Biocontrol	740.80	80.40	289652.80	175734.00	1.65
Untreated control	660.40		258216.40	172403.00	1.50

Price of sugarcane: Rs. 391/- per quintal during 2023

IV. 9. 6. Large scale demonstrations of proven biocontrol technologies against sugarcane early shoot borer *Chilo infuscatellus*

Large scale demonstrations on the effectiveness of *T. chilonis* against early shoot borer, *C. infuscatellus* were carried out over an area of 410 acres in collaboration with KVKs and Regional Station (Gurdaspur). The demonstrations were conducted in 11 districts, i.e. Patiala, Hoshiarpur, Jalandhar, Kapurthala, Gurdaspur, Barnala, Moga, Mohali, Muktsar Sahib, Amritsar and Ludhiana districts. The parasitoid, *T. chilonis* was released 8 times at 10 days interval from mid-April to end-June @ 50,000 per ha and was compared with chemical control, i.e. chlorantraniliprole (Coragen 18.5 SC) @ 375 ml/ha applied 45 days after planting and untreated control.

The incidence of early shoot borer in biocontrol and chemical control fields was 3.93 and 1.24 per cent, respectively. However, both the treatments were significantly better than untreated control (9.40 %) (Table 106). The yield in control (658.20 q/ha) was significantly lower than released fields (736.40 q/ha) and chemical control (836.20 q/ha). It is concluded that eight releases of *T. chilonis* at 10 days interval during mid-April to end-June @ 50,000 per ha for the management of early shoot borer were better than untreated control, however, these were inferior to chemical control. The cost benefit ratio in biocontrol (1.64) and chemical control (1.80) was higher as compared to untreated control (1.49) (Table 107).

Table 106. Large scale demonstrations using *T. chilonis* against *C. infuscatellus* in sugarcane during 2023

Treatments	Incidence (%)	Yield (q/ha)
Biocontrol*	3.93[b]	736.40[b]
Chlorantraniliprole 18.5 SC @ 375 ml/ ha	1.24[a]	836.20[a]
Untreated control	9.40[c]	658.20[c]

***8 releases of *T. chilonis* @ 50,000 per ha at 10 days interval during Mid-April to end-June**

Table 107. Benefit Cost analysis (2023)

Treatments	Yield (q/ha)	Additional yield over control (q/ha)	Gross returns (Rs.)	Cost of cultivation (Rs/ha)	Benefit Cost ratio
Biocontrol	736.40	69.10	287932.40	175734.00	1.64
Chlorantraniliprole 18.5 SC @ 375 ml/ ha	836.20	168.90	326954.20	182141.00	1.80
Untreated control	656.20		256574.20	172403.00	1.49

Price of sugarcane: Rs. 391/- per quintal during 2023

IV. 9. 7. Large scale demonstrations of proven biocontrol technologies against sugarcane top borer, *Scirpophaga excerptalis*

Large-scale demonstrations on the effectiveness of *T. japonicum* against top borer, *S. excerptalis* were carried over an area of 255 acres in collaboration with KVKs in Patiala, Hoshiarpur, Jalandhar, Kapurthala, Gurdaspur, Barnala, Moga, Mohali, Muktsar Sahib, Amritsar and Ludhiana districts. The parasitoid, *T. japonicum* was released 8 times at 10 days interval from mid-April to end-June @ 50,000 per ha and was compared with chemical control, i.e. chlorantraniliprole (Ferterra 0.4 GR @ 25 kg/ha applied during last week of June).

The incidence of top borer in biocontrol and chemical control fields was 4.47 and 2.10 per cent, respectively. However, both the treatments were significantly better than untreated control (10.58 %) (Table 108). The yield in control (652.40 q/ha) was significantly lower than release fields (732.80 q/ha) and chemical control (821.40 q/ha). It is concluded that eight releases of *T. japonicum* at 10 days interval during mid-April to end-June @ 50,000 per ha proved effective for the management of top borer. The benefit cost ratio in biocontrol (1.63) and chemical control (1.76) was higher as compared to untreated control (1:1.48) (Table 109).

Table 108. Large scale demonstrations using *T. japonicum* against *Scirpophaga excerptalis* during 2023

Treatments	Incidence (%)	Yield (q/ha
Biocontrol*	4.47[b]	732.80[b]
Chlorantraniliprole 0.4 GR @ 25 kg/ha	2.10[a]	821.40[a]
Untreated control	10.58[c]	652.40[c]

***8 releases of *T. japonicum* @ 50,000 per ha at 10 days interval during Mid-April to end-June**

Table 109. Benefit Cost analysis (2023)

Treatments	Yield (q/ha)	Additional yield over control (q/ha)	Gross returns (Rs.)	Cost of cultivation (Rs/ha)	Cost Benefit ratio
Biocontrol	732.80	68.00	286524.80	175734.00	1.63
Chlorantraniliprole 0.4 GR @ 25 kg/ha	821.40	157.60	321167.40	182141.00	1.76
Untreated control	652.40		255088.40	172403.00	1.48

Price of sugarcane: Rs. 391/- per quintal during 2023

Fig 31. Field releases of tricho-cards in sugarcane

IV. 9. 8. Large scale demonstration of *Trichogramma* sp. against sugarcane borers.

OUAT, Bhubaneshwar

Results: The crop was sown during 3rd week of February to last week of February 2023. Release of *T. chilonis* and *T. japonicum* were done as per treatment schedule and compared with farmers practice and untreated control. Maximum infestation due to ESB, and TSB in BIPM package were 11.40 % and 2.95 % as against 11.68 % and 3.02 % in FP indicating comparable level of infestation. But, infestation levels due to ESB (11.02%) and TSB (2.90 %) were recorded in untreated control in pre release condition. Both the BIPM and the farmers practice were at par in post release observations. Highest cane yield (75.29 t/ha) and B: C ratio (1.65) were recorded in BIPM package where as in FP (73.01 t/ha) with B:C ratio (1.61). Lowest yield (58.32 t/ha) and B: C ratio (1.32) were noted in untreated control (Table 110).

Table 110. Effect of *Trichogramma* sp. against borer pests of sugarcane (Sabita)

Treatments	Early shoot borer(%)		Top shoot borer(%)		Yield (t/ha)	B:C ratio
	Pre release	Post release	Pre release	Post release		
Release of *T. chilonis* @ 50,000/ha at 10 days interval after 45 DAP (8 times) & *T. Japonicum* 5-6 months after planting	11.40	5.73 (2.39)	2.95	0.0.80 (0.89)	75.29	1.65
Farmer's practice (chlorantraniliprole 18.5 SC 375 ml / ha)	11.68	4.93 (2.22)	3.02	0.66 (0.81)	73.01	1.61
Untreated control	11.02	14.62 (3.82)	2.90	3.41 (1.85)	58.32	1.32
S.E. (m) ±	-	0.04	-	0.04	1.88	
C.D(p=0.05)	NS	0.13	NS	0.12	5.64	

Figures in the parentheses are square root transformation values

OILSEEDS

IV. 10. Biological control of insect pests of Groundnut

IV. 10. 1. Evaluation of entomopathogens against leaf miner and tobacco caterpillar in groundnut (UAS, Raichur; ANGRAU, Anakapalle; TNAU, Coimbatore)

TNAU, Coimbatore

Table 111. Evaluation of entomopathogens against leaf miner and tobacco caterpillar in groundnut.

Treatments	No. of active leaf miner / 20 leaflets *			% Plant damage due to *Spodoptera litura* **			Yield (kg/ha)*	CB Ratio
	Pre treat-ment	7 DAS	14 DAS	Pre treat-ment	7 DAS	14 DAS		
T1: *Metarhizium rileyi* KK-Nr-1 (1x10^8 spores/g) @ 5 g/L	4.23 (1.99)	2.64 (1.63)[c]	2.07 (1.44)[c]	21.63 (26.14)	20.25 (25.42)	19.22 (4.32)	1628.47 (40.30)[a]	3.54
T2: *Bacillus thuringiensis* RARS TPT-C33 2% @ 1ml/L	3.85 (1.89)	2.27 (1.51)[a]	1.81 (1.35)[b]	22.45 (26.92)	20.67 (25.79)	19.75 (4.38)	1533.72 (39.12)[a]	3.27
T3: Emamectin benzoate 5 SG @ 0.2 gm/L	4.51 (2.07)	2.46 (1.57)[b]	1.53 (1.24)[a]	23.08 (27.45)	21.25 (26.08)	18.24 (4.19)	1704.28 (41.25)[a]	3.74
T4: Control	3.74 (1.85)	4.26 (2.06)[d]	4.84 (2.20)[d]	21.38 (25.88)	23.75 (27.66)	27.53 (5.08)	1275.45 (34.26)[b]	2.53
CD (P = 0.05)	NS	0.016	0.020	NS	NS	NS	2.492	
SEd	NS	0.007	0.009	NS	NS	NS	1.187	

DAS – Days after spraying

Figures in parentheses are square root transformed values*/ arcsine transformed values**

Means followed by a common letter in a column are not significantly different. (P=0.05)

The population of groundnut leaf miner larvae/20 leaflets was minimum in Emamectin benzoate 5 SG @0.2gm/L (1.53) followed by *Bacillus thuringiensis* RARS TPT-C33 2% @ 1ml/L (1.81) and *Metarhizium rileyi* KK-Nr-1 (1×10^8 spores/g) @ 5g/L (2.07) as against 4.84 larvae/20 leaflets in the control plot on 14 days after spraying (Table 111). However, there was no significant difference in the plant damage due to *Spodoptera litura* in different treatments. Pod yield in Emamectin benzoate 5 SG @0.2gm/L (1704 Kg/ha) was on par with yield in *M. rileyi* KK-Nr-1 (1×10^8 spores/g) @ 5g/L (1628 Kg/ha) and *B. thuringiensis* RARS TPT-C33 2% @ 1 ml/L (1704 Kg/ha). CB ratio was maximum in Emamectin benzoate 5 SG @ 0.2 gm/L (3.74) followed by *M.rileyi* KK-Nr-1 (1×10^8 spores/g) @ 5g/L (3.54) and *B. thuringiensis* RARS TPT-C33 2% @ 1ml/L (3.27).

UAS Raichur

Results: Highest per cent reduction of leaf miner and defoliator larvae was noticed in *M. rileyi* (KK-Nr-1) @ 1×10^8 spores/ml (5g/L) with 75.81 and 77.29 per cent over control, respectively. *M. rileyi* (KK-Nr-1) @ 1×10^8 spores/ml (5g/L) recorded highest pod and halum yield of 26.34 q/ha and 29.56 q/ha, respectively while it was 19.38 q/ha and 23.42 q/ha, pod and haulm yield, respectively in untreated control (Table 112).

Table 112. Evaluation of entomopathogens against leaf miner and tobacco caterpillar in groundnut during 2023-24

Sl. No.	Treatment Details	Dosage (g/l)	Leafminer (Active mines/20 leaflets)			ROC (%)	Defoliator (No. of larvae/ mrl)			ROC (%)	Yield (q/ha)	
			IDBS	7 DAS	10 DAS		IDBS	7 DAS	10 DAS		Pod	Halum
T_1	*Metarhizium rileyi* (KK-Nr-1)	1×10^8 @ 5gm/l	9.28 (3.13)	3.54 (2.01)	1.26 (1.33)	75.81 (60.54)	4.46 (2.23)	1.26 (1.33)	0.72 (1.10)	77.29 (61.54)	26.34	29.56
T_2	*Bacillus thuringiensis* RARS TPT-C33 2%	1ml/L	10.12 (3.26)	5.18 (2.38)	3.24 (1.93)	57.56 (49.35)	4.28 (2.19)	2.72 (1.79)	1.48 (1.41)	51.83 (46.05)	21.58	25.62
T_3	Emamectin benzoate 5 SG		9.56 (3.17)	2.06 (1.60)	0.72 (1.10)	85.99 (68.02)	4.14 (2.15)	0.84 (1.16)	0.28 (0.88)	87.16 (69.00)	31.16	33.84
T_4	Untreated control		9.74 (3.20)	10.28 (3.28)	9.56 (3.17)	0.00 (0.00)	4.32 (2.20)	4.58 (2.25)	4.14 (2.15)	0.00 (0.00)	19.38	23.42
S Em ±			0.21	0.05	0.13	-	0.04	0.07	0.03	-	1.06	1.18
CD (P=0.05)			NS	0.16	0.40	-	NS	0.22	0.11	-	3.19	3.55

***Figures in parentheses are square root transformed values**

#Figures in parentheses are arcsine transformed values

ANGRAU, Anakapalle

Groundnut leaf miner damage and *Spodoptera litura* damage recorded significantly low in *Metarhizium rileyi* (AKP Nr1) @ 5 g/L (1.985% and 7.0%) with higher pod yield 23.64 q /ha followed by *Bacillus thuringiensis* RARS TPT C33 @ 2 g/L (2.08% and 9.0 %) with pod yield (23.58q/ha) and were on par with Emamectin benzoate 5SD@ 0.4 g/L (1.56% and 6.67 %). Percent reduction in leaf miner and *S. litura* damage over untreated control was high in chemical treatment (39.25 % and 79.58%) followed by *B. thuringiensis* RARS TPT C33 (18.57% and 72.45% as two sprays (**Table 113).**

Table 113. Evaluation of entomopathogens against leaf miner and tobacco caterpillar in groundnut

Treatment	Leaf miner damage %			Percent reduction in Leaf miner damage over control	*Spodoptera litura* plant damage %			Percent reduction in *Spodoptera* damage over control	Pod Yield q/ha
	Before spray	After First spray	After Second spray		Before spray	After First spray	After Second spray		
T1: *Bacillus thuringiensis* RARS TPT C33 @ 2 g / lit	2.46 (0.379)	2.12 (0.304)	2.087	18.57	8.88 (0.883)	6.26 (0.462)	9.0 (0.937)	72.45	23.58
T2- *Metarhizium rileyi* (KKNr1) @ 5 g/L	3.37 (0.373)	1.99 (0.291)	2.353	8.19	10.0 (0.969)	7.29 (0.843)	14.33 (1.145)	56.14	21.15
T3: Emamectin benzoate 5SD @ 0.4 g/L	2.74 (0.42)	0.973 (0.026)	1.557	39.25	8.94 (0.898)	5.64 (0.771)	6.67 (0.731)	79.58	26.27
T4-Untreated Control	1.95 (0.286)	2.943 (0.459)	2.563	-	8.7 (0.910)	11.22 (1.032)	32.67 (1.501)	-	18.36

CD(0.05)	NS	0.902	0.623		NS	1.52	6.59		NS
CV%		23.79	15.71			11.20	10.86		21.14

Values in parenthesis are logarithmic transformed values

IV. 10. 2. Evaluation of promising entomopathogenic fungi and bacteria strains for the management of white grubs (*Holotrichia* sp.) in groundnut

SKUAST, Jammu

Number of white grubs / 10 m row was significantly lowest in T3 – *M. anisoplia*e NBAIR-Ma4 2.0 % WP @ 7.5 kg/ha in 250 kg FYM (0.33), followed by T2 – *M. anisopliae* NBAIR-Ma4 2.0 % WP @ 5.0 kg/ha in 250 kg FYM(0.67), that was comparable to that of the insecticidal treatment (0.67). Accodingly, per cent plant dasmage by root grubs was also lowest in T3 (4.32 %) followed by T2 (8.89 %) and T7 (9.73 %). Groundnut yield was also significantly highest in T3 (13.23 q/ha), followed by T7 (13.00 q/ha) and T2 (12.67 q/ha).

Table 114. Evaluation of entomopathogens against leaf miner and tobacco caterpillar in groundnut

Treatments	% plant damage	% reduction over control	No. of white grubs / 10 m row	% reduction over control	Yield (q/h)	% increase over control
T1 – *Metarhizium anisopliae* NBAIR-Ma4 2.0% WP @ 2.5 kg/ha in 250 kg FYM	15.45 (23.16)	51.17	1.00	40.12	7.34	29.45
T2 – *M. anisopliae* NBAIR-Ma4 2.0% WP @ 5.0 kg/ha in 250 kg FYM	8.89 (17.35)	71.83	0.67	59.88	8.67	35.27
T3 – *M. anisopliae* NBAIR-Ma4 2.0% WP @ 7.5 kg/ha in 250 kg FYM	4.32 (1.99)	86.35	0.33	80.24	9.23	62.78
T4 – *Bacillus thuringiensis* NBAIR-Bt-AB1 20% @ 500 g/ha in 250 kg FYM	18.97 (25.82)	40.04	1.33	20.36	7.33	29.28
T5 – *B. thuringiensis* NBAIR-BtAB1 20% @ 1kg/ha in 250 kg FYM	16.02 (23.59)	49.37	1.00	40.12	7.78	37.21
T6 – *B. thuringiensis* NBAIR-BtAB1 20% @ 1.5 kg/ha in 250 kg FYM	15.51 (23.19)	50.98	1.00	40.12	8.66	52.73
T7 – Imidacloprid 40% + Fipronil 40% 80 WG @ 300 g/ha	9.73 (18.18)	69.25	0.67	59.88	9.00	58.73
T8 – Untreated control	31.64 (34.23)	-	1.67	-	5.67	-
CD (P<0.05)	(2.35)	-	0.9	-	0.63	-

IV. 11. Biological control of insect pests of Mustard

IV. 11. 1. Evaluation of entomopathogens against mustard aphid

SKUST, Kashmir

The number of aphids/plant was significantly lower in the treated plots as compared to the control plots. It was found that the reduction in aphids/plant over control was 72.80, 74.93 and 70.84% in the plots treated with the *B. bassiana* + Azadirachtin, Imidacloprid, *L. lecanii,* respectively. The yield of mustard (kg/ha) was 1255.32, 1262.42, 1186.64 and 572.70 in the plots treated with the *B. bassiana* + Azadirachtin, Imidacloprid, *L. lecanii* and control plots, respectively. The yield increase over control (%) was 54.37, 54.63 and 51.73 in the plots treated with the *B. bassiana* + Azadirachtin, Imidacloprid and *L. lecanii*, respectively (Table 115).

Table 115. Field efficacy of entomopathogens against mustard aphid, *Lipaphis erysimi*

Treatments /Locations	Aphids/plant (Mean ± SE)	Reduction over control (%)	Yield (kg/ha) (Mean ± SE)	Percent yield increase over control (%)
T1 (*Beauveria bassiana* NBAIR Bb 5a (1 × 10^8 spores/g) @ 5g/L + Azadirachtin 1500pm @ 2 ml/L)	19.83±1.23[a]	72.80	1255.32±88.32[c]	54.37
T2 (Imidacloprid 17.8 SL @ 0.3ml/lit)	18.28±1.09[a]	74.93	1262.42±89.25[c]	54.63
T3 *Lecanicilium lecanii* (Commercial) 1x10^8 spores/ml @ 5.0 ml/ L	21.26±2.24[b]	70.84	1186.64±78.32[b]	51.73
T4 (Control)	72.91±4.43[c]	-	572.70±11.24[a]	-
CD(0.05)	1.35		4.87	

Mean ± SE followed by different letters in the same columns are significantly different by Tukey's test (P<0.05). SE are the Standard error of the respective means

AAU, Jorhat

Results: The **population of aphids were significantly reduced in both the treatment.** POP recommendation (Imidacloprid 17.8 SL @ 0.4ml/L) and the treatment *Beauveria bassiana* NBAIR Bb 5a (1 × 10^8 spores/g) @ 5g/L + Azadirachtin 1500 ppm @ 2 ml/L after 7 and 15 DAT as compared to control. However, coccinellids were more in entomopathogen treated plots than POP recommendation. No significant difference of yield was observed in between entomopathogen treatment and POP recommendation

Table 116. Efficacy of entomopathogens against mustard aphid

Treatments	No. of aphids per 10 cm twig			No. of occinld/ 5 plants	Seed Yield (Qt/ha)
	Pretreatment	7 DAT	15 DAT		
T1- *Beauveria bassiana* NBAIR Bb 5a (1 × 10^8 spores/g) @ 5g/L + Azadirachtin 1500 ppm @ 2 ml/L	32.67	12.31	9.47	2.56	6.59
T2- POP recommendation (Imidacloprid 17.8 SL @ 0.4ml/L)	31.32	7.84	4.06	0.96	7.05
T3- Control	30.37	42.20	28.46	2.70	3.45
CD (0.05)	NS	4.15	4.57	1.04	1.88

CAU, Pasighat

Table 117. Field efficacy of entomopathogens against Mustard Aphids

Treatments	No. of aphids per 10 cm twig		No. of Coccinellids per five plants		Percent pest reduction over control (%)	Seed Yield (q/ha)	Percent yield increase over control (%)
	Pre-treatment count	Post Treatment count	Pre treatment	Post treatment			
T1- *Beauveriabassiana* NBAIR Bb 5a (1 × 10^8 spores/g) @ 5g/L +Azadirachtin 1500 ppm @ 2 ml/L	10.13 (3.26)*	5.46 (2.43)	3.41 (1.97)	2.10 (1.60)	35.76	9.18	43.66
T2- Imidacloprid 17.8 SL @ 0.4ml/L	10.25 (3.28)	5.12 (2.36)	3.20 (1.91)	1.56 (1.42)	39.76	9.50	48.66
T3-Untreated Control	10.36 (3.29)	8.50 (2.99)	3.32 (1.94)	2.45 (1.71)		6.39	-
S. Em ±	0.06	0.09	0.09	0.06		0.31	
C.D. at 5 %	NS	0.28	NS	0.18		0.94	

***Figures in the parenthesis $\sqrt{x + 0.5}$ transformed values**

Results:

Though the chemical Imidacloprid 17.8 SL @ 0.4 ml/L was found effective treatment in reducing mustard aphids, the *Beauveria bassiana* NBAIR Bb 5a (1 × 10^8 spores/g) @ 5 g/L +Azadirachtin 1500 ppm @ 2 ml/L was comparatively next best treatment in reducing pest incidence to 5.46 aphids/10 cm twig *i.e.,* 35.76 % reduction over control. However, the chemical (9.50 q/ha) and biopesticide combination (9.14 q/ha) both were found statistically on par in terms of crop yield. The biopesticide combination found safer for the predatory lady bird beetles.

FRUIT CROPS

IV. 12. Biological control of insect pests of Litchi

IV. 12. 1. Bio-intensive management of litchi fruit borer, *Conopomorpha sinensis* in litchi

PAU, Ludhiana

Bio-intensive pest management practices for the management of litchi fruit borer was conducted during *Kharif*, 2023 at PAU Fruit Research Station, Gangian (Hoshiarpur). Three treatments include : BIPM, farmer's practice and untreated control. Each block was further divided into 10 units (each unit representing one replication). The BIPM practices include ploughing during March-April, regular clean cultivation, collection and destruction of fallen infested fruits during May-June and releases of *T. embryophagum*@ 4000 parasitized eggs per tree six times at 7-10 days interval starting from fruit initiation to colour break stage. The observations were recorded by collecting 100 fruits from each unit and per cent damage was worked out on the basis of total and infested fruit number. Fruit yield was recorded on tree basis and converted to quintals per ha.

BIPM was effective in reducing the damage caused by fruit borer (6.60 %) and it was at par with chemical control (5.80%). The untreated control recorded the maximum damage (20.80 %). The marketable yield in BIPM (159.48 q/ha) and farmer's practice (162.35 q/ha) were not significantly different. The untreated control recorded the lowest yield of 125.88 q/ha (Table 118).

Table 118. Bio-intensive management of litchi fruit borer, *Conopomorpha sinensis* in litchi

Treatments	Per cent infested fruits (%)	Marketable yield (q/ha)
BIPM	6.60 (14.66)	159.48
Farmers' Practice (chemical control)	5.80 (13.79)	162.35
Control	20.80 (27.07)	125.88
CD (p=0.05)	(1.97)	14.18
CV (%)	14.22	12.70

Figures in parentheses are arc sine transformed values


Fig 32. Management of litchi fruit borer

IV. 12. 2. Demonstration of Biointensive pest management module for codling moth, *Cydiapomonella* infesting apple in Ladakh

SKUAST, Kashmir

The demonstration of biointensive pest management module for codling moth was conducted at Saliskot, Minji and Trespone villages of Kargil, Ladakh during 2023. The results revealed that the fruit damage and fruit drop in BIPM plots was significantly lower than control plots. The fruit damage in BIPM plots was 9.24 %,whilst it was 7.75% in Chlorpyriphos treated plots. The untreated control plots recorded the highest damage of 53.32%. There fruit drop in the BIPM and Chlorpyriphos treated plots were 4.52% and 4.12% respectively. The control plot recorded the highest fruit drop of 48.50%.The BIPM plots recorded 82.67 % reduction in fruit damage and 72.73% increase in the yield over control (Table 119).

Table 119. Evaluation of Biointensive pest management module for codling moth, *Cydia pomonella* infesting apple in Ladakh during 2023

Treatments /Locations	Fruit damage (%) (Mean ± SE)	Percent reduction over control	Trap catch (Mean ± SE)	Fruit drop (%)	Yield (Kg/tree) (Mean ± SE)	Percent yield increase over control
T1 BIPM (Saliskot)	9.24±1.55[b]	82.67	7.30±0.82[a]	4.52±0.92[a]	123.75±4.14[c]	72.73
T2 Chlorpyriphos (Minji)	7.75±1.17[a]	85.46	8.50±1.12[b]	4.12±0.82[b]	127.30±4.82[b]	73.48
T3 Control (Trespone)	53.32±4.22[c]	-	20.40±2.84[c]	48.50±3.22[c]	33.75±2.11[a]	-
C.D (0.05)	2.17		2.32	1.98	2.98	

Mean±SE followed by different letters in the same columns are significantly different by Tukey's test (*p*<0.05). SE are the Standard error of the respective means.

IV. 12. 3. Demonstration on management of apple root borer using *Metarrhizium anisopliae*

The demonstration on management of apple root borer revealed that the infested trees/ha (%) were significantly lower in the plots treated with the *M. anisopliae* as compared to control. The reduction in infested trees/ha over control was 77.56 and 78.59% in the plots treated with the *M. anisopliae* and Chlorpyriphos, respectively. The yield of apple (kg/ha) was 12480.47, 12492.25 and 5876.72 in the plots treated with the *M. anisopliae,* Chlorpyriphos and control plots,respectively. (Table 120).

Table 120. Field efficacy of *Metarhizium anisopliae* against apple root borer, *Dorysthenes huegelii*

Treatments /Locations	Infested trees/ha (%) (Mean ± SE)	Reduction over control (%)	Yield (Kg/ha) (Mean ± SE)	Percent yield increase over control (%)
T1 (*M. anisopliae* NBAIR (1x 10^8 spores/g @ 30 g per tree mixed with enriched FYM)	4.32±0.89[a]	77.56	12480.47±92.84[b]	52.91
T2 (Chlorpyriphos 20 EC@ 0.04%)	4.12±0.81[a]	78.59	12492.25±92.89[b]	52.95
T3 (Control)	19.25±2.10[b]	-	5876.72±62.80[a]	-
C.D(0.05)	1.24		4.76	

Mean ± SE followed by different letters in the same columns are significantly different by Tukey's test (*p*<0.05). SE are the Standard error of the respective means

DrYSPUHF, Solan

At solan, treating the trees with *M. anisopliae* resulted in 69.02 per cent mortality of the apple root borer grubs. Chlorpyriphos (0.06%) caused the highest mortality of 90.30 per cent (Table 121).

Table 121. Detailed locations of the demonstrationson management of apple root borer using *Metarhizium anisopliae*

S.N.	Location	Number of orchards	Mortality (%)
1	Kotkhai-district Shimla	2	69.50±0.99
2	Theog, district-Shimla	2	70.80±1.21
3	Daru Deoria (Sirmaur)	2	68.90±2.08
4	Rogi, district Kinnaur	2	68.80±1.84
5	Lippa districtKinnaur	1	72.10±1.32
6.	Kalpa-districtKinnaur	3	69.90±1.66
7	Jubbal-district Shimla	1	64.10±1.76
	Mean±S.E (m)		69.02±0.76
6	Control	1	90.30±1.54
	Total	**14**	

Fig 33. Apple root borer, *Dorysthenes huegelii*

IV. 13. Biological control of insect pests of Banana

IV. 13. 1. Evaluation of *Beauveria bassiana* against banana pseudostem weevil, *Odoiporous longicollis*

KAU, Thrissur

An experiment to evaluate the entomopathogenic fungus *Beauveria bassiana* against banana pseudostem weevil, *Odoiporous longicollis* was carried out at Banana Research Station, Kannara, Thrissur district (Table 122).

Table 122. Effect of *Beauveria bassiana* on banana pseudostem weevil, *Odoiporous longicollis*

Treatments	Dam-age (%)	Per cent damage reduction over control	Yield (t/ha)	Per cent yield increase over control
T3: Untreated Control	51.79[a]	-	13.81[b]	-
CD (0.05%)	11.307		2.183	

T2: KAU POP recommendation (Chlorpyriphos @ 300 g a.i/ha)	28.57[b]	44.83	17.70[a]	28.17
T1: Sucker treatment with talc formulation of *Beauveria bassiana* NBAIRBb5a @ 20g/L + Soil drenching with NBAIR Bb5a @ 20g/L + Applicationof NBAIR Bb5a capsules in the leaf axils at 5, 6 and 7 MAP + Applicationof NBAIR B5a capsules into the bore holes	39.29[b]	24.14	16.29[a]	17.95

Banana treated with chlorpyriphos recorded the lowest weevil infestation (28.57%), followed by the treatment with *Beauveria bassiana* NBAIR Bb5a (39.29%). Both the treatments were at par but were superior to the untreated control recording 51.79% infestation. Plots treated with chlorpyriphos recorded a significantly higher mean yield of 17.70 t/ha, followed by those treated with the EPF (16.29 t/ha). Untreated control plots recorded significantly lower yield of 13.81 t/ha. Application of NBAIR Bb 5a as sucker treatment, soil application and leaf axil /bore hole filling with capsules can be effective in controlling the pseudostem weevil in banana.

Fig 34. Field view of experimental plot at BRS, Kannara to evaluate the entomopathogens on banana pseudostem weevil, *Odoiporous longicoliis*

IV. 14. Biological control of insect pests of Citrus

IV. 14. 1. Evaluation of different isolates of entomopathogenic fungi against citrus thrips

DrYSRHU, Tirupathi

Among the three entomopathogens evaluated, *Lecanicilium lecanii* @ 5g/L was found effective with least infestation by thrips on fruits (6.03%) as compared to *Beauveria bassiana* @ 5g/L (6.82%) and *Metarhizium anisopliae* @ 5g/L(7.46%). Maximum infestation of 11.59% of fruits was recorded in control whilst the lowest damage by thrips on fruits was recorded in acephate (4.92%) treated trees. Though T_4 i.e. acephate produced higher fruit of 16.93t/ha but it was on par with T_1 (*Beauveria bassiana*-15.97t/ha) and T_3 (*Lecanicilium lecanii*-15.67t/ha).

Table 123. Efficacy of entomopathogens against thrips infesting sweet orange

Treatments	Fruits infestation (%)*	No. of fruits/ tree	Yield (t/ha)
T_1:*Beauveria bassiana* (NBAIR Strain) @ 5g/Litre	6.82(16.24)	110.90	15.97
T_2:*Metarhizium anisopliae* (NBAIR Strain) @ 5g/Litre	7.46 (16.91)	106.50	14.54
T_3:*Lecanicilium lecanii* (NBAIR Strain) @ 5g/Litre	6.03(15.38)	116.13	15.67
T_4:Local check (Acephate 75SP @ 0.1%)	4.92(14.08)	122.30	16.93
T5: Control	11.59(20.78)	97.60	10.80
SE (m±)	1.50	2.64	1.81
CD at 5%	4.34	7.07	5.20

*** Figures in parentheses angular transformed values**

IV. 14. 2. Evaluation of different isolates of entomopathogenic fungi against citrus Rust and Green mites

Among the three entomopathogens evaluated, *Beauveria bassiana* @5g/L was found effective with lower infestation by rust mites on fruits (4.76%) while least infestation was recorded in propargite 57EC with 3.81%. In case of green mites infestation on fruits, *Beauveria bassiana* @5g/L (5.87%) caused lowest damage among entomopathogens tested. Acaricide propargite 57EC caused lowest damage by green mites (4.92%). The yield data showed that though T4 produced higher yield of 16.93t/ha but it was on par with T_1 (15.68t/ha) and minimum yield was recorded in control (11.91t/ha).

Table 124. Efficacy of entomopathogens against mites infesting sweet orange

Treatments	**Fruits infestation**		**No. of fruits/ tree**	**Yield (t/ha)**
	rust mites (%)	**green mites (%)**		
T_1: *Beauveria bassiana* (NBAIR Strain) @ 5g/Litre	4.76 (13.89)*	5.87 (15.20)*	122.42	15.68
T_2: *Metarhizium anisopliae* (NBAIR Strain) @ 5g/Litre	7.14 (16.58)	8.78(18.23)	118.00	14.78
T_3: *Lecanicilium lecanii* (NBAIR Strain) @ 5g/Litre	5.98 (15.32)	6.82 (16.24)	115.25	14.54
T_4: Local check (Propargite 57EC @ 0.1%)	3.81 (12.67)	4.92 (14.08)	136.50	16.93
T5: Control	9.05 (18.48)	11.59 (20.78)	102.03	11.91
SE (m±)	1.00	1.26	6.71	2.34
CD at 5%	2.90	3.64	17.44	7.11

***Figures in parentheses angular transformed values**

PLANTATION CROPS

IV. 15. Biological control of insect pests of Coconut

IV. 15. 1. Surveillance of rugose spiraling whitefly on coconut and assessing the population of natural bio-control agents

ICAR-CPCRI, Kasaragod

Population dynamics of two exotic whiteflies *viz.,* rugose spiraling whitefly, *Aleurodicus rugioperculatus* (RSW) and Bondar's nesting whitefly *Paraleyrodes bondari* (BNW) as well as the natural parasitism by *Encarsia guadeloupae* on RSW are presented (Fig 35 & 36), respectively. RSW population ranged from 0.30 to 2.80 live colonies/ leaflet whereas BNW population ranged from 0.45 to 4.80 live colonies / leaflet. BNW is prevalent in higher population range than RSW which has wider range values. Parasitism by *E. guadeloupae* on RSW ranged from 15% to 69% synchronizing with elevated RSW population. Weather factors and parasitism play a major role in population regulation of exotic whiteflies in coconut palm.

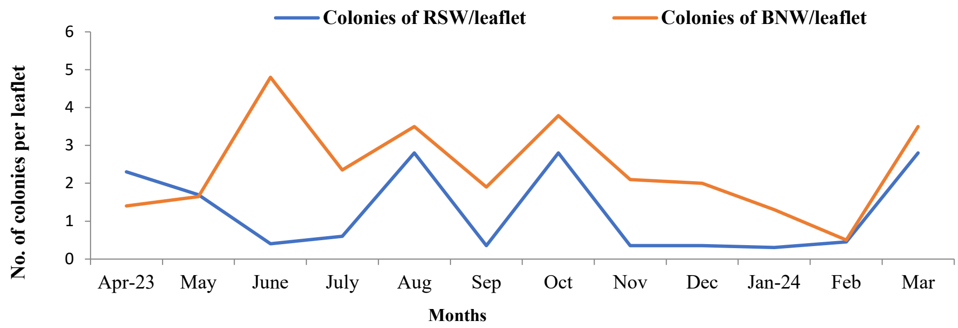

Fig 35. Population dynamics of RSW and BNW on coconut at Kayamkulam

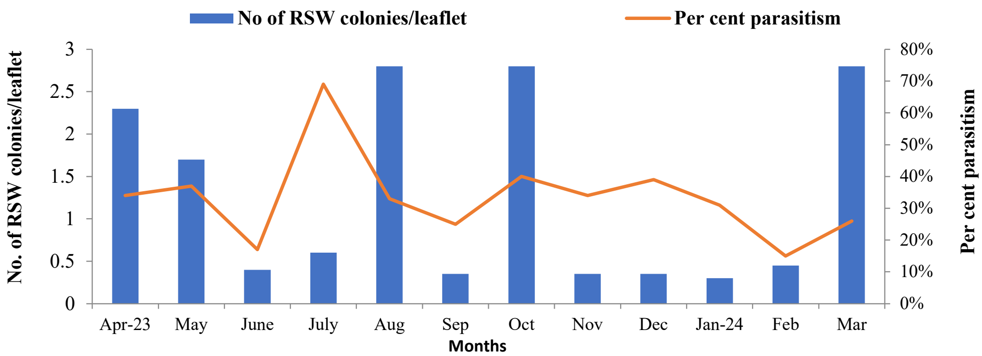

Fig 36. Parasitic potential of *Encarsia guadeloupae* on RSW

IV. 15. 2. Biological control of rugose spiraling whitefly in coconut

ICAR-CPCRI, Kasaragod

Bio-suppression of the exotic rugose spiraling whitefly, *Aleurodicus rugioperculatus* using the entomopathogen, *Isaria fumosorosea* (Pfu-5), neem oil (0.05%), water spray and conservation biological control (*E. guadeloupae*) is presented in Table 125. RSW population was found to be very low ranging from 0.07 to 0.11 live colonies / leaflet as pre-treatment count. All treatments were found effective in pest regulation and are non-significant. Conservation biological control was found to be equally effective as that of palms sprayed with *I. fumosorosea* as well as neem oil. There was an increase in pest population 60 days after treatment (DAT), and the least observed in palms sprayed with neem oil (0.05%). Parasitism by *Encarsia guadeloupae* was found to be ranging from 13.33% to 62.27% in all treated palms.

Table 125. Bio-suppression of rugose spiraling whitefly in coconut during 2023

Treatments	RSW population (No. of colonies / leaflet)*					Parasitism (%)
	Pre-treat-ment	15 DAT	Reduction (%)	60 DAT	Reduction (%)	
Isaria fumosorosea (5g /L)	0.07 (0.12)	0.04 (0.07)	50.00	0.39 (0.42)	-450.00	13.33
Neem oil (0.05%)	0.11 (0.17)	1.04 (0.52)	-869.23	0.46 (0.26)	-333.33	62.27
Water spray	0.11 (0.17)	0.07 (0.12)	33.33	0.11 (0.21)	0.00	0.00
Conservation biological control	0.11 (0.10)	0.39 (0.37)	-266.67	0.36 (0.44)	-233.33	34.13
P=0.05		NS		NS		

DAT- days after treatment

IV. 15. 3. Large scale demonstration on management of rugose spiraling whitefly using *Isaria fumosorosea*

ANGRAU, RARS, Srikakulam

Large scale demonstration on rugose spiraling whitefly using entomopathogenic fungi, *Isaria fumosorosea* (ICAR-NBAIR Pfu-5) was carried out in 25.5 acres in 8 farmers field. Initiated the experiment in February, 24 after noticing RSW infestation and data on pest infestation and intensity was recorded before spray and RSW reduction was recorded after two sprays (Table 126).

Table 126. Efficacy of *Isaria fumosorosea* NBAIR pfu5 in management of coconut rugose spiralling whitefly

Treatments	Before spray			After spray		After second spray			% reduction in intensity	
	% infes-tation	% inten-sity	Live colo-nies/ leaflet	% infes-tation	Live colonies/ leaflet	% infes-tation	% inten-sity	Live colo-nies/ leaflet	After one spray	After two sprays
T1: Spraying *Isaria fumosorosea* NBAIR pfu-5 @ 5 g/L + Release of *Encarsia guadeloupae*	41.62	30.5	21.8	18.96	10.22	18.22	16.42	6.42	60.86	85.75
T2: Spraying neem formulation 10000 ppm @ 5 ml/L	42.33	31.4	22.52	24.33	20.56	25.5	22.27	15.51	29.06	41.0

The results in reveals that after second spray, there is 85.75% reduction in RSW intensity in foliar application of *I. fumosorosea* ICAR-NBAIR Pfu-5 @ 5 g/L and release of parasitoid, *E. guadeloupae* treatment followed by spraying of neem oil (10000 ppm) 5 ml/L spray 41.00% (Table 126)

UBKV, Coochbehar

The result reveals that T_2 (neem oil 0.5% + 0.005% soap powder) performed better than the T_1 (*Isaria fumosorosea* (Pfu-5) $1x10^8$ spores/mL+ Tween 80) in reducing the damage of RSW with the leaf infestation of 44.86 and 50.57%, respectively (Table 127). However both the treatment performed well in comparison with the control treatment. Treatment with neem oil 0.5% + 0.005% soap powder recorded highest nut yield of 70.43 nuts/palm.

Table 127. Biological suppression of rugose spiraling whitefly and nesting white fly in coconut

Treatments	Leaf infested with RSW and nesting white fly (%)			Number of parasitized nymphs		Yield (No. of Nuts/ palm)	yield increase over control (%)
	Pre treatment	Post treatment	Reduction over control (%)	Pre treatment	Post treatment		
T1- *Isaria fumosorosea* (Pfu-5) 1x10^{8} spores/mL+ Tween 80	73.77 (47.58)[2]	50.57 (30.39)	61.47	2.20 (1.48)[1]	1.88 (1.37)	61.71 (7.85)[1]	34.15
T2- neem oil 0.5% + 0.005% soap powder	74.52 (48.22)	44.86 (26.68)	82.03	2.39 (1.54)	1.51 (1.22)	70.43 (8.39)	53.10
T3- Untreated Control (Water spray)	75.14 (48.74)	81.66 (54.78)	-	2.24 (1.49)	2.18 (1.47)	46.00 (6.78)	-
SEm (±)	-	1.45	-	-	0.09	0.13	-
CD (0.05%)	N.S.	4.49	-	N.S.	0.30	0.40	-
CV (%)	-	5.53	-	-	10.03	2.39	-

[1]: Square root transformation; [2]: Angular transformation

YSRHU-HRS, Ambajipeta

The results in reveals that after third spray, there was 79.25% mean reduction in egg spirals / leaflet in neem oil spray treatment over control followed *I. fumosorosea* spray 69.25%, 77.49% eggs / leaflet in neemoil spray treatment over control followed *I. fumosorosea* spray 68.24% (Table 128). Other hand, 80.82% reduction nymph /leaflet in neem oil spray treatment over control followed *I. fumosorosea* spray 65.29% and 87.37 % reduction adults / leaflet in neem oil spray treatment over control where as 70.03 % in *I. fumosorosea* spray.

Table 128. Pre-treatment observation on RSW population in various treatments

Treatments	Number of population/leaflet														
	Spirals			Eggs			Nymph			Pupae			Adult		
	Pre treatment	Post treatment	Reduction over control (%)	Pre treatment	Post treatment	Reduction over control (%)	Pre treatment	Post treatment	Reduction over control (%)	Pre treatment	Post treatment	Reduction over control (%)	Pre treatment	Post treatment	Reduction over control (%)
T_1- *I. fumosorosea* spray	11.45 (3.46)	4.21 (2.17)	69.50	64.40 (8.06)	28.25 (5.36)	68.24	16.95 (4.17)	9.25 (3.12)	65.29	18.10 (4.31)	7.10 (2.75)	70.03	8.80 (3.05)	4.21 (2.12)	70.03
T_2-Neem oil spray	14.18 (3.83)	3.54 (2.01)	79.25	62.93 (7.96)	19.56 (4.47)	77.49	24.18 (4.97)	7.29 (2.79)	80.82	22.65 (4.81)	4.85 (2.31)	86.38	10.48 (3.31)	2.11 (1.62)	87.37
T_3- Control	18.38 (4.34)	22.12 (4.70)		35.00 (5.96)	48.28 (6.68)		14.13 (3.83)	22.19 (4.79)		18.75 (4.39)	24.54 (5.01)		7.75 (2.87)	12.35 (3.58)	

IV. 15. 4. Large scale suppression of rugose spiraling whitefly using parasitoid *Encarsia guadeloupae* and *Apertochyrsa astur* coconut

TNAU, Coimbatore

A bio-intensive IPM module with *Encarsia guadeloupae* natural conservation and release of *Apertochyrsa astur* eggs @1000/ha + Yellow sticky traps @ 20/ha was demonstrated in Anaimalai, Coimbatore district. In BIPM field, there was 4.38 RSW/leaflet and 4.53 BNW/leaflet six months after the implementation of treatment as against 11.07 and 10.43 respectively in the control (Table 129). The parasitisation by *Encarsia guadeloupae* was 48.54% in the BIPM plots as against 40.25% in the control (Table 130). There was 74.56 % reduction in the RSW population while in control plot as against 40.39% reduction in RSW population after six months. In case of Bondars nesting whitefly, 68.43 and 37.24% reduction was observed in BIPM module and control respectively. *E. guadeloupae* parasitisation was increased to the tune of 58.06 % in BIPM module. There were 60.94 and 36.14 % increase in the population of *Apertochyrsa astur* in BIPM module and control respectively (Table 131).

Table 129. Effect of BIPM module of rugose spiraling whitefly and Bondars nesting whitefly in coconut during 2024 at Coimbatore

Tretments	Population of RSW/leaflet*				Population of BNW/leaflet*			
	Pre treat-ment	Two months	Four months	Six months	Pre-treat-ment	Two months	Four months	Six months
BIPM Module	17.22 (4.09)	12.67 (3.56)[a]	8.71 (2.95)[a]	4.38 (2.09)[a]	14.35 (3.71)	10.38 (3.30)[a]	7.72 (2.77)[a]	4.53 (2.12)[a]
Control	18.57 (4.26)	15.42 (3.96)[b]	13.54 (3.68)[b]	11.07 (3.34)[b]	16.62 (4.02)	13.73 (3.70)[b]	11.64 (3.41)[b]	10.43 (3.23)[b]
SEd	NS	0.173	0.076	0.144	NS	0.091	0.096	0.081
CD (P = 0.05)	NS	0.364	0.161	0.304	NS	0.193	0.202	0.171

Figures in parentheses are square root transformed values*/arcsine transformed values; In a column means followed by same letter(s) are not significantly different (p=0.05) by LSD; Values are mean of seven replications**

Table 130. Effect of BIPM module of natural enemies of whiteflies in coconut during 2024 at Coimbatore

Treat-ments	*Encarsia* sp. parasitisation % **				*Apertochrysa astur* Grubs no/10 leaflets*				RSW trapped in yellow sticky trap in 180 days (nos/trap) *	Yield (total nuts/ ha/ yr)
	Pre treat-ment	Two months	Four months	Six months	Pre treat-ment	Two months	Four months	Six months		
BIPM Module	30.71 (33.22)	36.23 (37.18)	42.51 (40.69)[a]	48.54 (44.33)[a]	8.32 (2.82)	10.15 (3.18)[a]	11.45 (3.39)[a]	13.39 (3.65)[a]	2364 (48.91)[a]	15362 (123.81)[a]
Control	32.56 (33.57)	35.19 (36.38)	37.52 (37.77)[b]	40.25 (39.38)[b]	7.61 (2.70)	8.74 (2.95)[b]	9.62 (3.09)[b]	10.36 (3.25)[b]	0 (0.70)[b]	13687 (116.84)[b]
SEd	NS	NS	0.783	0.344	NS	0.101	0.130	0.074	0.639	2.738
CD (P = 0.05)	NS	NS	1.646	0.723	NS	0.212	0.273	0.157	1.342	5.750

Figures in parentheses are square root transformed values*/ arcsine transformed values; Values are mean of seven replications; In a column means followed by same letter(s) are not significantly different (p=0.05) by LSD**

Table 131. Effect of BIPM module on whiteflies and their natural enemies in coconut during 2024 at Coimbatore

Treat-ments .015	% Reduction in population of RSW from Pre - Treatment Count			% Reduction in population of BNW from Pre - Treatment Count			% Increase in *Encarsia* sp. parasitisation from Pre - Treatment Count			% Increase in *Apertochrysa astur* Grubs from Pre - Treatment Count			% Increase in yield over control
	Two months	Four months	Six months	Two months	Four months	Six months	Two months	Four months	Six months	Two months	Four months	Six months	
BIPM Module	26.42	49.42	74.56	27.67	46.20	68.43	17.97	38.42	58.06	22.00	37.62	60.94	12.238
Control	16.96	27.09	40.39	17.39	29.96	37.24	8.08	15.23	23.62	14.85	26.41	36.14	-

IV. 15. 5. Area-wide demonstration of biological suppression of black headed caterpillar using *Goniozus nephantidis* and *Bracon brevicornis*

ICAR-CPCRI, Kasaragod

Regular monitoring on the incidence of black headed caterpillar, *Opisina arenosella* was undertaken in Kerala (Table 132). Systematic release of stage specific parasitoids, *Goniozus nephantidis* @ 20/ palm & *Bracon brevicornis* @ 30 adults/palm) could reduce the pest incidence from 30.6 % to 0.40 % in a period of four years. Percentage reduction of pest population ranged from 62.7 % to 98.7 % in four years period with complete recoupment of palm health. Conditioning of parasitoids to higher temperature to with stand climate extremes in underway.

Table 132. Incidence of black headed caterpillar over years after release of parastioids in coconut

Period	Pest incidence (%)	Reduction (%)
October, 2019	30.6	
March, 2020	11.4	62.7
March, 2021	1.1	96.4
March, 2022	0.7	97.7
March, 2023	0.5	98.4
October, 2023	0.4	98.7*

***Significant t<0.05**

YSRHU-HRS, Ambajapeta

The experiment was initiated on August, 2023 in famer's field of Allipalli (17.1867° N, 81.0064° E) village of Chinthalapudi Mandal, Eluru district in the area of 5 ha (790 coconut palms) with age of

25-40 years (Fig.37). Parasitoids, *Goniozus nephantidis* @ 15,800 and *Bracon brevicornis* at 15,800 were released in (T_1) experimental field at 45 interval and data was recorded on various pest stages. Spraying of Chlorantraniliprole 18.5 SC @ 0.4 ml/L (T_2) was not under taken due to the tall palms. Pest incidence of 10 larvae/leaflet in pre-treatment and 5.30 larvae/leaflet in post treatment was recorded. After 3 months of parasitoids release, there was 25.51 % pest reduction in the treatment over control (Table 133).

Table 133. Pre and post treatment observations on pest incidence, percent infestation of black headed caterpillar at Allipalli Village during 2023-24

Treatments	Infested leaflets in a frond (%)			Pest incidence (larvae)/ leaflet		
	Pre treat-ment	Post treat-ment	Reduction over control (%)	Pre treat-ment	Post treat-ment	Reduction over control (%)
T_1: Augmentative release of *Goniozus nephantidis* and *Bracon brevicornis* @ 20 parasitoids/palm	39.75	36.88	15.09	10.10	5.30	25.51
T_2:Untreated control	37.75	41.25	-	8.70	12.30	-

Fig 37. Area-wide demonstration of biological suppression of black headed caterpillar

IV. 15. 6. Converging biological suppression approaches for area-wide management of rhinoceros beetle in coconut

ICAR-CPCRI, Kasaragod

The damage caused by coconut rhinoceros beetle on spear leaf and fronds are assessed and the leaf damage after incorporation of *Metarhizium majus* in to breeding zone in Vallikunnam panchayat in Kerala are presented (Table 134; Fig.38). Damage by coconut rhinoceros beetle on fronds and spear leaf after incorporation of *Metarhizium majus* in to the breeding sites was reduced 36.9% and 40.7%, respectively. Ease is field level application among dairy farmers and creation of mass awareness for the whole panchayat is the success of the programme which had greater penetration of the technology. Farmers are confident in the pest reduction and could observe *M. majus* infected grubs in the breeding zone.

Table 134. Leaf damage by rhinoceros beetle in coconut

Treatments (n=25)	Frond infested per palm (%)	Leaf damage (%)	Spear leaf damage (%)
Before treatment	4.19	21.5	40.8
After treatment	2.64	14.7	24.2*
Reduction (%)	36.9	31.6	40.7

***Significant t<0.05**

Fig 38. Technological awareness and distribution of *Metarhizium majus*

YSRHU, HRS, Ambajipeta

Farmer's field with the infestation of Rhinoceros beetle was identified at Ambajipeta Mandal. One hectare of 3-5 years old coconut (East coast tall) palms were selected for the demonstration of an entomofungal pathogen *Metarhizium majus* for the management of coconut rhinoceros beetle. *Metarhizium majus* culture was obtained from ICAR-CPCRI, Kasargod. Pre treatment data on pest incidence (58.33 %), leaf damage (41.31 %) in T_1- *Metarhizium majus* and 62.21 %, 46.25 % observed in T_2: POP Recommendation respectively were recorded. In post treatment observations 51.48 % of pest incidence, 35.42 % leaf incidence was observed in T_1- *Metarhizium majus* and 60.55 % of pest incidence, 40.57 % leaf incidence was observed (Table 135; Fig.39).

Table 135. Pre and post treatment observation on area wide demonstration of an entomofungal pathogen *Metarhizium majus* for the management of rhinoceros beetle in coconut in Andhra Pradesh

Treatments	Infested leaflets in a frond (%)		
	Pre-treatment*	Post treatment	Reduction over control (%)
T_1: *Metarhizium majus* CPCRI Mm 601) $5x10^{11}$ spores/ ml (5g/L)	39.75	36.88	15.09 %
T_2: POP Recommendation (Wooden ash 1kg/ m^3 cowdung pit)	37.75	41.25	-

Fig 39. Area wide demonstration of a rhinoceros beetle at Ambajipeta

VEGETABLE CROPS

IV. 16. Biological control of insect pests of Tomato

IV. 16. 1. Evaluation of predatory mite, *N. longispinosus* for the management of spider mite, *T. urticae* in tomato under polyhouse

YSPUHF, Solan

Predatory mite *N. longispinosus* and anthocorid predator *B. pallescens* were evaluated for the management of phytophagous mite, *Tetranychus urticae* on tomato. Per cent reduction in mite population over control was highest (96.90 %) with application of spiromesifen followed by release of predatory mite *N. longispinosus* (85.76 %) and anthocorid *B. pallescens* (80.80 %). The yield recorded with spiromesifen (458.0 q/ha) was statistically at par with predatory mite *N. longispinosus* (441.67q/ha) and anthocorid *B. pallescens* (415.33q/Ha) (Table 136).

Table 136. Effect of predatory mite, *N. longispinosus* for the management of spider mite, *T. urticae* in tomato under polyhouse

Treatment	Population of mite per cm^2 per leaf		Per cent leaf damage (%)		PROC (%)	Yield (Q/ha)	Increase in yield over Control (%)
	Pre-treatment	Post-trement	Pre-treatment	Post-treatment			
T_1 (*N. longispinosus* @10 per plant)	3.83 (2.13)	1.50 (1.53)	14.33 (22.14)	7.67 (15.80)	85.76	441.67	72.98
T_2 (*B. pallescens* @ 20 per plant)	4.17 (2.27)	2.17 (1.73)	13.83 (21.79)	10.33 (18.62)	80.80	415.33	62.67
T_3 (Spiromesifen 240 SC @ 100 g.a.i.ha^{-1})	4.33 (2.30)	1.33 (1.50)	15.17 (22.80)	1.67 (6.55)	96.90	458.00	79.38
T_4 (Control)	4.17 (2.25)	15.67 (4.06)	14.67 (22.39)	53.83 (47.22)	-	255.33	-
$CD_{0.05}$	NS	0.473	NS	4.25	-	34.143	-

IV. 16. 2. Demonstration of bio-intensive pest management practices for the management of insect pests (fruit borer/pinworm/ sucking pests) of Tomato (PJTSAU, Hyderabad; SKUAST-K; UBKV, Pundibari; YSPUHF, Solan; AAU, Jorhat; MPUAT, Udaipur)

PJTSAU, Hyderabad

The trial was conducted in the farmers field of Raikal village of Ranagareddy District, Telangana State during *rabi* 2023-24 on Tomato var. Ayaan (Syngenta). The results in the given Table 137. reveals that between BIPM practices and farmers practice, there is no significant difference interms of percentage of leafmines per plant (21.02% & 31.81%) but in terms of reduction in fruit damage percentage, significantly differed (21.82 & 51.04) with farmer's practice. BIPM package recorded highest predator (coccinellids & Spiders) per plant (3.99) which is significantly differed with farmers practice (0.49) and on par with the untreated check (4.06). In terms of percent yield increase, BIPM practice (67.64%) was on par with the farmers practice (71.50%) when compared with untreated check which recorded 12750 kg/ha.

Table 137. Demonstration of bio-intensive pest management practices for the management of insect pests (fruit borer/pinworm/ sucking pests) of Tomato

Treatments	No. of mined leaves/plant			Fruit damage (%)		Predators(no/plant)		Yield (kg/plot)	Per cent Yield
	Pre TC	Post TC	%pest reduc-tion over conrol	% fruit damage	%pest reduc-tion over conrol	Pre TC	Post TC		
T1: BIPM package	1.69 (1.45)	1.35 (1.32)	21.02	4.12 (2.09)	21.82	3.13 (1.85)	3.99 (2.08)	21375	67.64
T2: Farmers package	1.72 (1.45)	1.16 (1.24)	31.81	2.58 (1.70)	51.04	2.99 (1.81)	0.49 (0.98)	21875	71.56
T3:Untreated Control	1.56 (1.39)	1.76 (1.45)	-	5.27 (2.30)	-	3.68 (1.91)	4.06 (2.05)	12750	
SEM	0.1	0.11	-	0.15	-	0.14	0.12		
CD (.05%)	0.29	0.33	-	0.44	-	0.41	0.37		
CV	10.1	12.21	-	10.6	-	10.83	10.72		

SKUAST, Jammu

The BIPM plots showed significantly less fruit damage and number of aphids/leaf as compared to control plots, the differences being significant between the treatments. It was found that the BIPM plots recorded 80.24 % reduction in fruit damage and 63.89% increase in yield as compared to the control (Table 138). Significant differences were also observed in the yield of tomato in BIPM plots (25632 kg/ha), Cypermethrin treated plots (25985 kg/ha) and the control plots (9255 Kg/ha).

Table 138. Evaluation of Bio intensive pest management practices for the management of insect pests of tomato

Treatments /Locations	Fruit damage (%) (Mean ± SE)	Reduction over control (%)	Aphids/ Leaf (Mean ± SE)	Yield (Kg/ha) (Mean ± SE)	Percent yield increase over control (%)
T1 BIPM	2.45±0.94[a]	80.24	0.32±0.09[a]	25632±2763.72[c]	63.89
T2 Cypermethrin	2.32±0.94[a]	81.29	0.24±0.08[b]	25985±2795.52[b]	64.38
T3 Control	12.40±2.20[c]	-	1.72±0.67[c]	9255±1554.32[a]	-
C.D(0.05)	1.27		0.31	4.65	

Mean ± SE followed by different letters in the same columns are significantly different by Tukey's test (*p*<0.05). SE is the Standard error of the respective means.

UBKV, Pundibari

The result of the experiment in the Table 140. shows that BIPM field recorded 72.23% reduction over control of infestation of white fly whereas in fruit borer damage BIPM field recorded 79.75 reduction over control. The highest yield was recorded from university POP (Flubendiamide 20% WG & Thiamethoxam 25% WG) treated field (3966.00 Kg/ha) followed by BIPM field (3424.00 Kg/ha). However, the population of natural enemies was recorded in more numbers in BIPM field than chemical treated field.

YSPUHF, Solan

The result revealed that in the BIPM plots, the mean mine density was 1.24 mines/leaf whereas, in Chemical treated plots the mean mine density was 1.13 mines/leaf. Per cent fruit infestation by *T. absoluta* in BIPM was 5.16 which was statistically on par with chemical (4.51%). The yield of the BIPM plots (31.36 t/ha) was also significantly at par with that of chemical treatment plots (30.52 t/ha) (Table 139).

Table 139. *Tuta absoluta* infestation on tomato leaves

Treatment	Mean number of *Tuta* Mines/leaf	Percent fruits infested by *T. absoluta*	mites /cm² / leaf	Yield (t/ha)
BIPM	1.24 ±0.07	5.16 ±0.76	1.18 ±0.04	31.36 ±0.41
Chemical control	1.14 ±0.05	4.51 ±0.59	1.11 ±0.05	30.52 ±0.33
t-value	1.16714	0.63761	0.98582	1.66732
P<0.05	0.129191	0.265879	0.168645	0.0555

Table 140. Bio- intensive pest management practices for the management of insect pests of tomato

Treatments	White flies/leaf			Fruit borer damage (%)			Natural enemies (Spider/ Lady bird beetle) (No./m²)		Yield (Kg/ha)	% yield increase over control
	Pre treatment	Post treatment	% reduction over control	Pre treatment	Post treatment	% reduction over control	Pre treatment	Post treatment		
T1- BIPM	13.43 (3.66)[1]	3.57 (1.87)	72.23	10.43 (5.99)[2]	2.43 (1.39)	79.75	5.00 (2.23)	3.00 (1.71)	3424.0 (8.14)[3]	44.41
T2-University POP	12.43 (3.52)	0.43 (0.43)	96.65	10.57 (6.07)	0.43 (0.25)	96.41	4.57 (2.12)	0.86 (0.92)	3966.0 (8.29)	67.27
T3-Untreated Control	11.71 (3.42)	12.86 (3.58)	-	9.86 (5.66)	12.00 (6.89)	-	4.14 (2.01)	7.14 (2.66)	2371.7 (7.76)	-
SEm (±)	-	0.214	-	-	0.298	-	-	0.24	0.05	-
CD (0.05%)	N.S.	0.66	-	N.S	0.92	-	N.S.	0.73	0.18	-
CV (%)	-	15.47	-	-	14.86	-	-	19.91	1.00	-

[1]: Square root transformation; [2]: Angular transformation; [3]: Log transformation

AAU, Jorhat

The tomato fruit borer damage was reduced to the tune of 69.53% in BIPM Plot, against 75.81% in chemical treated plots. There was no significant difference in between yield of BIPM (6684 kg/ha) and chemical treated plots (7046 kg/ha) with B:C ratio 1:2.72 and 1:2.94, respectively.

MPUAT, Udaipur

Demonstration experiment was conducted in *rabi* 2023-24. During the experimental period, incidence of *H. armigera* was recorded. The highest fruit damage (49.65%) and larval population (6.20 larvae/plant) was found in untreated control followed by BIPM package and Chemical control. BIPM package was equally effective as chemical control against *H. armigera*. Chemical control module recorded the highest yield (15.15 t/ha) which was at par with the yield recorded in BIPM package (12.80 t/ha). Significantly, low yield was recorded in untreated control (5.95 t/ha) (Table 141. It could be concluded that BIPM package had promising results in minimizing the pest damage with higher yield

Table 141. Effect of different modules on incidence of *H. armigera* and yield of tomato during *rabi*, 2023-24

S.No	Modules/Treatments	*H. armigera* larvae /plant*		Fruit damage* (%)	Fruit yield (t/ha)
		Pre- Treatment popn.	Post- Treatment popn.		
1.	BIPM Package*	5.20 (2.39)*	3.50 (2.00)	30.85 (33.74)	12.80
2.	Chemical Control (Spinosad 45 SC @ 1.0 ml/ 3 lit)	4.95 (2.32)	2.41 (1.71)	25.19 (30.10)	15.15
3.	Untreated Control	5.8 (2.51)	6.20 (2.59)	49.65 (44.80)	5.95
	CD (at 5 %)	NS	0.210	3.759	1.167

*Figures in parenthesis are square root transformed values

IV. 17. Biological control of insect pests of Okra

IV. 17. 1. Evaluation of entomopathogens against sucking pests (hoppers, aphids and Whitefly) of Okra (ICAR-IIHR, Bengaluru; AAU, Anand)

ICAR-IIHR, Bengaluru

Different entomopathogens were evaluated against sucking pests of okra. In this experiment, only leaf hoppers incidence was observed. Among the different entomopathogens evaluated, *Metarhizium anisopliae* NBAIR Ma4 (1x10^8 spores/g) @5 g/L recorded significant effective control of leaf hopper with 2.59 mean leaf hoppers per plant followed by *Beauveria bassiana* NBAIR Bb5a (1x10^8spores/g) @ 5 g/ L (2.70 mean leaf hopper per plant) and *Metarhizium anisopliae* IIHR Strain @5ml /L (2.89 mean leaf hoppers per plant) (Table 142).

Table 142. Evaluation of different entomopathogens against leaf hopper in Okra

Sl.no	Treatment details	Mean number of leaf hoppers/plant									
		Pre count	First Spray		Second spray		Third spray		Fourth spray		Pooled
			3DAS	7DAS	3DAS	7DAS	3DAS	7DAS	3DAS	7DAS	
T1	*Metarhizium anisopliae* IIHR Strain @ 5ml /L	3.61 (2.01)	2.90 (1.86)	2.72 (1.79)	3.34 (1.95)	3.13 (1.87)	2.85 (1.83)	2.34 (1.51)	2.87 (1.82)	2.61 (1.79)	2.86 (1.83)

T2	*Metarhizium anisopliae* NBAIR Ma4 (1x10[8] spores/g) @ 5 g/L	4.1 (2.14)	3.15 (1.9)	2.73 (1.79)	2.65 (1.77)	2.52 (1.73)	2.5 (1.73)	2.07 (1.43)	2.72 (1.79)	2.4 (1.68)	2.59 (1.76)
T3	*Beauveria bassiana* NBAIR Bb5a (1x10[8] spores/g) @5 g/ L	4.50 (2.21)	2.9 (1.84)	2.6 (1.75)	2.4 (1.69)	3.55 (1.98)	2.7 (1.77)	2.61 (1.61)	2.74 (1.77)	2.05 (1.58)	2.65 (1.77)
T4	*Lecanicillium lecanii* NBAIR Vl8 @ (1x10[8] spores/g) @5g/L	4.25 (2.17)	3.01 (1.86)	3.51 (1.99)	3.01 (1.85)	2.42 (1.70)	3.23 (1.91)	3.22 (1.78)	2.81 (1.81)	2.62 (1.74)	2.98 (1.86)
T5	*Pseudomonas fluorescens* NBAIR-PFDWD 10g/L	4.9 (2.31)	3.89 (2.07)	5.08 (2.35)	4.76 (2.28)	5.37 (2.41)	5.42 (2.43)	4.27 (2.05)	5.83 (2.51)	5.13 (2.37)	4.96 (2.34)
T6	Imidacloprid 17.8 SC @ 0.3mL/L	4.9 (2.31)	1.17 (1.27)	2.65 (1.76)	2.98 (1.86)	2.5 (1.71)	1.76 (1.50)	2.14 (1.45)	1.44 (3.91)	1.83 (1.52)	2.05 (1.59)
T7	Control	4.66 (2.32)	5.83 (2.51)	5.97 (2.54)	6.00 (2.54)	6.78 (2.69)	5.88 (2.52)	5.36 (2.30)	5.52 (2.45)	6.09 (2.54)	5.85 (2.52)
	CD @0.05%	NS	0.42	0.32	0.31	0.46	0.38	0.39	0.32	0.49	0.21
	CV	0.04	0.19	0.16	0.15	0.19	0.19	0.19	0.20	0.21	0.17

AAU, Anand

Significantly lowest population of jassid was documented in treatment T_2-POP, Imidacloprid 17.8 SL (6.79/ 3 leaves) as compared to treatment T_1-Oil based formulation of *Metarhizium anisopliae* IIHR Strain (7.91/ 3 leaves) and in case of whitefly, treatment T_2-POP, Imidacloprid 17.8 SL showed non-significantly lowest population (1.69/3 leaves) as compared to treatment T_1-Oil based formulation of *M. anisopliae* IIHR Strain (1.90/3 leaves). The significantly lowest population of aphid was documented in treatment T_2-POP, Imidacloprid 17.8 SL (5.21/ 3 leaves) as compared to treatment T_1-Oil based formulation of *M. anisopliae* IIHR strain (8.92/ 3 leaves).

The YVMV incidence was non-significantly lower in treatment T_2- POP, Imidacloprid 17.8 SL (1.84 %) as compared to treatment T_1- Oil based formulation of *M. anisopliae* IIHR strain (2.53 %). The treatment T_2-POP, Imidacloprid 17.8 SL recorded the significantly higher yield (134.14 q/ha) as compared to treatment T_1-Oil based formulation of *M. anisopliae* IIHR strain (102.14 q/ha). The highest (116.85%) increase in yield over untreated control was obtained in the treatment T_2-POP, recommendation, Imidacloprid 17.8 SL as compared to treatment T_1-Oil based formulation of *M. anisopliae* IIHR strain (65.11%) (Table 143).

Table 143. Evaluation of entomopathogens against sucking pests, YVMV disease incidence and yield in okra (2023-24)

Treatments	No. of aphids/3 leaves		No. of white-flies/3 leaves		No. of jas-sids/3 leaves		YVMV disease incidence (%)	Yield (q/ha)	Yield increase over control (%)	B:C Ratio
	BS	Pooled over spray	BS	Pooled over spray	BS	Pooled over spray				
Oil based formulation of *Metarhizium anisopliae* IIHR Strain @ 5ml/L	3.53* (11.96)	3.07b (8.92)	1.83 (2.85)	1.55 (1.90)	3.96 (15.18)	2.90b (7.91)	9.14** (2.53)	102.14b	65.11	3.57
POP Recommendation (Imida-cloprid 17.8 SL @ 0.3 ml/l)	3.91 (14.79)	2.39a (5.21)	1.89 (3.06)	1.48 (1.69)	4.19 (17.06)	2.70a (6.79)	7.79 (1.84)	134.14a	116.85	5.45
Untreated control	3.83 (14.17)	3.73c (13.41)	1.65 (2.24)	1.53 (1.84)	3.96 (15.18)	4.54c (20.11)	8.32 (2.09)	61.86c	-	-

S. Em ±(T)	0.18	0.04	0.09	0.03	0.20	0.04	0.40	4.54	-	-
C.D. at 5 % T	NS	0.13	NS	NS	NS	0.14	NS	13.98	-	-
C. V. (%)	12.55	12.50	12.78	13.78	12.98	12.17	12.70	12.08	-	-

***Figures are $\sqrt{x + 0.5}$ transformed values whereas those in parentheses are retransformed values**
****Figures outside the parentheses are arcsine transformed values, those inside are retransformed values**
BS: Before spray, NS: Non-significant

IV. 17. 2. Evaluation of *Neoseilus indicus* for the management of spider mites on okra (KAU, Thrissur

The result presented in Tables 144 and 145 reveals that, mean mite population of 0.54 mites/cm^2 recorded in acaricide treated plots was the lowest and was followed by that of plots in which *N. indicus* was released (0.99 mites/cm^2). Both these treatments were significantly superior to untreated plots with average mite population of 4.55 mites/cm^2. Difference was also observed in terms of yield per plant. *Neoseilus indicus* released plots recorded the highest mean yield of 23.67 t/ha, followed by acaricide treated plot (23.53 t/ha), both being on par with each other. Untreated control plots recorded significantly lower yield of 20.34 t/ha. The above trial has indicated that two releases of the predatory mite, *N. indicus* @ 30 no/plant can be effective in controlling spider mites with superior yield and confirms the potential of *N. indicus* as a biocontrol agent under open field condition.

Table 144. Field efficacy of *Neoseilus indicus* against spider mites on okra

Treatments	Number of mites /cm^2 leaf area								Per cent pest reduction over control
	Pre count	Post count							
		3 DAR$_1$	6 DAR$_1$	9 DAR$_1$	3 DAR$_2$	6 DAR$_2$	9 DAR$_2$	Mean	
T_1: Release of *N. indicus* @ 30 no./ plant	5.15	2.05^{b}	1.35^{b}	1.03^{b}	0.53^{b}	0.52^{b}	0.47^{b}	0.99^{b}	78.24
T_2: Spiromesifen 22.9 SC @ 8 ml/10L	4.69	1.40^{c}	0.87^{c}	0.56^{b}	0.22^{c}	0.09^{c}	0.12^{b}	0.54^{c}	88.13
T_3: Control	4.36	4.16^{a}	4.68^{a}	4.90^{a}	5.12^{a}	4.02^{a}	4.42^{a}	4.55^{a}	
CD (0.05)	NS	0.594	0.316	0.631	0.280	0.297	0.352	0.190	

***DAR – Days after release**

Table 145. Effect of different treatments on yield of okra

Treatments	Yield (t/ha)	Percent yield increase over control
T_1: Release of *N. indicus* @ 30 no./ plant	23.67^{a}	16.38
T_2: Spiromesifen22.9 SC @ 8 ml/10L	23.53^{a}	15.68
T_3: Control	20.34^{b}	-
CD (0.05)	2.925	

IV. 18. Biological control of insect pests of Cucumber

IV. 18. 1. Demonstration of *N. longispinosus* for the management of phytophagous mites, *T. urticae* on cucumber under polyhouse

YSPUHF, Solan

Demonstrations were carried out in four polyhouses for the management of phytophagous mite, *T. urticae* on cucumber by using predatory mites *N. longispinosus*. Data presented in Table 146 revealed that the population of phytophagous mites was 2.66, 2.02, 1.57 and 1.37 mites/cm^2 on 7th, 14th, 21st and 28th days after treatment, respectively with predatory mites *N. longispinosus* whereas in chemical treated plots it was 2.37, 1.93, 0.81 and 0.63 mites/cm^2 on 7th, 14th, 21st and 28th days after treatment, respectively. The highest yield (177.60 q/plant) was recorded in plants treated with spiromesifen (100g a.i./ha) followed by *N. longispinosus* (170.60 q/plant).

Table 146. Effect of *N. longispinosus* against *T. urticae* in cucumber

S.No.	Sampling Interval	Treatment		t-value	P<0.05
		T_1 (*N. longispinosus*)	T_2 (Spiromesifen)		
		Population of mites /cm^2 / leaf			
	Before Release	4.89 ±0.14	4.93 ±0.10	-0.2237	0.4127
1	7-day	2.66 ±0.10	2.37 ±0.09	2.0415	0.0281
2	14-day	2.02 ±0.21	1.93 ±0.12	0.3703	0.3577
3	21-day	1.57 ±0.08	0.81 ±0.14	3.9771	0.0004
4	28-day	1.37 ±0.23	0.63 ±0.11	2.8799	0.0062
	Yield(q/ha)	170.60 ±4.61	177.60 ±4.24	-1.0597	0.1516

IV. 18. 2. Efficacy of reduviid predator, *Sycanus collaris* against tobacco caterpillar, *Spodoptera litura* on cucumber in polyhouse

KAU, Thrissur

The pooled results of the experiment conducted during 2022-23 and 2023-24 are presented in Table 147. The cumulative mean fruit damage, at 14.00 per cent was the lowest in plots treated with chlorantraniliprole and was followed by plots in which *S. collaris* were released @ 20 no./10m^2 with mean fruit damage of 15.01 per cent, both being on par with each other. The highest extent of damage was observed in untreated plots, averaging 32.52 per cent damaged fruits. Both the *S. collaris* and chemical treated plots recorded more than fifty per cent reduction in damage over control (53.84 and 56.95 %).

Significant differences were also observed in terms of yield per plant. Insecticide treated plots recorded the highest mean yield of 2.26 kg per plant and was significantly superior to remaining treatments. This was followed by *S. collaris* released @ 20 nymphs/ 10m^2, with a mean yield of 1.71 kg/plant, both being significantly superior to untreated control recording 1.30 kg/plant.

Table 147. Field efficacy of *Sycanus collaris* against *Spodoptera litura* on cucumber (2022-23 & 2023-24)

Treatments	Mean fruit damage (%)				Cumulative mean fruit damage (%)	Per cent damage reduction over control	Marketable yield (kg/plant)	Per cent yield increase over control
	1 DAT	3 DAT	5 DAT	7 DAT				
T_1: Release of *Sycanus collaris* @ 20 nymphs/10 m^2	28.78 (31.71)	4.62 (6.47)^{c}	13.28 (16.37)^{b}	3.47 (5.64)^{c}	15.01 (22.12)^{b}	53.84	1.71^{b}	31.54
T_2: Chlorantraniliprole 18.5 SC 30 g. a.i/ha	18.65 (22.86)	13.03 (18.04)^{b}	17.27 (22.36)^{b}	7.98 (14.28)^{b}	14.00 (21.64)^{b}	56.95	2.26^{a}	73.85
T_3: Control	32.93 (33.46)	47.27 (45.23)^{a}	44.74 (43.89)^{a}	27.06 (30.66)^{a}	32.52 (34.52)^{a}	-	1.30^{c}	-
CD @ (0.05)	NS	10.502	13.484	7.028	4.799		0.310	

(Values in parenthesis are arc sin transformed values)

IV. 19. Biological control of insect pests of Bitter Gourd

IV. 19. 1. Evaluation of BIPM practices against sucking pests and fruit flies *Zeugodacus cucurbitae* in bitter gourd (KAU, Kumarakoam; AAU, Jorhat; ICAR-IIVR, Varanasi)

KAU, Kumarakoam

The results revealed that, there is no significant difference in number of sucking pest (aphids, whiteflies, jassids), lepidopteran pest (cucumber moth), epilachna beetle and damage caused by fruit fly *Zeugodacus cucurbitae* among the three treatments (BIPM practices, POP recommendation (Jaggary 1% + Malathion 50 EC @ 2ml/L and untreated control). Analysis of data on yield revealed that, there was no significant difference in yield among the treatments but highest yield was recorded in plot treated with BIPM practices (1.25 kg/plot).

AAU, Jorhat

The population of Epilachna beetle was significantly reduced after application of *Lecanicillium lecanii* NBAIR Vl8 5 g /L + Neem oil (2.5 ml/L). The per cent fruit damage reduction over control was 58.85% in BIPM and 51.63 in PoP recommendation with yield 44.41 q/ha and 42.35 q/ha, respectively (Table 148)

Table 148. Efficacy of BIPM practices against sucking pests and fruit flies *Zeugodacus cucurbitae* in bitter gourd

Treatments	Pre treatmt	Post treat-mt	% fruit damage after installation of cue lure			Reduction damage (%) over control	Yield (q/ha)
	Epilachna/pl	Epilachna/pl	7 DAI	10 DAI	15 DAI		
T1: BIPM practices	2.60	0.40	17.62	13.06	8.43	58.85	44.41
T2: POP Recommendation (Jaggary 1% + Emamectin benzoate 1ml/L @ 2ml/L	2.80	0.80	16.42	12.46	9.91	51.63	42.35
T3: Untreated control	2.20	1.80	18.34	22.97	20.49	----	34.96
CD (0.05)	NS	0.91	NS	5.92	5.69		2.05

***DAI (days after installation)**

ICAR-IIVR, Varanasi

Pooled data for three years (2021-24) revealed that Biointensive pest management practices including installation of cue lure traps for fruit flies, spraying of *Lecanicillium lecanii* NBAIR Vl-8 (2.5 g /L) + Neem oil (2.5 ml/L) for sucking pests and spraying of NBAIR *Bacillus thuringiensis* G4 @ 2 ml/L for leaf webber (*Diaphania indica*) was found effective with lowest fruit damage (8.49%) by cucurbit fruit flies accompanied with harbouring lowest whitefly (0.73/leaf), jassid (0.46 /leaf) and cucumber moth (2.91/plant) population among all the three treatments under IIVR, Varanasi condition Table 149

Table 149. Effect of different pest management modules on major insect pests of bitter gourd (Pooled data 2021-22, 2022-23 and 2023-24)

Treatments	Fruit fly (%)				Whitefly/Leaf				Jassid/Leaf				Cucumber moth/ Plant			
	2021	2022	2023	Avg	2021	2022	2023	Avg	2021	2022	2023	Avg	2021	2022	2023	Avg
T1: BIPM practices • Installation of cue lure traps @ 15/ha for mass trapping for Ccurbit fruit flies • Spray of *Lecanicillium lecanii* NBAIR Vl-8 (2.5 g /L) + Neem oil (2.5 ml/L) for sucking pests • *Bacillus thuringiensis* NBAIR Bt G4 @ 2 ml/L for leaf Webber (*Diaphania indica*)	7.46	8.45	9.57	8.49	0.74	0.57	0.89	0.73	0.59	0.33	0.46	0.46	3.35	3.23	2.16	2.91
T2: POP Recommendation (Jaggary 1% + Malathion 50 EC @ 2 ml/L)	16.6	15.6	17.4	16.6	1.83	1.69	1.87	1.80	1.35	1.21	1.43	1.33	7.54	6.49	5.41	6.48
T3: Untreated control practice	23.4	26.0	28.1	25.9	2.16	2.43	3.49	2.69	1.57	1.68	2.11	1.79	8.25	8.16	8.4	8.27
CD (5%)	4.26	2.56	4.49	5.11	0.61	0.87	0.91	0.71	0.57	0.79	0.53	0.89	2.33	1.56	1.66	1.56

IV. 20. Biological control of insect pests of Cauliflower

IV. 20. 1. Large scale field evaluation of Biointensive management practices for the pests of cauliflower (YSPUHF, Solan; AAU, Jorhat; CAU, Pasighat)

YSPUHF, Solan

Evaluation of biointensive management module comprising of mustard as trap crop and application of biocontrol agents was carried out in field.The data presented in Table 150 revealed that the per cent reduction of aphids over untreated control in BIPM and Spinosad @ 2.50 % SC spray was 73.87 and 80.26 per cent, respectively Table 150. Significantly lower populationof DBM was observed in BIPM as compared to untreated control. The yield of cauliflower in BIPM was 185.71 q/ha which was statistically at par with chemical treatment (192.86 q/ha).

Table 150. Effect of Biointensive management practices on aphid population in cauliflower during 2023-24

Treatment	Mean Aphids/three leaves	Reduction in aphid over Control (%)	Mean number of DBM larvae/plant	Yield (q/ha)
T1 (BIPM)	12.10 (3.62)	73.87	0.38 (1.18)	185.71
T2 (POP)	9.14 (3.18)	80.26	0.43 (1.19)	192.86
T3 (Control)	46.31 (6.88)	-	3.93 (2.20)	158.86
$CD_{0.05}$	0.19		0.26	21.00

*Figures in parenthesis are square root transformation values

AAU, Jorhat

In BIPM, aphid population was significantly reduced (1.92/plant) than PoP recommendation (Chlorantranileprole 18.5 SC @ 0.3ml/L) (3.33/ plant) (Table 151). The population of *Pieris brassicae* was significantly lower in PoP recommendation as compared to BIPM. There was no significant difference in yield in between BIPM and PoP recommendation.

Table 151. Efficacy of biointensive management practices against *Brevicoryne brassicae* on cauliflower

Treatments	Aphid counts/plant					
	Pre count	20 DAT	27 DAT	35 DAT	42 DAT	50 DAT
T1: BIPM	18.00	9.49	3.66	4.85	3.33	1.92
T2- POP recommendation	16.00	11.26	6.28	7.33	4.26	3.33
T3- Control	18.33	17.66	18.66	18.0	15.66	13.33
CD (0.05)	NS	3.80	1.84	2.14	1.53	1.13

CAU, Pasighat

The BIPM module recorded significantly lower incidence of aphids (3.50 v/s 4.73 /plant), cabbage butterfly caterpillars (0.62 v/s 0.84/plant) and curd damage (3.60 % v/s 4.85 %) in comparison to POP chemical module and untreated control. Due to higher pest incidence the POP module recorded significantly lower curd yield of 16.90 t/ha against BIPM (31.30 t/ha). BIPM module resulted in 85.20 percent increase in yield over untreated control (Table 152).

Table 152. Efficacy of BIPM module on pest incidence, curd damage and yield of Cauliflower

Modules	No. of *P. brassicae* larva/ plant		No. of *B. brassicae* / plant		Curd damage (%) Post-T	% damage reduction	Yield (t/ ha)	Percent Yield Increase
	Pre-T	Post-T	Pre-T	Post-T				
BIPM Module	1.95 (1.55)*	0.62 (1.05)	10.63 (3.33)	3.50 (1.99)	3.60 (10.8)**	80.4	31.30	85.20
POP recommendation	1.85 (1.52)	0.84 (1.15)	10.24 (3.27)	4.73 (2.88)	4.85 (12.5)	73.8	29.15	72.48
Untreated Control	1.90 (1.52)	2.73 (1.79)	10.31 (3.28)	18.50 (4.35)	18.40 (25.3)	-	16.90	-
S. Em ±	0.10	0.04	0.06	0.06	0.71		0.56	
C.D. at 5 %	NS	0.12	NS	0.18	2.18		1.72	

*Figures in the parenthesis are √x + 0.5 transformed values

**Figures in the parenthesis are Arc Sine transformed values

IV. 21. Biological control of insect pests of Cabbage

IV. 21. 1. Evaluation of biointensive management practices for the cabbage pests aphids (*Myzus persicae*) and diamondback moth (*Plutella xylostella*) (ICAR- IIVR, Varanasi; MPKV, Pune; CAU, Pasighat)

ICAR- IIVR, Varanasi

Bio-intensive insect pest management module (BIPM) registered lowest diamondback moth larval population (6.67/plant) accompanied with highest per cent reduction over control (56.67) followed by common package of practices (with 10.82 DBM population/plant and 29.70 PROC) where 5% NSKE was sprayed. Similarly, the lowest aphid population (*Myzus persicae* and *Brevicoryne brassicae*) was also recorded in the BIPM package (2.65/leaf and 62.36 PROC) followed by package of practices (4.97/leaf and 26.40 PROC) and untreated control plots (7.04/leaf) (Table 153).

Table 153. Evaluation of BIPM practices for the cabbage aphids and diamondback moth

Treatments	Before spray/ Plant	DBM/ Plant	Percent reduction over control	Before spray/ leaf	Aphid / leaf	Percent reduction over control	Predatory Lady bird beetle /plant	Spiders / plant
BIPM	14.49	6.67[c]	56.67	11.46	2.65[c]	62.36	2.69[a]	2.07[a]
POP (NSKE 5%)	14.68	10.82[b]	29.70	12.38	4.97[b]	26.40	2.78[a]	2.19[a]
Untreated control	16.57	15.39[a]	--	10.67	7.04[a]	--	3.17[a]	2.54[a]
CD (5%)	--	2.89	--	--	2.67	--	0.46	0.44

MPKV, Pune

The data on evaluation of biointesive management practices against cabbage aphid and diamond back moth revealed that the treatment with BIPM components was significantly superior over rest of two treatments and recorded aphids (18.46 aphids/leaf) with 79.71 per cent reduction over control and least larval population of diamondback moth (0.19 larva/head) with 89.78 per cent reduction over control. Moreover, BIPM treatment recorded highest marketable yield (12.32 t/ha) of cabbage and significantly superior. The next effective treatment was POP recommendation (spraying 5% NSKE) which recorded 35.24 aphids/leaf and 0.55 larva/head with 10.58 t/ha yield Table 154. The highest yield of 12.32 t/ha was registered in the treatment of BIPM with 2.05 B:C ratio followed by POP recommendation of spraying of NSKE @ 5 % with 10.58 t/ha cabbage yield. The least yield was recorded in untreated control (8.69 t/ha).

Table 154. Evaluation of Biointensive management practices against cabbage aphid, *Brevicoryne brassicae* L. and diamondback moth *Plutella xylostella* L.

Treatment	Cabbage aphids/leaf (No.)		Reduction over control (%)	DBM larva/head (No.)		Reduction over control (%)	Yield (t/ha)
	Pre count	Post count		Pre count	Post count		
T_1:BIPM	70.54 (7.90)*	18.46 (4.37)	79.71	1.90 (1.58)	0.19 (1.05)	89.78	12.32
T_2: POP Spraying 5% NSKE	73.20 (8.71)	35.24 (5.65)	61.26	1.44 (1.42)	0.55 (1.25)	70.43	10.58
T_3: Untreated Control	69.36 (8.46)	90.96 (9.97)	-	1.86 (1.73)	1.86 (1.66)		8.69
SE±	N.S.	0.21		N.S.	0.04		0.63
CD at 5%	1.07	0.64		0.26	0.13		1.95
CV	10.86	8.24		13.64	8.25		15.87

*Figures in parenthesis are √x+1 transformed values

CAU, Pasighat

The BIPM module recorded significantly lower pest incidence (2.10 DBM larvae/plant, 3.26 aphids/plant and 7.30% head damage) in comparison to POP module (2.68 DBM larvae/plant, 4.10 aphids/plant and 8.60 % head damage). Whereas, the predators population was significantly higher (1.20 coccinellids/plant) in BIPM; exhibits its eco-friendly nature towards natural enemies. Due to lower pest incidence, the BIPM module documented the highest cabbage head yield *i.e.,*25.50 t/ha and lowest in 14.03 t/ha due to highest head damage (17.96 %) Table 155.

Table 155. Efficacy of BIPM module on pest incidence, head damage and yield of Cabbage

Modules	No. Lepidoptera larva/plant		No. of Aphids / plant		Cabbage head damage (%) PostT	Percent reduction in Crop damage	No. of Predators/plant		Yield (t/ha)	Percent Yield Increase Over Control
	PreT	PostT	PreT	PostT			PreT	PostT		
BIPM Module	5.10 (2.36)	2.10 (1.58)	11.85 (3.51)	3.26 (1.91)	7.30 (15.58)	59.35	1.14 (5.85)	1.20 (6.03)	25.50	81.75
POP recommendation	5.25 (2.38)	2.68 (1.75)	12.01 (3.54)	4.10 (2.10)	8.60 (16.98)	52.20	1.35 (6.44)	0.50 (3.99)	23.02	64.07
Untreated Control	5.30 (2.39)	5.60 (2.45)	11.59 (3.47)	8.38 (2.95)	17.96 (25.01)	-	1.23 (6.09)	1.46 (6.77)	14.03	-

S. Em ±	0.08	0.13	0.07	0.18	0.78		0.53	0.61	0.85	
C.D. at 5 %	NS	0.39	NS	0.56	2.40		NS	1.88	2.63	

***Figures in the parenthesis are √x + 0.5 transformed values**
****Figures in the parenthesis are Arc Sine transformed values**

IV. 22. Biological control of insect pests of Onion

IV. 22. 1. Evaluation of bio-efficacy of entomopathogens against onion thrips (*Thrips tabaci* L.)

TNAU, Coimbatore

The results revealed, thrips population was 2.27 and 2.33 in *Beauveria bassiana* NBAIR Bb5a (1 x 10^8 spores/g) @ 5g/L and *Metarhizium anisopliae* NBAIR Ma4 (1x 10^8 spores/g) @ 5g/L respectively on 10 Days After Spraying and these two treatments were on par with insecticide treatment (1.87). Among the entomopathogens treatments, the yield was maximum in *Beauveria bassiana* NBAIR Bb5a (1x10^8 spores/g) @ 5g/L (16198 Kg/ha) followed by *Metarhizium anisopliae* NBAIR Ma4 (1x10^8 spores/g) @ 5g/L (15788 Kg/ha). CB ratio was 2.51 in *Beauveria bassiana* NBAIR Bb5a (1x10^8 spores/g) @ 5g/L treated plots respectively (Table 156).

Table 156. Evaluation of different entomopathogens against Onion thrips, *Thrips tabaci* L

Treatment	No. of thrips/leaf*				Yield* (Kg/ha)	Yield increase over Control (%)	CB ratio
	Pre count	3 DAS	7 DAS	10 DAS			
T1: *Beauveria bassiana* NBAIR Bb5a (1 x 10^8 spores/g) @ 5gm/L	4.47 (2.110)	2.27 (1.505)^{bc}	2.67 (1.633)^{bc}	2.27 (1.501)^{ab}	16199 (127.27)^{a}	17.53	2.51
T2: *Metarhizium anisopliae* NBAIR Ma4 (1 x 10^8 spores/g) @ 5gm/L	4.20 (2.049)	1.87 (1.358)^{ab}	2.40 (1.547)^{b}	2.33 (1.527)^{ab}	15788 (125.64)^{b}	14.55	2.37
T3: *Lecanicillium lecanii* NBAIR V18 (1 x 10^8 spores/g) @ 5gm/L	4.07 (2.016)	2.13 (1.458)^{b}	2.20 (1.480)^{b}	2.87 (1.692)^{bc}	15209 (123.32)^{c}	10.35	2.28
T4: *Pseudomonas fluorescens* NBAIR PfDwD – 2% WP 20gm/L	4.07 (2.010)	2.93 (1.710)^{d}	2.47 (1.569)^{b}	2.93 (1.707)^{bc}	15317 (123.76)^{c}	11.13	2.29
T5: Azadirachtin 1500 ppm @2ml/lit	4.27 (2.062)	2.87 (1.692)^{cd}	2.20 (1.479)^{b}	2.27 (1.490)^{ab}	16122 (126.97)^{ab}	16.98	2.49
T6: POP recommendation (Dimethoate 30 EC)	4.07 (2.010)	1.40 (1.181)^{a}	1.27 (1.125)^{a}	1.87 (1.358)^{a}	15945 (126.27)^{ab}	15.69	2.45
T7: Control	3.733 (1.930)	4.07 (2.015)^{e}	3.27 (1.807)^{c}	3.40 (1.843)^{c}	13783 (117.39)^{d}		2.01
SED	NS	0.096	0.083	0.115	0.695		
CD (P=0.05)		0.201	0.175	0.242	1.464		

DAS- Days After Spraying

***Figures in parentheses are square root transformed values**

****Figures in parentheses are arcsine transformed values**

In a column means followed by same letter(s) are not significantly different (p=0.05) by LSD

Values are mean of 3 replications

IV. 23. Biological control of insect pests of Chilli

IV. 23. 1. Evaluation of entomopathogens against sucking pests of chilli (thrips, aphids and whitefly) of chilli (ICAR, IIHR Bengaluru; PJTSAU, Hyderabad; HRS, Ambajipeta; CAU Pasighat)

ICAR-IIHR, Bengaluru

Different entomopathogens were evaluated against chili thrips, *Thrips parvispinus* as predominant species as well as *Scirtothrips dorsalis* in the later stage of crop. Among the entomopathogens evaluated, four sprays of *Bacillus albus* NBAIR-BATP @ 20ml/L and *Pseudomonas fluorescens* NBAIR-PFDWD 10g/L was significantly superior over other entomopathogens.The mean number of thrips per plant observed was 3.9 in *B. albus* followed by 4.3 in *P. fluorescens* (Table 157).

Table 157. Evaluation of different entomopathogens against thrips, *Thrips parvispinus* in chilli

	Treatment details	Mean number of thrips/plant										Yield t/ha
		Pre-count	First Spray (*Thrips parvispinus*)		Second spray (*T. parvispinus*)		Third spray (*Scirtothrips dorsalis*)		Fourth spray (*S. dorsalis*)		Pooled	
			3DAS	7DAS	3DAS	7DAS	3DAS	7DAS	3DAS	7DAS		
T1	*Metarhizium anisopliae* IIHR Strain @5ml /L	20.0 (4.5)	8.3 (3.0)	10.5 (3.3)	6.5 (2.7)	4.5 (2.2)	3.5 (2.0)	2.6 (1.8)	0.8	-	5.2 (2.3)	2.0
T2	*Metarhizium anisopliae* NBAIR Ma4 (1x10[8] spores/g)@5 g/L	18.1 (4.3)	12.0 (3.5)	12.8 (3.6)	7.1 (2.8)	4.2 (2.2)	2.5 (1.2)	0.7 (1.1)	0.7	-	5.7 (2.5)	1.1
T3	*Beauveria bassiana* NBAIR Bb5a (1x10[8] spores/g) @5 g/ L	17.3 (4.2)	8.8 (3.0)	10.2 (3.3)	4.2 (2.3)	2.7 (1.8)	3.5 (2.0)	1.5 (1.4)	0.7	-	4.4 (2.2)	1.3
T4	*Lecanicillium lecanii* NBAIR Vl8 @ (1x10[8] spores/g) @5g/L	20.3 (4.6)	13.9 (3.8)	10.5 (3.3)	11.9 (3.5)	3.8 (2.1)	4.3 (2.2)	1.4 (1.4)	1.3	-	6.7 (2.7)	1.8
T5	*Pseudomonas fluorescens* NBAIR-PFDWD 10g/L	20.7 (4.6)	8.5 (3.0)	7.9 (2.9)	7.4 (2.8)	1.5 (1.4)	3.1 (1.9)	0.9 (1.2)	0.9	-	4.3 (2.2)	1.8
T6	*Bacillus albus* NBAIR-BATP 20ml/L	17.6 (4.3)	7.7 (2.8)	7.8 (2.9)	4.1 (2.3)	3.9 (2.1)	1.5 (1.4)	1.6 (1.4)	0.7	-	3.9 (2.0)	1.7
T7	Fipronil @ 1mL/L	16.1 (4.1)	5.9 (2.5)	7.6 (2.8)	4.5 (2.2)	1.3 (1.3)	2.0 (1.6)	1.4 (1.4)	0.5	-	3.3 (2.0)	2.1
T8	Control	16.2 (4.1)	17.6 (4.3)	11.8 (3.5)	6.3 (2.6)	4.5 (2.2)	4.2 (2.2)	1.7 (1.5)	1.1	-	6.7 (2.7)	0.8
	CD @ 0.05%	0.3	0.5	0.3	0.3	0.2	0.2	0.1	NS	-	0.1	0.4
	CV	3.5	4.4	5.1	5.4	6.3	5.6	6.2	9.5	-	2.2	12.7

Values in Parenthesis are sqrt(x+0.5) transformed values

PJTSAU, Hyderabad

The trial was conducted in the College Farm, PJTSAU, Rajendranagar during *rabi* 2023-24 in an area of 800 sq.m., with four treatments including unsprayed control with six replications laid out in RBD on chilli (green) crop var. PHS 2121.The results revealed, among the four treatments, application of Fipronil @ 2.0 ml/L resulted reduction in thrips incidence (68.77%) and leaf damage symptoms

(51.11%) when compared with *M. anisopliae* IIHR Strain @ 5ml /L (19.62% and 16.63%), *Beauveria bassiana* NBAIR *Bb*5a @ 5 ml/L (25.19% and 10.35%) and Untreated check (100%) (Table 158). Whereas in terms of yields, application of Fipronil has recorded 82.75% higher yield followed by *M. anisopliae* IIHR Strain (23.13%), *Beauveria bassiana* NBAIR *Bb*5a (13.79%) when compared with untreated control.

Table 158. Evaluation of entomopathogens against sucking pests of chilli (thrips, aphids and Whitefly) using oilbased formulation of *Metarhizium anisopliae*)

Treatments	Thrips Population per leaf/ Plant *			Percentage leaf damage by thrips (%)*			Yield (Kg/ha)	yield increase over control (%)
	Pre- treat-ment count	Post Treatment count	pest reduction over con-trol (%)	Pre treat-ment	Post treat-ment	Pest reduction over con-trol (%)		
T1: *M. anisopliae* IIHR Strain (1x10^8 spores/g) @ 5ml /L	6.53 (2.64)	5.20 (2.38)	19.62	72.69 (58.74)	56.35 (48.82)	16.63	1440	24.13
T2: *Beauveria bassiana* NBAIR *Bb*5a (1x10^8 spores/g) @ 5 ml/L	6.86 (2.66)	4.84 (2.26)	25.19	69.5 (56.66)	62.63 (52.80)	10.35	1320	13.79
T3: Fipronil @ 2.0 ml/L	6.7 (2.59)	2.02 (1.57)	68.77	70.44 (57.66)	21.87 (27.49)	51.11	2120	82.75
T4: Untreated control	6.36 (2.55)	6.47 (2.60)	-	72.14 (59.84)	72.98 (58.78)	-	1160	-
SEM	0.22	0.15	-	4.19	3.7	-	-	-
CD (.05%)	0.67	0.47	-	12.63	11.2	-	-	-
CV	12.11	10.14	-	10.17	11.26	-	-	-

HRS, Ambajipeta

The spraying experiment was carried out in Narayanalanaka village (16.7160° N, 81.8958° E) of Kothapeta mandal in Dr.B.R.Ambedkar Konaseema district. The results reveal that after final spray (fourth spray), imidacloprid had 2.65 thrips population. The bio pesticide treatments oil-based formulation of *Metarhizium anisopliae* and powder based formulation *Beauveria bassiana* also recorded low thrips population *i.e.,* 3.68 and 5.31 thrips per flower respectively after final (fourth) spray. In untreated control block the maximum population of thrips ranging from 11.35 to 31.23 was recorded (Table 159). There is 91.13 percent pest reduction in the imidacloprid treatment over control followed 88.38 percent oil based formulation of *Metarhizium anisopliae* and 81.21 percent powder formulation *Beauveria bassiana* (NBAIR Bb5a). No other sucking pests were observed in experimental plot.

Table 159. Field evaluation of entomopathogens against sucking pests of chilli

S. No.	Treatments	Dosage	Average number of thrips per 10 flowers per plant 7 days after spray		
			Pre count*	Post treat-ment	Percent pest reduc-tion over control (%)
1	T_1- Oil based formulation of *M. anisopliae* IIHR Strain (1x10^8 spores/ml)	5 ml/l	11.50 (3.46)	3.68 (2.01)	88.38%

2	T_2- Powder formulation *Beauveria bassiana* NBAIR Bb5a (1x10^8 spores/g)	5 g/ l	10.26 (3.28)	5.31 (2.37)	81.21%
3	T_3- Imidacloprid 17.8 SL	0.3ml/l	10.85 (3.36)	2.65 (1.72)	91.13%
4	T_4- Untreated control	-	11.35 (3.44)	31.23 (5.60)	--
	Sem	-	-	0.14	
	CD (5%)	-	-	0.42	

***Fig in parenthesis are √x+0.5 transformed values**

CAU, Pasighat

The oil based formulation of *M. anisopliae* IIHR Strain (1x10^8 spores/g) @ 5ml/L was found significantly superior (6.03 thrips/plant) over powder formulation *Beauveria bassiana* NBAIR Bb5a (1x10^8 spores/g) @ 5 g/ L (7.38 thrips/plant). The *M. anisopliae* treated plots yielded 16.02 q chilli fruits/ha, which is 56.29 % higher than the control. However, the Imidacloprid 17.8 SL @ 0.3ml/L recorded with lowest thrips incidence (5.06/plant) and highest fruit yield (16.98 q/ha).

IV. 23. 2. Effect of ICAR NBAIR promising entomopathogen strains against South East Asian thrips (*Thrips parvispinus*) in Chilli (PJTSAU, Hyderabad)

The trial was conducted in the ARI Farm, PJTSAU, Rajendranagar during *rabi* 2023-24 in an area of 800 sq.m., with six treatments including unsprayed control and with six replications laid out in RBD on Chilli crop var. PHS 2121.The results revealed, application of acetamiprid 0.2 g/L resulted in reduction of *Thrips parvispinus* incidence by 63.90 percent followed by *Lecanicillium lecanii* Vl8 @ 5g /L (47.58%), *Beauveria bassiana* Bb 5a @ 5g /L (31.87%), *Pseudomonas fluorescens* PfDWD @ 10g/L (13.14%), *Bacillus albus* NBAIR BATP @10g/L (7.10%) when compared with untreated check. Application of acetamiprid 0.2g/L has recorded higher yield by 68.75 per cent followed by *Lecanicillium lecanii* Vl8 (43.75%).

Table 160. Effect of ICAR NBAIR promising entomopathogen strains against South East Asian thrips (*Thrips parvispinus*) in Chilli

Treatments	Black thrips population per leaf/ Plant *		Percent pest reduction over control (%)	Yield (Kg/ha)	Percent yield increase over control (%)
	Pre- treatment count	Post-Treatment count			
T1: *Beauveria bassiana Bb* 5a @ 5g /L	7.15 (2.75)	5.04 (2.22)	31.87	760	18.75
T2: *Lecanicillium lecanii Vl*8 @ 5g /L	6.95 (2.72)	3.80 (2.05)	47.58	920	43.75
T3: *Bacillus albus* NBAIR BATP @10g/L	6.25 (2.50)	5.78 (2.45)	7.10	720	12.5
T4: *Pseudomonas fluorescens PfDWD @10g/L*	6.9 (2.71)	6.03 (2.55)	13.14	680	6.25

T5: Acetamiprid 0.2g/L	7.125 (2.75)	2.89 (1.83)	63.90	1080	68.75
T6: Untreated control	6.725 (2.66)	6.62 (2.66)	-	640	
SEM	0.2	0.19	-	-	-
CD (0.05%)	0.61	0.57	-	-	-
CV	10.82	11.7	-	-	-

IV. 24. Biological control of insect pests of Brinjal

IV. 24. 1. Demonstration of bio intensive management practices for the management fruit and shoot borer in brinjal (KAU, Vellayani)

The experiment was laid out in August 2023 to December 2023 at Thumba, under Kadinamkulam Krishi bhavan in an area of 50 cents (0.2ha). Anaylsis of two- year data on shoot damage, fruit damage and yield revealed that the BIPM module was equally effective as KAU PoP as the parameters did not vary significantly from each other. It is not able that the natural enemy population was significantly higher in BIPM plots compared to chemical treated plots.

IV. 24. 2. Demonstration of bio-intensive management practices for the management of pests (fruit borer/ sucking pests) of brinjal (KAU, Kumarakom, PJTSAU, Hyderabad, TNAU, Coimbatore)

KAU, Kumarakom

The fruit and shoot damage in brinjal due to *Leucinodes orbonalis* was significantly low (24.51% and 16.15%) in plots sprayed with pesticide (Chlorantraniliprole 18.5 SC @ 30 ai/ha (2ml/10 L) followed by 30.78% shoot damage and 20.60% fruit damage in BIPM plots (*Bacillus thuringiensis* (NBAIR BtG4) 2ml/L (two rounds of spray) + *Lecanicillium lecanii* (one round of spray) + *Trichogramma chilonis* (8 releases) + Pheromone traps @ 20/ha). In the control plot, shoot and fruit damage was 39.82 % and 42.73 % respectively. The marketable fruit yield was 9.58t/ha in BIPM plots while in control plots the yield was 7.55 t/ha (Table 161).

PJTSAU, Hyderabad

The trial was conducted in Mankal village of Rangareddy District, Telangana State during *rabi* 2023-24 on Brinjal var. Kirti (Ankur). The results in the Table 162 reveals that among three treatments farmers practice has reduced the percent infestation of leaf hopper by 61.14 percent, shoot damage by 43.30 percent and fruit damage by 43.50 percent when compared with untreated check. Whereas in terms of percentage of yield increase BIPM and farmers practice are on par with each other when compared with untreated check.

TNAU, Coimbatore

The fruit damage in brinjal due to *Leucinodes orbonalis* was significantly low (30.57 %) in BIPM plots (*Bacillus thuringiensis* (NBAIR BtG4) 2ml/L (two rounds of spray) + *L. lecanii* (one round of spray) + *Trichogramma chilonis* (8 releases) + Pheromone traps @ 20/ha) compared to 51.35 per cent in the control plot. The marketable fruit yield was 18063 kg/ha in BIPM plots while in control plots the yield was 13586 Kg/ha. The cost benefit ratio realized in BIPM was 3.19 as against 3.31 in insecticides treated plots (Table 163).

IV. 24. 3. Evaluation of entomopathogens against *Myllocerous subfasciatus* on brinjal

ICAR-IIHR Bengaluru

During 2023-24 different entomopathogens were evaluated against brinjal ash weevil, *Myllcerus subfacsiatus*. All the treatments showed statistically non-significant results. None of the entmopathogenic fungi and entomopathogenic nematodes showed significant efficacy against ash weevils in brinjal.

Table 161. Bio intensive management practices for the management of pests (fruit borer/ sucking pests) of brinjal

Treatments	Shoot damage (%)		Fruit damage (%)		No. of leaf hoppers/three leaves		Yield (t/ha)	Yield increase over control (%)
	Pre count	Post count	Pre count	Post count	Pre count	Post count		
T1: BIPM practices	32.36 (5.53)	30.78 (5.38)	25.55 (4.89)[b]	20.60 (3.83)[b]	0.91 (1.17)	1.00 (1.20)	9.58[b]	26.88
T2: POP Recommendation (Chlorantraniliprole 18.5 SC @ 30 ai/ha (2ml/10 L)	32.63 (5.64)	24.51 (4.90)	20.83 (4.64)[b]	16.15 (3.90)[b]	0.54 (1.00)	0.63 (1.02)	12.94[b]	71.39
T3: Untreated control	30.88 (5.50)	39.82 (6.26)	42.35 (6.44) [a]	42.73 (6.46)[a]	1.20 (1.27)	0.60 (1.01)	7.55[a]	
CD (0.05%)	NS	NS	0.61	1.00	0.14	0.15	1.35	
	21.54	21.49	21.66	39.54	22.77	26.91	25.27	

Table 162. Demonstration of BIPM for the management of pests (fruit borer/sucking) of brinjal

Treatment	Leafhopper no/ plant			Shoot damage (%)			Fruit damage (%)	Per cent reduction over control (%)	Yield (q/acre)	Percent yield increase over control (%)
	Pre count	Post counts	reduction over control (%)	Pre count	Post counts	reduction over control (%)				
BIPM	12.13 (3.54)	8.45 (2.95)	29.60	13.93 (21.82)	10.49 (18.84)	21.74	11.30 (19.56)	24.36	29375	76.69
Farmers Practice	11.91 (3.6)	4.31 (2.45)	61.14	13.83 (21.49)	6.98 (15.25)	43.30	8.44 (17.06)	43.50	29625	78.19
Untreated control	12.28 (3.45)	12.43 (3.59)		14.99 (22.73)	15.82 (23.26)		14.94 (22.71)	-	16625	
SEM	0.29	0.23		1.17	1.72		0.83	-		
CD (5%)	0.88	0.72		1.66	3.70		2.5	-		
CV	11.66	11.29		13.19	14.9		11.15	-		

Table 163. Bio-intensive insect management in brinjal

Treatments	Fruit damage (%) **			Yield Kg/ha (Marketable fruits) *	Yield increase over control (%)	CB ratio
	Pre Treat-ment	Post Treat-ment	Reduction over control (%)			
T1: BIPM - Module	39.14 (38.56)	30.57 (33.54)[b]	40.47	18062.56 (134.35)[a]	32.98	3.19
T2: Insecticide	38.67 (38.20)	24.41 (29.55)[a]	52.47	19273.42 (138.71)[a]	41.38	3.31
T3: Control	40.42 (39.25)	51.35 (45.78)[c]	-	13585.66 (116.44)[b]	-	2.43
SEd	-	1.301	-	2.437	-	-
CD (P=0.05)	-	2.732	-	4.929	-	-

Figures in parentheses are square root transformed values*/ arcsine transformed values

Means followed by a common letter in a column are not significantly different(P=0.05)

IV. 24. 4. Evaluation of promising strains of entomopathogenic bacteria and fungi against Brinjal shoot and fruit borer (*Leucinodes orbonalis*) (SKUAST-Jammu)

Mean shoot infestation percentage was lowest in Chlorantraniliprole (5.254%), followed by *P. entomophila* (6.454%). Accordingly, the mean fruit infestation was also significantly lowest in Chlorantraniliprole (6.872%), followed by *P. entomophila* (7.938%), and the yield (20.903 and 19.783 in Chlorantraniliprole and *P. entomophila* respectively (Table 164 & 165.)

Table 164. Effect of entomopathogenic bacteria and fungi on brinjal shoot and fruit borer infestation

Treatments	Pre count	% Shoot Infestation						Mean infes-tation	% reduc-tion over con-trol
		I spray		II Spray		III Spray			
		7 DAS	14 DAS	7 DAS	14 DAS	7 DAS	14 DAS		
T1 – *Pseudomonas entomophila* strain NBAIR-PEOWN (10 gm / litre)	11.917	8.533	6.883	5.033	7.183	6.15	4.942	6.454	74.07
T2 - *Beauveria bassiana* strain NBAIR-Bb5a (5 gm/litre)	12.042	10.09	8.73	10.33	8.76	8.89	8.65	9.24	62.86
T3 – Chlorantraniliprole 18.5 SC 30g a.i./ha	11.78	7.49	5.53	4.16	6.41	4.75	3.16	5.25	78.89
T4 – Untreated control	11.88	14.28	20.83	32.49	16.04	28.60	37.07	24.89	-
CD (P=0.05)	NA	0.81	0.78	1.00	0.81	0.87	1.329	-	-

Table 165. Effect of entomopathogenic bacteria and fungi on fruit infestation and yield

Treatments	Mean fruit infestation (%)	% reduction over control	Yield (t/ha)
T1 – *Pseudomonas entomophila* strain NBAIR-PEOWN (10 gm / litre)	7.938	70.54	19.783
T2 - *Beauveria bassiana* strain NBAIR-Bb5a (5 gm/litre)	13.332	50.52	17.015
T3 – Chlorantraniliprole 18.5 SC 30g a.i./ha	6.872	74.49	20.903
T4 – Untreated control	26.945	-	12.913
CD (P=0.05)	0.955	-	0.858

IV. 24. 5. Evaluation of entomopathogens against *Epilachna vigintioctopunctata* on Brinjal \ CAU, Pasighat

Among the biopesticides, *Metarhizium anisopliae* IIHR Strain oil formulation (1x10^8 spores/ml)@5 ml/L was the best treatment in reduction of Hadda beetles incidence (2.15 beetles/plant) and infestation (4.10 % defoliation) (Table 166) on Brinjal.

Table 166. Field efficacy of entomopathogens against *Epilachna vigintioctopunctata* on Brinjal

Treatments	Mean number of Hadda beetles/plant		Percent pest reduction over control (%)	Percent defoliation by grubs & adults of Hadda beetle on Brinjal		Percent damage reduction over control (%)	Fruit yield (q/ha)	Percent yield increase over control (%)
	Pre-treatment count	Post Treatment count		Pre treatment	Post treatment			
T1:*Metarhizium anisopliae* IIHR Strain oil formulation (1x10^8 spores/ml) @ 5 ml/L	3.18 (1.91)	2.15 (1.81)	55.20	9.05 (17.49)**	4.10 (11.62)	63.49	29.33	26.42
T2: *Beauveria bassiana* IIHR Strain (1x10^8 spores/g) WP formulation @ 5 g/L	3.10 (1.89)	3.92 (2.09)	18.33	9.10 (17.49)	6.90 (15.20)	38.55	28.21	21.59
T3: *Metarhizium anisopliae* NBAIR Ma4 (1x10^8 spores/g) WP formulation @ 5 g/L	3.85 (1.82)	3.14 (1.90)	34.58	9.01 (17.44)	5.23 (13.19)	53.42	28.48	22.75
T4: *Beauveria bassiana* NBAIR Bb-5a (1x10^8 spores/g) WP formulation @ 5 g/L	3.33 (1.94)	2.86 (1.82)	40.41	9.39 (17.83)	4.92 (12.77)	56.18	28.75	23.92
T5: *Heterorhabditis indica* NBAIR H38 @ 2.5 10^9 IJs ha^{-1}	3.92 (2.09)	3.41 (1.97)	28.95	9.98 (18.39)	5.44 (13.51)	51.55	27.40	18.10
T6: Chlorpyriphos 20 EC @ 2 ml/L	3.63 (2.03)	1.53 (1.42)	68.12	10.03 (18.42)	3.86 (11.27)	65.62	31.23	34.61
T7: Untreated control	3.51 (1.98)	4.80 (2.30)	-	9.80 (18.22)	11.23 (19.53)	-	23.20	
S. Em ±	0.16	0.09		0.82	0.76		1.13	
C.D. at 5 %	NS	0.28		NS	2.36		3.49	

*Figures in the parenthesis √x + 0.5 transformed values and **Figures in the parenthesis are Arc sine transformed values

IV. 25. Biological control of insect pests of Cassava Pests

IV. 25. 1. Field evaluation of parasitoid and predators for the management of cassava mealybug

TNAU, Coimbatore

A field trial was conducted in K.G. Valasu village of Erode district. The cassava mealybug population was low in *Anagyrus lopezi* released plot (1.85 colonies / plant) followed by *Apetochrysa astur* (2.21 colonies / plant) and the insecticide treated plots (7.13 colonies /plant) on 60 days after imposing treatments. Rosette damage was also low in (6.08, 7.43 and 22.71 %) respectively in *A. lopezi, A. astur* and insecticide treated plots (Table 167). CB ratio was maximum in *A. lopezi* released plot (3.02) followed by *A. astur* released plots (2.83) while in insecticide treatment it was 2.78 (Table 168).

Table 167. Effects of entomophages on population and damage of cassava mealybug

Treatments	Colonies/plant (Nos.)*				Rosette damage (%) **			
	Pre treat-ment	15 DAT	30 DAT	60 DAT	Pre treat-ment	15 DAT	30 DAT	60 DAT
T1: *Apertochrysa astur*	10.52 (3.08)	8.74 (3.14)[bc]	6.77 (2.60)[b]	2.21 (1.48)[b]	35.21 (35.24)	33.05 (35.09)[b]	25.74 (30.48)	7.43 (15.82)[b]
T2: *Anagyrus lopezi*	9.47 (2.93)	7.33 (2.76)[ab]	5.61 (2.37)[a]	1.85 (1.36)[a]	32.69 (33.43)	29.37 (32.82)a	20.18 (26.69)	6.08 (14.27)[a]
T3: Insecticide	11.38 (3.18)	6.04 (2.50)[a]	7.13 (2.67)[c]	8.67 (2.94)[c]	34.47 (34.70)	32.36 (34.67)[b]	28.15 (32.04)	22.71 (28.46)[c]
T4: Control	10.33 (3.04)	12.45 (3.32)[c]	11.82 (3.44)[d]	15.27 (3.91)[d]	33.18 (33.49)	35.22 (36.40)[c]	36.43 (37.13)	38.72 (38.48)[d]
SEd	NS	0.244	0.014	0.007	NS	0.250	0.216	0.095
CD (P = 0.05)	NS	0.513	0.030	0.014	NS	0.525	0.455	0.199

DAT – Days after treatment

Figures in parentheses are square root transformed values*/ arcsine transformed values Means followed by a common letter in a column are not significantly different(P=0.05) Values are mean of five replications.**

Table 168. Effects of entomophages on natural enemies of cassava mealybug and tuber yield

Treatments	Natural enemies/plant (Nos.)*						Yield (t/ha)	Yield increase Over control	CB Ratio
	Apertochrysa astur		Coccinellids		*Anagyrus lopezi*				
	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT			
T1:*Apertochrysa astur*	2.81 (1.67)[a]	3.62 (1.90)[a]	2.71 (1.65)[a]	3.03 (1.74)[a]	0.53 0.73)[c]	1.06 (1.03)[c]	25.28 (5.03)[b]	18.85	2.83
T2: *Anagyrus lopezi*	2.54 (1.59)[b]	3.05 (1.75)[b]	2.35 (1.53)[b]	2.79 (1.67)[b]	1.55 (1.25)[a]	3.13 (1.77)[a]	26.53 (5.15)[a]	24.73	3.02

T3: Insecticide	1.33 (1.15)[d]	1.42 (1.19)[d]	1.44 (1.20)[d]	1.67 (1.29)[d]	0.21 (0.46)[d]	0.38 (0.62)[d]	24.96 (4.99)[c]	17.35	2.78
T4: Control	1.62 (1.27)[c]	2.41 (1.55)[c]	2.06 (1.44)[c]	2.55 (1.59)[c]	0.66 (0.81)[b]	1.58 (1.26)[b]	21.27 (4.61)[d]	-	2.23
SEd	0.009	0.009	0.006	0.007	0.004	0.007	0.021	-	-
CD(P = 0.05)	0.018	0.018	0.013	0.015	0.010	0.016	0.045	-	-

DAT – Days after treatment

Figures in parentheses are square root transformed values*/arcsine transformed values**

Values are mean of five replications.

V. TRIBAL SUB PLAN

Table 169. TSP

Institute HQ/Name of the regional station/Centre implementing the activity	Activity	Number of beneficiaries	Name of the villages District and Sate
GBPUAT, Pantnagar	• 60q Biocontrol agent PBAT-3 • Distributed quality seed of paddy (5.8q), a vegetable seed kit, 400nos. containing 50g seeds in each packet of coriander, fenugreek, spinach and raddish. • Distributed polysheet (2x10m), 400nos. • Placed yellow sticky trap (nos. 4000) • 20 field days conducted. • 7 trainings conducted.	200	Vijayrmpura and Sheetpuri District Udham Singh Nagar, Bajpur block
AAU, Anand	• Input distribution was rganized to train the farmers on use of biocontrol inputs and strategies to tackle key pests and diseases to achieve sustainable crop production. • Planting material • Biocontrol agents • Sprayers	150	Patara, Chalamali, Bhagavanpura Katha mandava, Sardiya, Bhuriya kuva Kadvaliya, Rendi, Devirampura Dudhiya, Gaidetha, Sodhaliya Gamadi, Bor Talav, Navati Barva Kadachhala, Pitha, Dhebarpura Kanboi, Vandha, Gola Gamadi Bhuriyakuiva, Ferkuva, Gajipur
ANGRAU, Andhra Pradesh	• Awareness programmes will be conducted in April, 24 and demonstrations will be initiated from June, 2024	180	Araku division Alluriseetharamaraju district (Earlier Visakhapatnam Dt)
SKUAST, Kashmir	• Conducting awareness • programmes on biological control and organic farming • Conducting demonstrations and field days • Input distribution	511	Trespone, Kargil Kargil, Ladakh Shadab Karewa, Shopian Shopian, Jammu & Kashmir Saliskot, Minji and Trespone villages of Kargil, Ladakh Kargil, Ladakh Shalimar and Harwan villages of Srinagar Srinagar, Jammu & Kashmir Wadura, Sopore Baramulla, Jammu & Kashmir Lajora, Pulwama Pulwama, Jammu & Kashmir Trespone, Kargil Kargil, Ladakh Shadab Karewa, Shopian Shopian, Jammu & Kashmir

UBKV, Pundibari	• Conducting awareness • programmes on biological control and organic farming. (4 numbers of training programme were organized) • Input distribution • (Biopesticides, Arecanut seedlings and Agricultural implements like spade, khurpi, tyne etc). (3 numbers of programme were organized)	330	Singimari (Coochbehar-II) Deodanga (Jaldapara) Gitdabling (Kalimpong) Alipurduar, Coochbehar and Kalimpong Dhulagaon (Falakata) Alipurduar and Coochbehar
DrYSPUH&F, Solan	• Conducting Awareness	110	03 Places/Villages (1)KVK, Reckong Peo, (2)Village Lippa and (3) Village Nako District Kinnaur (Himachal Pradesh)
PJTSAU, Hyderabad	• Conducting awareness • programmes on biological control and on organic farming. • Distribution of biocontrol agents	230	Gousikonda thanda, Indriyala of Pochamplli Mandal Nasrullabad Thanda Kothathand, Jadcharla Mandal Yadadri Bhuvanagiri Dt. Mahabubnagar Dt., Telangana Gousikonda thanda, Indriyala of Pochamplli Mandal Nasrullabad Thanda Kothathanda Jadcharla Mandal Yadadri Bhuvanagiri Dt. Mahabubnagar Dt. Telangana
MPKV, Pune	• Conducting awareness programmes on biological control and organic farming • Input distribution1000 kg *Metarhizium*	200	At/Post: Gadewadi Tal. Ambegaon, Pune (Maharashtra)
AAU, Jorhat	• Training on biological control and distribution of fish finger links	**366**	Aizawl, Mizoram, Aizawl Uttar Kalia & Lality chapari Panisagar, North tripura KVK, Tripura, North Tripura Saraibill, Kokrajhar, Assam Mugani Tandwi FPC, Saraibill Kokrajhar, Kokrajhar, Sagenpara Gaon Ghiladhari, Golaghat, Merapani Golaghat, Balipara, Raha, Nagaon, Lality chapori, Sunpura, Kalachand, Dima Hasao, Manam self help group, Lality Chapory, Beseria, Tezpur, Sonitpur
MPUAT, Udaipur	• Trainings field demonstration input distribution	370	Kurabad, Udaipur, On-Campus Bhutiya and Lag Village Kiyavato ka fala, Gudli and sagtadi village Vallabh, sagtadi, bori, kurabad, bambora, girva, rodda, shyampura, jhadol, pahadi, debari, datisar, jhadolsarada, butvas Udaipur, Rajasthan
IGKV, Raipur	• Distribution of biocontrol agents	500	Gariyaband, RMD, CARS Ambikapur (Surguja), Dhamtari, Tanakhar Chhattisgarh

CAU, Pasighat, Arunachal Pradesh	• Awareness cum Biocontrol inputs distribution Programme to farmers under Tribal Sub Plan	185	Adipasi, Dalbing, Mebo, Ayeng and Mebo, Sikatode, Sikabamin, East Siang& Upper Siang

MPKV, Pune

Fig 40. Dr. S. N. Sushil, Director, ICAR-NBAIR, Benguluru

Fig 41. Dr. P. G. Patil, Hon'ble Vice Chancellor, MPKV

GBPUAT

Fig 42. Input distribution and demonstration of biocontrol technologies at the end of tribal farmers

VI. GENERAL INFORMATION

Functioning of the co-ordinate project

VI. 1. Scientific staff strength of the centres

Sl. No	Name of the centres	Name of the Scientist/s	Phone number	E-mail ID
Regular Centres				
1	**AAU, Anand**	Dr. Nainesh B. Patel (PI)	09998960525	nainesh@aau.in
		Dr. B. L. Raghunandan	09972842619	raghumic2@gmail.com
2	**AAU, Jorhat**	Dr. Anjumoni Devee (PI)	08721810977	amdevee@gmail.com
		Dr. Nomi Sarmah	08811060844	nomi.sarmah@aau.ac.in
3	**ANGRAU, Anakapalle**	D. Anil Kumar (PI)	08790819738	d.anilkumar@angrau.ac.in
4	**GBPUAT, Pantnagar**	Dr. Roopali Sharma (PI)	07830355250	roopalibiocontrol@gmail.com
		Dr.R. P. Maurya	09639750151	rpmauryaento@gmail.com
5	**KAU, Thrissur**	Dr. Madhu Subramanian (PI)	09447100151	madhu.s@kau.in
		Dr. Smitha R	09495309610	smitha.revi@kau.in
6	**MPKV, Pune**	Dr. More (PI)	08329513891	ento3655@gmail.com
		Dr. B. A. Bade	09423050458	bade.babasaheb@gmail.com
7	**PAU, Ludhiana**	Dr.Kamaldeep Singh Sangha (PI)	08146250055	kssangha@pau.edu
		Dr. Neelam Joshi	08146996976	neelamjoshi_01@pau.edu
		Dr. P. S. Shera	09872205425	psshera@pau.edu
8	**PJTSAU, Hyderabad**	Dr. A. Rama Krishna Babu (PI)	085000 32381	dr.arkrishnababu2023ew@gmail.com
9	**SKUAST, Srinagar**	Dr.Rizwana khurshid	9469256433	rizwanawani1234@gmail.com
		Dr. Mudasir Gani Bhat	9419267194	mudasirento@skuastkashmir.ac.in
10	**TNAU, Coimbatore**	Dr. Y.S.Johnson Thagaraj Edward (PI)	09443670481	johnte_ys@rediffmail.com johnte_ys@tnau.ac.in
11	**YSPUHF, Solan**	Dr. S. C. Verma (PI)	09418828036	scvermaento@gmail.com
		Dr. V.G.Chandel	07018899646	vishv.chandel@gmail.com
Voluntary Centres				
12	**CAU, Pasighat**	Dr. Ajaykumara K.M (PI)	07252027083	ajaykumarakmath@gmail.com
		Dr. R. C. Shakywar	07085505874	rcshakywar@gmail.com
13	**MPUAT, Udaipur**	Dr. M. K. Mahla (PI)	09829219205	mkmahla2@gmail.com
14	**OUAT, Bhubaneswar**	Dr. T. Samal (PI)	09438073235	tribikram.samal@gmail.com
15	**UAS, Raichur**	Dr. Arunkumar Hosamani (PI)	09449762175	arent23@gmail.com

16	**ICAR-CISH, Lucknow**	Dr. Snehasish Routray (PI)	09556868461	snehasishroutray@gmail.com
		Dr.Vimal Kumar	080959 88958	vimalc2222@gmail.com
17	**ICAR-CPCRI, Kayangu-lam**	Dr. Joseph Rajkumar (PI)	09447978662	joseph.rajkumar@icar.gov.in
		Dr. K. M. Anes	08606381982	anes.meerasahib@icar.gov.in
18	**ICAR-IIHR, Bangalore**	Dr. B. R. Jayanthi Mala (PI)	08861767095	jayanthimala@iihr.res.in
		Dr. Keerthi M C	09686956192	keerthimanikya@gmail.com
19	**ICAR-IIMR (Millets), Hyderabad**	Dr. G. Shyam Prasad (PI)	09866431157	shyam@millets.res.in
		Dr. G. Rajesha	08729974471	rajeshag337@gmail.com
20	**ICAR-IIRR, Hyderabad**	Dr. Chitra Shanker (PI)	09441866612	chitrashanker@gmail.com
		Dr. C. Kannan	09425865057	agrikannan@gmail.com
21	**ICAR-IIVR, Varanasi**	Dr. Jaydeep Halder (PI)	09453653467	jaydeep.halder@gmail.com
22	**ICAR-NCIPM, New Delhi**	Dr. Anoop Kumar (PI)	08588090462	anooptiwariento@gmail.com
		Dr. Mukesh Kumar Khokhar	07838205167	Khokharmk3@gmail.com
23	**DRYSRUH, Ambajapeta**	Dr. N. B. V. Chalapathi Rao (PI)	09849769231	chalapathirao73@gmail.com
		Mrs. B. Neeraja	08985435304	neeru.boddepalli@gmail.com
24	**IGKV, Raipur**	Dr. Yogesh Kumar Meshram	09424148633	ym058163.yk@gmail.com
25	**KAU, Kumarakom**	Dr. M.K.Dhanya (PI)	09447388215	dhanya.mk@kau.in
		Dr. Pallavi Nair K	09446223140	Pallavi.k@kau.in
26	**KAU, Vellayani**	Dr. Reji Rani,O. P (PI)	09446378182	rejiniop@gmail.com
27	**UBKV, Pundibari**	Dr. S. K. Sahoo (PI)	09647255868	shyamalsahoo@gmail.com
		Dr. Anamika Debnath	09474827173	dr.anamikadebnath@rediffmail.com
		Debanjan Chakraborty	09647800589	debanjan.ubkv@gmail.com
		Moulita Chatterjee	09679350517	moumita.2014@gmail.com
		Biswajit Patra	09547152202	biswa.kris@gmail.com
28	**PDKV, Akola**	Dr. D. B. Undirwade (PI)	09850819992	hdentomology@gmail.com
29	**SKUAST, Jammu**	Dr. Reena (PI)	09419153105	bkreena12@gmail.com
30	**KSNUAHS, Shivamogga**	Dr. Divya M (PI)	08867732666	divyam@uahs.edu.in
		Dr. S. Pradeep	09663977455	drpradeepent@rediffmail.com
31	**DRYSRUH, Tirupati**	Dr. Srinivasa Reddy (PI)	09440572070	dsr2020@gmail.com
32	**ICAR-SBI, Coimbatore**	Dr. N. Geetha (PI)	09442076920	mvsbi@yahoo.com
		Dr.T.Ramasubramanian	09442912010	tramasubbu@gmail.com
		Dr. P. Malathi	09487022404	emalathi@yahoo.com
33	**WNC-ICAR-IIMR, Hy-derabad**	Dr. J. C. Sekhar (PI)	09908600340	jcswnc@rediffmail.com
34	**NIPHM, Hyderabad**	Ms. N. Lavanya (PI)	08978778708	16lkiran@gmail.com

		Dr. S. Jesu Rajan	09704514603	sjrajan83@gmail.com
35	**College of Agriculture, Lembucherra, Agartala, Tripura**	Dr. Navendu nair (PI)	09862858147	navendunair@gmail.com
36	**ICAR-NRRI, Cuttack**	Mr. Annamalai M (PI)	08695241420	annamalaiagriento@gmail.com
		Dr. S. R. Prabhukarthikeyan	09655807346	prabhukarthipat@gmail.com
37	**ICAR-Directorate of Floriculture Research, Pune, Maharashtra**			
38	**ICAR-NRC on Litchi, Muzaffarpur, Bihar**	Dr Ipsita Samal (PI)	8920364022	ipsita.samal@icar.gov.in
		Dr Vinod Kumar		Vinod.Kumar11@icar.gov.in
39	**ICAR-CTRI, Rajahmundry, Andra Pradesh**	Dr. K. Rajasekhara Rao	8917223043	rajasekhararao.korada@gmail.com
		Dr. V. Venkateswarulu	8894459994	venkiiari@yahoo.com
		Dr. S. Ramakrishnan	9880054867	ramkictri@yahoo.com
40	**Department of Entomology, College of Agriculture, CSK Himachal Pradesh, Krishi Vishvavidyalaya, Palampur, HP**	Dr. Surjeet Kumar	9418153087	skumarhpau@gmail.com
41	**Tapioca and Castor Research Station, TNAU, Yethapur, Salem, Tamil Nadu**	Dr. P. A. Saravanan	8248566316	Saravanan.pa@tnau.ac.in

VI. 2. Budget of AICRP on Biological Control for 2023 – 2024

Details of Expenditure	Sanctioned and allotted grants (Rs. In lakhs)	Grants released during 2022-23 from ICAR (Rs. In lakhs)	Total expenditure
Pay and allowances	286.32	286.32	286.32
Capita	30.00	30.00	30.00
Recurring contingency	410.90	410.90	410.90
TA	31.10	31.10	31.10
Total	818.32	818.32	818.32

VI. 3. VISITORS

CPCRI, Kayangulam

- Dr. A. K. Singh, Deputy Director General, ICAR- Horticulture, New Delhi on 13 - 14thMay 2023 as part of ‘Kalpa Vajra’ Valedictory cum future programme
- Dr. Hanumantha Gowda, Chief Coconut Development Officer, CDB, Kochi on 13 - 14thMay

2023 as part of 'Kalpa Vajra' Valedictory cum future programme.

- Mr. D. Kuppuramu, Chairman, Coir Board on 13 - 14th May 2023 as part of 'Kalpa Vajra' Valedictory cum future programme.
- Shri. K. Krishnankutty, Minister for Electricity, Govt. of Kerala visited ICAR-CPCRI, Regional Station, Kayamkulam on 09.05.2023.

SKUAST, Srinagar

- Hon'ble Vice Chancellor, Dr. YSPHUF, Solan Himachal Pradesh visited the Biological Control Lab on 01.06.2023.
- Trainees under "Holistic Agriculture Development Program" visited the Biological control lab, Division of Entomology on 12.02.2024.

KAU, Vellayani

- Dr. S. N. Sushil, Director, ICAR – NBAIR, Bengaluru and Dr. M. Sampath Kumar, Senior Scientist, NBAIR, Bengaluru visited AICRP BCCP – Centre and evaluated the Centre on 24.5.23.

ANGRAU, Anakapalle

- Dr. Hema Prabha, Director, SBI, Coimbatore Visit to Biocontrol lab and Maize Collaborative trial along with ANGRAU Board of manangement member and scientists on 16.9.2023.
- Hon'ble members of Board of management, ANGRAU visited AICRP on Biocontrol lab on 27.02.2024 and and interacted about biocontrol agents and biopesticides.
- Dr. Radhakrishnan Murali, FAO consultant, Delhi and Dr.A.Kandan, Principal Scientist, NBAIR, Bengaluru visited Biocontrol lab and interacted on the production status on 21.9.23.
- Dr. L. Prasanthi, Director of Research, ANGRAU visited Biocontrol stall during kisan mela on 17.12.2023.
- Hon'ble members of Board of management, ANGRAU visited AICRP on Biocontrol lab on 31.01.2024 and 27.02.2024 interacted about biocontrol agents and biopesticides.

DrYSPUHF, Solan

- Professor Megh Nath Parajulee visited biocontrol Laboratory from Texas University, United States dated on 18.11.2023 and interacted with faculty and students.
- Students of Eternal University Baru Sahib visited BioControl laboratory dated on 15.9.2023.

MPKV, Pune

- Hon'ble Vice chancellor MPKV Dr. P. G. Patil visited AICRP on Biological Control on 03/04/2023 and appreciated the efforts taken by the scientist and staff.
- Shri. Abdul Satar, Hon. Minister of Agriculture, Maharashtra State visited to Biocontrol Laboratory on 08/05/2023.
- Dr. H. Shivanna, Former Vice Chancellor, UAS, Dharwad visited to this AICRP centre on 09/11/2023.
- Mr. John Villium, Thailand visited to this AICRP centre on 05/02/2024.

- Dr. S. N. Sushil, Director, NBAIR visited the field experiements and AICRP Biocontrol Pune centre on 13/01/2024.

DrYSRHU, Ambajapeta

- On 06.02.2024, the team of scientists from ICAR-NBAIR, Bengaluru, Dr. S. N. Sushil, Director NBAIR, Bangalore & Coordinator ICAR AICRP on Biocontrol, Dr. K. Sreedevi, Principal Scientist [Ento], NBAIR and G. Sivakumar, Nodal officer, ICAR AICRP on Biocontrol control visited.
- On 11.12.2023, Dr. B. Augustine Jerard, Project Coordinator ICAR AICRP on Palms, ICAR-CPCRI Kasargod visited DrYSRHU HRS Ambajipeta along with Dr. Elien Apshara, Principal Scientist, ICAR -CPCRI Vittal and Dr. Sumitha, Scientist incharge PC cell.

Fig 43. ICAR-NBAIR Director & staff visit

AAU, Jorhat

- Dr.Himanshu Pathak, Secretary (DARE) & Director General (ICAR), New Delhi
- Dr. T. R. Sharma, DDG (Crop Science), ICAR, New Delhi
- Smt Ajanta Neog, Minister of Finance, Government of Assam
- Dr. C Chinnamade Gowda, Coordinator, Acarology, UAS, GVKV, Bangalore
- Dr. Malvika Choudhury, Global Team leader, CABI, New Delhi
- Dr. A.S. Badola, Director, RARI, AINP Soil Arthropod, Jaipur

Fig 44. Visit of Dr. Himanshu Pathak, Secretary (DARE) & Director General (ICAR), New Delhi

PAU, Ludhiana

- Sh. Sandeep Kumar, Sh. Arvind Kumar and Sh. Pardeep Dingra from Department of Horticulture, Government of Jammu and Kashmir (April 27, 2023)
- Dr. J. P. Singh, Plant Protection Advisor to Government of India (February 7, 2024)

TNAU, Coimbatore

- Agricultural Production Commissioner, Government of Tamil Nadu visited on 01.12.23

MPUAT, Udaipur

- Dr. A. K. Karnatak, HVC, MPUAT, Udaipur.
- Dr. S.K. Sharma, ADG, HRM, ICAR.
- Dr. Subhash Chander, Director, ICAR-NCIPM, New-Delhi.
- Dr. R. G. Agarwal, President, Dhanuka Agritech Pvt. Ltd.
- Dr. Ajeet Tomar, Vice-President, Dhanuka Agritech Pvt. Ltd.

IGKV, Raipur

- Dr. Jesy M.D. Director Rubber Res. Institute of India along with Dean SGCARS Jagdalpur.
- Dr. J. Ganguli visited Bio-control laboratory on 03/04/2023.
- Dr. D. K. Yadav, Assistant Director General (Seed), Indian Council of Agricultural Research, New Delhi visited and observed the Bio-control Laboratory, along with Dr. Vivek Tripathi, Director Research Services, Dr. S. S. Tuteja Director Field, Indira Gandhi Agricultural University on 27/07/2023.
- Dr. S. N. Sushil, Director ICAR-NBAIR Bangalore & A. K. Srivastava Director, ICAR, NBAIM Mau, U.P. visited Biocontrol lab on 05/09/2023.
- Hon'ble Vice Chancellor IGKV, Raipur & Devendra Verma Agriculture Expert visited Biocontrol lab.
- Mir. Tariq Ali Sir (IAS) DG. Women and Child Development, Jammu & Kashmir visited Biocontrol lab on 05/12/2023.

- Hon’ble MLAs of Lundra and Samri visited Biocontrol lab on 11th December 2023.
- Dr. Gandhi Gracy Senior Scientist NBAIR Bengalore Visited Biocontrol lab on 1st March 2024.

KAU, Thrissur

- Dr. S. N. Sushil, Director, NBAIR, Bengaluru and Dr. Sampathkumar, NBAIR, Bengaluru and Dr. David, NBAIR, Bengaluru visited the centre.
- Sri. Badal, Minister for Agriculture and Animal Husbandry, Jharkand visited the centre on 20-05-2023.

Fig 45. Dr. S.N. Sushil inaugurated the programme on biocontrol of cassava mealybug

GBPUAT

- Sri Bhagat Singh Koshyari, Ex Governer Maharashtra.
- Dr. R. S. Paroda, Ex-DG, ICAR, New Delhi
- Ex Director Agriculture, Government of Nepal

Visit of Monitoring team from NBAIR at Biocontrol laboratory, Pantnagar

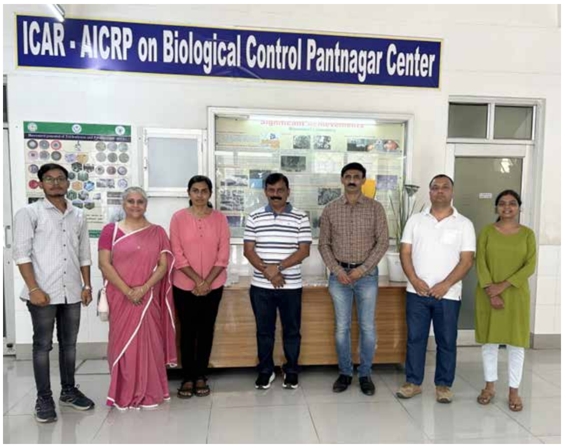

Fig 46. Team of scientists from ICAR-NBAIR, Bengaluru

CAU, Pasighat

- Dr. Mukesh Sehgal, Principal Scientist (Nematology), ICAR-NRCIPM, New Delhi
- Dr. K. Mamocha Singh, The Registrar, CAU (Imphal), Manipur

VI. 4. Awards/ Honours/ Recognitions

CPCRI, Kayankulam

- Dr.Jilu V. Sajan, Dr. Josephrajkumar A., Dr. Merin Babu, Dr. Prathibha P. S. and Dr. Anes, K. M. received Best paper award for the paper titled "New record of collateral hosts of coreid bug, *Paradasynus rostratus* Distant (Hemiptera: Coreidae) infesting coconut" in Third International Scientific Conference on Environmental Research: Issues, Challenges and Strategies for Sustainable Development organized by Eurasian Academy of Environmental Science during 1-2 December 2023 at Karwar, Karnataka.

SKUAST, Srinagar

- Dr. Mudasir Gani was invited as a guest speaker on the theme "Integrated Pest Management" and topic "Using Viruses For Insect Pest Management And Focussing On Baculoviruses" by the National Research and Development Center for Sustainable Agriculture (Estidamah), Minister of Environment, Water, and Agriculture (MEWA), Saudi Arabia for 1st International Forum and Exhibition for Sustainable Agriculture "Agricultural Development with Optimal Use of Natural Resources" at Riyadh, Saudi Arabia w.e.f. 20-22, November 2023.
- Certificate of appreciation to Dr. Mudasir Gani by National Research and Development Center for Sustainable Agriculture (Estidamah), Minister of Environment, Water, and Agriculture (MEWA), Saudi Arabia.
- Dr. Mudasir Gani acting as co-coordinator of the research activities of the Division of Entomology, SKUAST-Kashmir.

- Dr. Mudasir Gani acting as Co-Incharge of the Field experiments of the Division of Entomology, SKUAST-Kashmir.

ANGRAU, Anakapalle

- Associate developer of the ICAR-NBAIR's Technology - Shatpada Master Blaster- A novel *Bacillus albus* strain NBAIR-BATP with excellent insecticidal, antagonistic and growth promotion properties for the management of pests and diseases.
- Received Fellow Award of Plant Protection Association of India at International Conference on Plant Health Management, 2023 held at PJTSAU, Rajendranagar, Hyderabad on 18.11.2023

DrYSRHU, Ambajapeta

- On 19.08.2023, Dr. N. B. V. Chalapathi Rao, Principal Scientist & Head, Dr.YSRHU-HRS, Ambajipeta awarded as Best Scientist –Entomology from Eruvaaka foundation at KL University, Vaddeswaram, Guntur, AP.
- On 16.11.2023, Dr. N.B.V. Chalapthi Rao, Principal Scientist & Head, received Dr. Bap Reddy award for IPM for the Years 2020-22 from Plant protection association of India during the International Conference on Plant Health Management 2023.

AAU, Anand

- Dr. N. B. Patel, Principal Research Scientist, Environmental Protection Research Award in 1st International Agriculture Conference on "Natural Vs Organic Farming: In context to Bharatiya Agriculture" jointly organized by Gujarat Natural Farming and Science University, Anand; Hindustan Agricultural Research Welfare Society and IIMTU, Meerut at Bagadpur Krishi Bhawan, Moradabad (UP) during 24-26th December, 2023.
- Dr. Raghunandan B. L., Assistant Research Scientist, Best Oral Presentation –First Prize ISMPP 42nd Annual Conference & National Symposium on "Plant health management: A way forward for food safety, security and sustainability" Jointly organized by Department of Plant pathology, BACA, AAU, Anand, Gujarat and Indian Society of Mycology and Plant Pathology, RCA, MPUA&T, Udaipur, Rajasthan at AAU, Anand on 10-12 May-2023.
- Dr. Neha Patel, Research Associate, Best Poster Presentation – First Prize ISMPP 42nd Annual Conference & National Symposium on Plant health management: "A way forward for food safety, security and sustainability" Jointly organized by Department of Plant pathology, BACA, AAU, Anand, Gujarat and Indian Society of Mycology and Plant Pathology, RCA, MPUA&T, Udaipur, Rajasthan at AAU, Anand on 10-12 May-2023.

AAU, Jorhat

- Dr. Anjumoni Devee, 2nd position in oral presentation: Development of stem borer (*Scirpophaga* sp.) resistance Keteki Joha Rice variety through Gamma radiation" Organized by AAU, and Prof. H. S. Srivastava Foundation for Science, Lucknow. International Conference on Biodiversity, food security, sustainability & climate change. 25-28 April, 2023.

- Ravishankar G, Anjumoni Devee, Nomi Sarmah, Junmoni Gayon and Ankita Saikia, 2nd position in oral presentation: Bioefficacy of certain insecticides and botanicals against cabbage looper *Trichoplusia ni* (Hübner) (Lepidoptera: Noctuidae). National conference on "Women Scientists in Plant Health Management for Sustainable Development Goals" held at AAU, Jorhat-13, Assam, 22-23, Dec, 2023.

- S.S. Ahmed and Anjumoni Devee, 2nd position in oral presentation: Relative abundance and diversity of insect pests and natural enemies in selected Joha rice varieties of Assam. National conference on "Women Scientists in Plant Health Management for Sustainable Development Goals held at AAU, Jorhat-13, Assam, 22-23, Dec, 2023".

- Dr. Anjumoni Devee, External Question paper setter for the courses ENT505, ENT 509, ENT 601, ENT 602, ENT 605. College Of Postgraduate Studies In Agricultural Sciences, CAU, Umiam-793103, Meghalaya on 15.3.24.

- Dr. Anjumoni Devee, External Question paper setter for the course ENT 353. CAU, Pachighat on 20.1.24.

- Dr. Anjumoni Devee, External Thesis evaluator & viva voce of Mr. Sogala Mannohar vide Registration No. A-2021-014-M, M.Sc.(Ent). UBKV, Pundibari, WB on 18.8.23

Fig 47. Received Best exhibit award at Farmer's Fair at AAU-ARRI- Titabar

PAU, Ludhiana

- Dr P.S. Shera as team member got Silver Award for best paper presented during 'The 2nd Conference of Agricultural Innovation and Natural Resources, The Prince of Songkhla University, Hat Yai Campus, Songkla, Thailand. August 3-4, 2023.

GBPUAT, Pantnagar

- Received Agriculture Scientist Award-2023 in the in the 5th International Conference on "Recent Advances in Agricultural and Industrial Entomology and Environmental Sciences and their Impact on Food and Environmental Security" on September 29-30, 2023 in Entomology Research Institute, Loyola College, Chennai 600034, Tamil Nadu. The conference is jointly organized by Dr. B. Vasantharaj David Foundation and Entomology Research Institute, Chennai.

- Received three Faculty Excellence Award-2023 by the Dean College of Agriculture, GBPUAT, Pantnagar.

UAS Raichur

- Received incentive Award of UAS, Raichur

VI. 5. Extension Activities

NCIPM, New delhi

- Organized Rice IPM Field Day meeting on 22-09-2023 at Nidana village of Rohtak district of Haryana. More than 120 farmers participated in the programme.

SKUAST, Srinagar

- Organized Awareness-cum-Scientist Farmer Interaction programme at District Employment and Counselling centre, Shopian on March, 2024.
- Dr. Mudasir Gani delivered lecture on "Pest management in Saffron" to officials of line department during training programme on saffron at Directorate of Agriculture, Lal Mandi, Srinagar under on 22.12.2023.
- Dr. Rizwana Khurshid delivered lecture to officials of line department and farmers on "Flora availability for beekeeping and high income opportunities in beekeeping sector" on 13.09.2023 during two days district level seminar on Beekeeping in district Shopian under NBHM scheme.
- Dr. Rizwana Khurshid delivered lecture to officials of Agriculture department of district Ganderbal on "Pollination: Prospects and role in crop production; "Tools and Implements used in Apiculture", "Bee Forage and its distribution" on 01.09.2023 at Chief Agricultural Office Ganderbal.
- Dr. Rizwana Khurshid delivered lecture to officials of line department and farmers on "Flora availability for beekeeping and high income opportunities in beekeeping sector" on 20 and 21.09.2023 during two days district level seminar on scientific Beekeeping at Ganderbal sponsored by NBB.

ANGRAU, Anakapalle

- Participation in Diagnostic field visit as team member every month during the year 2023 in Bheemili division, Visakhapatnam district

DrYSPUHF, Solan

- Dr S C Verma delivered lecture on role of natural enemies in insect-pests management of crops on dated 3.10.2023 at Lippa, Kinnaur organised by department of Entomology UHF, Nauni, Solan, HP.

- Dr S C Verma delivered lecture on role of natural enemies in insect-pests management of crops on dated 4.10.2023 at Nako, Kinnaur organised by department of Entomology UHF, Nauni, Solan, HP.
- Dr S C Verma delivered lecture on role of natural enemies in insect-pests management of crops at Re Kong Peo, Kinnaur on dated 13.6.2023 organised by department of Entomology UHF, Nauni, Solan, HP.
- Dr S C Verma delivered lecture to the farmers of Uttarakhand on diversity of natural enemies in Natural against insect-pests of crops on dated 15/3/2023 organised by Directorate of Extension Education UHF, Nauni, Solan, HP.
- Dr S C Verma delivered lecture on role of biocontrol agents in management of insect-pests of crops under Natural Farming on dated 06/3/2023 organised by department of Soil Science and water Management.
- Dr S C Verma delivered lecture on role of biocontrol agents in management of insect-pests of crops under Natural Farming for Krishi Sakhi organised by ATM Kandaghat for 30 farm women on dated 25.8.2023.
- Dr VGS Chandel delivered lecture on applications of biocontrol against insect-pests of crops to the 100 numbers of farmers at State Biocontrol Laboratory Ranjhana, Shimla on dated 15.09.2023.

MPKV, Pune

- Dr. S. A. More participated in Shiwar feri and visited rice plots at Shelkewadi Tal. Maval Dist. Pune alongwith Extension Agronomist, REC and Incharge, Rice Research Station, Wadgaon Maval, Pune.
- Dr. S. A. More participated online programme on National Youth day on 12/01/2024 at at Shirname Hall, AC, Pune
- Dr. S. A. More participated in farmers training programme at Donde Tal, Rajgurunagar Dist. Pune on 19/03/2024 and delivered lecture on Biological Management of Vegetable Crop Pests to Farmers and students (146 participants)
- Dr. S. A. More participated in Exhibition organized at Pune University on 14/10/2023 and guided to the visiters regarding importance of bioagents and biopesticides
- Dr. S. A. More participated in in Hort Expo Exhibition at AC, Pune 20-23, Nov-23 and guided to the visiters regarding importance of bioagents and biopesticides
- Dr. S. A. More participated in Bhimthadi Jatra at AC, Pune25/12/2023 and delivered lecture on Importance of *Metarhizium*
- Dr. B. A. Bade attended *Shivar feri* at village Urawade Dist. Pune on 29/02/2024.
- Dr. S. A. More delivered lecture on Importance of bioagents and Biopesticides in Agriculture insect pest management on 29/11/2023 to the faculty and trainee of Metereology training.

DrYSRHU, Ambajapeta

- On 28.03.2023 Dr.YSRHU-HRS, Ambajipeta conducted coconut field day. Scientists explained the production and protection technologies along with field visit.
- On 26.04.2023, Dr.YSRHU-HRS, Ambajipeta in collaboration with Department of Horticulture, Dr. B.R. Ambedkar Konaseema District conducted awareness programme on Rugose Spiraling Whitefly (RSW) management in coconut to VHAs/VAAs of RBKs.
- On 27.04.2023, Dr. NBV Chalapathi Rao, Principal Scientist (Ento.) Participated in Rugose Spiraling Whitefly (RSW) awareness programme in collaboration with Department of Horticulture, Kakinada district at RB patnam village in Peddapuram mandal, Mallepally village, Gandepalli mandal and Gurrampalem Village Jaggampeta Mandal for the coconut and oil palm growing farmers, VHAs/VAAs of RBKs.
- On 06.05.2023, Scientists of Dr.YSRHU-HRS, Ambajipeta participated in Review meeting on unseasonal and heavy rains occurred during May hosted by Department of Horticulture and scientist offered solutions.
- On 24.05.2023, Scientists of Dr.YSRHU-HRS, Ambajipeta conducted awareness programme on biological control of insect pests and diseases of coconut and demonstrated the Grub release technique and clipping of *Apertochrysa astur* eggs in the whitefly infested coconut fields at Nangavaram village, Uppalaguptam mandal, Dr. B.R. Ambedkar Konseema district.
- From 22-24th June 2023, Dr. N. B. V. Chalapathi Rao , Principal Scientist (Entomology) participated in National Seminar on Evolving Extension Science Towards Secondary Agriculture for Sustainable Development, at UAS GKVK, Bengaluru, delivered a oral presentation on "Large scale impact of bio-control based IPM technology against Rugose spiraling whitefly Aleurodicus rugioperculatus in Andhra Pradesh" and received "Best Oral Presentation Award" .
- On 04.08.2023, Scientists of Dr.YSRHU-HRS, Ambajipeta conducted roving survey of coconut pests and diseases in Chintalapudi and Kamavarapukota area of Eluru district and recommended management measures and visited coconut black headed infested fields, created awareness and discussed with the farmers group of 30. ADH of Eluru, Horticulture officers, Village Horticulture Assistants, Village Agriculture Assistants were also participated.
- On 27.11.2023, Exposure visit of NABARD LEDP beneficiaries of coconut and coir value added products from pasarlapudi, eedarada and Jandupalli villages around 24 members visited our research station and learnt about the biocontrol agents production and intercrops, value added products in coconut along with field visit.
- On 04.12.2023, Scientists of Dr.YSRHU-HRS, Ambajipeta delivered lecture on the Management of Eriophyid mite and Rugose Spiraling Whitefly in coconut and also explained about biocontrol agents/products available with our research station in which Dr. L. Naram Naidu, Director of Research, Dr.YSR Horticultural University was the chief guest for the session in the Agritech 2023: conference and exhibition organized by Acharya NG Ranga Agricultural University, Lam, Guntur under the chairmanship of Director of Research

ANGRAU, Dr. Prasanthi.

- From 12.12.2023 to 14.12.2023 Scientists of Dr.YSRHU-HRS, Ambajipeta participated in 25th Placrosym at ICAR-IIOPR, Pedavegi and delivered oral presentations in the respective sessions.

- On 16.12.2023, Scientists of Dr.YSRHU-HRS, Ambajipeta conducted diagnostic survey in Allipalli village of Chintalapudi, Eluru which is hotspot for black headed caterpillar and cautioned the farmers and explained about integrated management measures. Observed the fields of parasitoids released fields and suggested for further release of parasitoids. Farmers expressed their views on biocontrol based management too. Sri. Kumarvel, Deputy Director, CDB, Vijayawada centre and Ms. Faria, Horiculture officer of Chintalapudi, Eluru district also participated this programme.

- On 29.12.2023, Dr.N.B.V.Chalapathi Rao, Principal Scientist & Head and Dr. V.Govardhan Rao, Senior Scientist (Pl. Path.) conducted diagnostic field visit in the coconut plantations of Pedapativarigudem village, Musunuru mandal, Eluru district and observed scale insect incidence at low level along with micronutrients deficiency and suggested the soil and leaf analysis for further confirmation.

- On 29.12.2023, 33 members of trainees from DAESI, Tanuku centre visited Dr.YSRHU-Horticultural Research Station, Ambajipeta as a part of field exposure. Scientists of Dr.YSRHU- HRS, Ambajipeta explained improved production and Protection technologies in coconut cultivation to the trainees.

- On 10.01.2024, Dr.N.B.V. Chalapathi Rao, Principal Scientist [Entomology] and Head, Dr.YSRHU-HRS Ambajipeta, Dr.V.Govardhan Rao Senior Scientist [Plant Pathology] participated in the farmer training programme on bio intensive management of Rugose spiraling whitefly in coconut and oil palm crop at Kalavalapalli village, Chagallu mandal, East Godavari district followed by diagnostic field visit at Kalavalapalli and at Chikkala villages. Observed the low level of pest incidence in oil palm and low to medium level of incidence in coconut. Recommend to follow IPM practice including release the *Apertochrysa astur* grubs spray *Isaria fumosorosea* (NBAIR-Pfu5) from Dr.YSRHU-HRS Ambajipeta by placing prior indents to combat the pest incidence. The District Horticulture officer, East Godavari Mandal Horticulture officer, Village Horticulture officer, RBK staff and 50 members of farmers from their villages attended.

- On 20.01.2024 Scientists of Dr.YSRHU-HRS, Ambajipeta conducted awareness programme on the Integrated Pest Management of Black headed caterpillar management in Coconut at Sannavilli village, Uppalaguptam Mandal of Dr. B. R. Ambedkar Konaseema district. Horticulture officer, MPTC, Sarpanch and RBK staff were also participated.

- On 07.02.2024, Dr. G. Sivakumar, Nodal officer, AICRP on Biological Control, ICAR-NBAIR visited Dr.YSRHU-HRS, Ambajipeta and also participated in awareness programme on Black headed caterpillar and interacted with farmers about the importance of biocontrol based management. Mass release of a total of 11000 parasitoids of *Bracon brevicornis* and *Goniozus nephantidis* in the Sannavilli village of Uppalaguptam mandal of Dr. B. R.

Ambedkar Konaseema district. During field visit, 500 adults of *Apertochrysa astur* adults were released in the Gangabondam experimental field as a part of quantitative evaluation of *Apertochrysa astur* Adult release technique for the management of RSW. The team also visited GIFT, FPO which is producing *Apertochrysa astur* predator which is having MoA with Dr.Y.S.R.Horticultural University.

AAU, Anand

- "Bio-agents Awareness Week" during 17-18 & 31 July 2023 was organized by AICRP on Biological Control of Crop Pests, ICAR Unit-9, AAU, Anand at different villages of Dedarda, Dabhasi, Untakhari and Rasnol. The main objective of this initiative was to sensitize farmers about the benefits of the bioagent *Trichogramma*.
- "Bio-agents Awareness Week" during 19 & 25-26 October 2023 was organized by AICRP on Biological Control of Crop Pests, ICAR Unit-9, AAU, Anand at different villages of Tarapur, Chaklasi, Navli, and Napad.
- "Bio-agents Awareness Week" during 10-11 & 16 January 2024 was organized by AICRP on Biological Control of Crop Pests, ICAR Unit-9, AAU, Anand at different Tasil of Petlad, Borsad, and Khambhat.

AAU, Jorhat

Training	Scientist attended	Date	Organized by	Location
General training	Dr. Anjumoni Devee & Dr. Nomi Sarmah	13.07. 2023	AICRP BC, AAU Jorhat	Rajabahar, Jorhat
General training	Dr. Anjumoni Devee & Dr. Nomi Sarmah	20. 09.2023	AICRP BC, AAU Jorhat	Satkhelia, Jorhat
General training	Dr. Anjumoni Devee	09.11. 2023	AICRP BC, AAU Jorhat	S.S.C.A, Dhubri
General training	Dr. Anjumoni Devee and Dr. Nomi Sarmah	18.11. 2023	AICRP BC, AAU Jorhat	Garigaon, Jorhat
General training	Dr. Anjumoni Devee and Dr. Nomi Sarmah	2.12.2023	AICRP BC, AAU	Sagunpara, Teok
General training	Dr. Anjumoni Devee and Dr. Nomi Sarmah	13.12.2023	AICRP BC, AAU	Merapani, Golaghat
General training	Dr. Anjumoni Devee and Dr. Nomi Sarmah	29.12. 2023	AICRP BC, AAU	Rajabahar, Jorhat
General training	Dr. Anjumoni Devee	24.01.2024	AICRP BC, AAU Jorhat	Panibill, Sivsagar

PAU, Ludhiana

Kisan mela	Date	Name of Scientist(s)
Regional *Kisan Mela*, Amritsar	5.9.2023	Dr. P S Shera
Regional *Kisan Mela*, Ballowal Saunkhri	8.9.2023	Dr. K S Sangha and Sudhendu Sharma
PAU *Kisan Mela*	14.9.2023 & 15.9.2023	Dr. K S Sangha, Neelam Joshi, P S Shera Rabinder Kaur & Sudhendu Sharma
Regional *Kisan Mela*, Amritsar	5.3.2024	Dr. P.S. Shera

Regional *Kisan Mela*, Ballowal Saunkhari	7.3.2024	Dr. K.S. Sangha and Sudhendu Sharma
PAU *Kisan Mela*	14.3.2024 & 15.3.2024	Dr. K S Sangha, Neelam Joshi, P S Shera Rabinder Kaur & Sudhendu Sharma

TNAU

Date	Title of Program	Benificiary/ Participants	Organizers
05.05.23	Management of coconut Rhinoceros beetle - Pollachi	Farmers	TNAU
14.07.23	Agri Intex Exhibition, Coimbatore	Farmers	CODDISIA
27.07.23	Agri society, Trichy	Farmers	Dept. of Agriculture
06.10.23	Release of *Acerophagus papayae* for the management of papaya mealybug -Annur	Farmers	TNAU
27.10.23	Release of *Acerophagus papayae* for the management of papaya mealybug at Theni	Farmers	TNAU
06.02.23	Mangement of RSW - Tiruppur	Farmers	TNAU
28.02.23	Mangement of RSW - Kanuvakarai (Annur)	Farmers	TNAU
01.03.23 &02.03.23	Kerala root wilt survey - Pollachi	Farmers	Dept. of Agriculture
21.03.23 & 22.03.23	Pesticide Orientation Programme	Farm graduates & Pesticide companies	TNAU
26.03.23	Management of cassava mealybug –Annur, Sulur	Farmers	TNAU

VI. 6. LIST OF PUBLICATIONS

ICAR-NCIPM, New delhi

Research articles

- Shukla Karunesh, K., Nigam, R., Birah, A., Kanojia, A. K., Kumar, A., Bhattacharya, B. K. and Chander, S. 2024. Detection of Aphid-Infested Mustard Crop Using Ground Spectroscopy. *Remote Sens*, 16 (1): 47.
- Kumar, A., Suroshe Sachin, S., Sonam Saini, G. K. and Singh Jitendra. 2023. Efficacy of genetically transformed *Metarhizium anisopliae* against *Spodoptera litura* and *Aphis craccivora*. *Saudi Journal of Biological Sciences*, 30 (1):103493.

Popular articles

- Khokhar, M. K., Kumar, A., Singh, S. P, Sehgal, M. and Chander, S. 2022. *Basmati* Dhan ke Rogon ka samekit prabhandhan. Kheti. 8: 51-53.

Extension Folder

- Rakesh Kumar., Mukesh Sehgal., Anoop Kumar., Mukesh Kumar Khokhar., Singh S. P. and Subhash Chander. 2023. *Dhaan Ki seedhi buwai men samekit nasheejeev prabandhan (IIPM). Extension Folder -42 ICAR-NCIPM, New Delhi.*

- मुकेश कुमार खोखर, अनूप कुमार, एस पी सिंह एवं मुकेश सहगल (2023) मक्का में समेकित नाशीजीव प्रबंधन प्रसार पत्रक-62 *ICAR-NCIPM, New Delhi.*

ICAR-CPCRI, Kayankulam

Research articles

- Anes, K. M., Merin Babu and Josephrajkumar, A. 2023. Root-knot nematode, *Meloidogyne enterolobii* Yang and Eisenback, 1983 infecting guava intercropped with coconut plantation in Kerala, India. *Indian J. Nematol*., 53(1): 15-20.

- Josephrajkumar, A., Anes, K. M., Merin Babu, Pratibha, P. S., Jilu, V. S. and Hegde, V. 2023. Exotic whiteflies and conservation biological control in coconut system. *IOP Conf. Ser.: Earth Environ. Sci.* 1179-012006.

- Kumar Arvind., Ginny Antony, Rajesh, M. K., Josephrajkumar, A. and Tony Grace. 2023. Reference genes for expression studies in different developmental stages of *Oryctes rhinoceros*, the coconut rhinoceros beetle. *J. Asia-Pacific Entomol.*, **26**: 102066.

- Logeshkumar, P., Nalini, R., Josephrajkumar, A., Chandramani, P., Mini, M. L., Durai Singh, R. and Murugan, M. 2023. Flight activity of invasive rugose spiralling whitefly (*Aleurodicus rugioperculatus* Martin) and Bondar's nesting whitefly (*Paraleyrodes bondari* Perrachi) in coconut orchards. *Res. Crop*. 24(2): 403-406.

- Logeshkumar, P., Nalini, R., Josephrajkumar, A., Chandramani, P., Mini, M. L., Durai Singh, R., Murugan, M. and Suresh, K. 2023. Competitive regulation of dominant exotic whiteflies on coconut palms as influenced by biotic and abiotic factors. *Indian J. Entomol.*, Online published Ref. No. e23248.

- Prathibha, P. S., Rajesh, M. K., Sabana, A. A., Subaharan, K., Venugopal, V. and Jilu, V. S. 2023. Distinguishing palm white grub complex, *Leucopholis* sp. (Coleoptera: Scarabaeidae: Melolonthinae) from India using High- Resolution Melting (HRM) analyses. *International Journal of Tropical Insect Science.*

- Saneera, E. K., Raguraman, S., Kannan, M., Josephrajkumar, A. and Jeyarani, S. 2023. Microscopy-based morphological characterization of rugose spiraling whitefly, (*Aleurodicus rugioperculatus* Martin) an exotic pest on coconut in India. *Microsc. Res. Tech.,* **86**(5): 529-538.

Conference papers

- Anes, K. M., Josephrajkumar, A., Merin Babu and Jilu, V. S. 2023. History of coconut nematology in India. In: Proceedings of National Workshop on Science History of India (Book of abstracts), 28 February 2023 at ICAR- CPCRI, Kayamkulam, pp.55.

- Anes, K. M., Merin Babu, Josephrajkumar A., Kesavakumar, H. Jilu, V. S. and Anithakumari, P. 2023. Prevalence of root knot nematodes (*Meloidogyne* sp.) in coconut intercrops and their integrated management. International Seminar on 'Exotic and underutilized horticultural crops: Priorities and emerging trends'. 17-19th October 2023 at ICAR-IIHR, Begaluru.

- Jilu V. S., Josephrajkumar, A., Merin Babu, Prathibha, P. S. and Anes, K. M. 2023. Biocontrol in coconut: In: Proceedings of National Workshop on Science History of India (Book of abstracts), 28 February 2023 at ICAR- CPCRI, Kayamkulam, pp. 52.
- Jilu V. Sajan, Josephrajkumar, A., Merin Babu, Prathibha, P. S. and Anes, K. M. 2023. New record of collateral hosts of coreid bug, *Paradasynus rostratus* Distant (Hemiptera: Coreidae) infesting coconut. In Third International Scientific Conference on Environmental Research: Issues, Challenges and Strategies for Sustainable Development. 1-2 December 2023 at Karwar, Karnataka, pp. 33.
- Josephrajkumar, A., Anes, K. M., Jilu V. Sajan and Merin Babu 2023. Innovative pest management strategies for coconut root (wilt) diseased tracts. *In:* Fifth International Congress on Kerala studies. 20-22nd May 2023 at AKG Centre for Research and Studies, Thiruvananthapuram, Kerala, pp. 107.
- Josephrajkumar, A., Anes, K. M., Merin Babu, Pratibha, P. S., Jilu, V. S. and Hegde, V. 2023. Exotic whiteflies and conservation biological control in coconut system. *IOP Conf. Ser.: Earth Environ. Sci.*
- Josephrajkumar, A., Merin Babu, Anes, K. M., Jilu V. Sajan and Regi J. Thomas. 2023. Insights into molecular characterization of pests and diseases in coconut. In: "National Seminar on Advances in Molecular Taxonomy and Phylogenetics" at Government College, Kottayam during 12-13 December 2023.
- Josephrajkumar, A., Merin Babu, Jilu V. Sajan, Prathibha, P. S., Logeshkumar, P., Anes K.M. and Vinayaka Hegde. 2023. Historical perspectives of whiteflies in India with emphasis on coconut. In: Proceedings of National Workshop on Science History of India (Book of abstracts), 28 February 2023 at ICAR- CPCRI, Kayamkulam, pp.55.
- Prathibha, P. S., Athira Prakash, Jilu V. Sajan, Sujithra, M. and Josephrajkumar, A. 2023. Population dynamics and management of coconut rugose spiralling whitefly *Aleurodicus rugioperculatus* Martin using essential oils. In Third International Scientific Conference on Environmental Research: Issues, Challenges and Strategies for Sustainable Development. 1-2 December 2023 at Karwar, Karnataka, pp. 32.
- Prathibha, P. S., Jilu V. Sajan, Josephrajkumar, A., Neenu, S. and Thamban, C. 2023. Integrated management of red palm weevil (*Rhynchophorus ferrugineus* Olivier) (Curculionidae: Coleoptera) in coconut. In 25th National Plantation Crops Symposium (PLACROSYM-XXV) with the theme 'Building smart and resilient farming and systems approaches for prosperity in plantation crops sector'. 12-14 December 2023 at IIOPR, Pedavegi, AP.
- Prathibha, P. S., Subaharan, K., Josephrajkumar, A., Patil, J. and Jilu, V. S. 2023. Historical perspectives of coconut white grub *Leucopholis coneophora* Burmeister (Coleoptera: Scarabaeidae). In: Proceedings of National Workshop on Science History of India (Book of abstracts), 28 February 2023 at ICAR- CPCRI, Kayamkulam, pp. 57.
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DrYSPUHF, Solan

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MPKV, Pune

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- A Success story on Biological Suppression of Sugarcane Woolly Aphid in Maharashtra. S. A, More, B.A. Bade, N. D. Tamboli and GR, Lolage.
- Entomopathogenic fungi: Management of hematophagous insects in cattle by S.A More, S. H. Mane, D. H. Kankhare and Anuja Gadhave in Smart and Sustainable dairy farming organized by IDA and ICRTC, Pune.

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- Dr. N. D. Tamboli. '*Metarhizium'* effective weapon for control of white grub, Prabhat, Satara, 03.04.2023.
- Dr. N. D. Tamboli. '*Metarhizium'* useful for biological control of pests, Awaz, Akluj, 31.03.2023.
- Dr. N. D. Tamboli. Fungi useful for biological control of pests, Shivsrushti, Indapur.
- Dr. N. D. Tamboli. Biological Pest Control: The need of the hour in face of increasing use of toxic pesticides, Laxmi Vaibhav News, Indapur, 13.12.2023.
- Dr. N. D. Tamboli. Entomopathogenic Fungi useful for biological control of pests, Shirdi Express, Indapur, 03.04.2023.

Conference papers

- Dr. S. A. More participated in two days International conference on Futuristic Farming on 20-21/12/2023 at Sherton Hotel (4 points), Vimannagar, Pune.

Reports/Manuals

- Prepared manual for PG course no. ENT 505 Biological control of crop pests and weeds.
- Prepared manual of PG course no. Ento501 Insect Morphology
- Prepared manual of PG course no. Ento-510 Management of Horticultural and Plantation Crop Pests.
- Prepared manual of UG course no. Ento 364 Management of Beneficial Insects.
- Prepared Research Planning Report (2024-25). Research Review Planning Committee of Agril. Entomology
- Prepared Research Report (2023-24) Research Review Committee of Entomology.
- Prepared annual report of ACIRP on Biological Control 2023-24

Conference papers

- Management of powdery mildew of grape by using Bio-Control Agents
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- "Jaivik padhatire patanga niyantran", published in Souvenir, Department of Agriculture, Assam, 2023.

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- Training manual on CAFT training on "Problems and prospects of natural farming for sustainable ecological balance" organized by Centre of advance faculty training, Deptt. Of Soil Science, AAU, Jorhat

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- Development of stem borer (*Scirpophaga* sp.) resistance Keteki Joha Rice variety through Gamma radiation" authored by Anjumoni Devee, S.S. Ahmed and Suman Bakshi at International Conference on Biodiversity, food security, sustainability & climate change", organized by Assam Agricultural University and Prof. H.S. Srivastava Foundation for Science, Lucknow, from 25/4/23 to 28/4/23, at AAU, Jorhat
- 'Relative abundance and diversity of insect pests and natural enemies in selected Joha rice varieties of Assam' authored by S.S. Ahmed and Anjumoni Devee, Presented in "Women Scientists in Plant Health Management for Sustainable Development Goals" December 22-23, 2023 at AAU, Jorhat-13, Assam.
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- Mexican Beetle- *Zygogramma bicolorata* dwara gajar ghas ka jaivik unmulan.
- Lady Bird Beetle- Mahu/Maini ka bahupayogi parbhakshi keet.
- Jaivik Keet Niyantran- ek parichay.
- And parjivi *Trichogramma* prajati ka keet prabandhan me upyog.
- Reduviid bug- ek bahupayogi parjivi keet.
- Bracon- ek prabhavshali parjivi keet.
- Reduviid bug – Ek Bahupayogi parbhashi keet.
- Trichocard keetoon ke undon awastha ke liye prabhavi jaivik niyantran.
- Braco card utpadan taknik.

GBPUAT, Pantnagar

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- Nath, A., Gowda, G. B., Maurya, R. P., Ullah, F., Patil, N. B., Adak, T., Rath, P. C. 2023. Sublethal phosphine fumigation induces transgenerational hormesis in a factitious host, *Corcyra cephalonica*. *Pest Management Science*.

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- Bio control agents & their applications
- Management of sheath blight of rice through biocontrol agents
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- Arunkumar., Bhupesh Chandra Kabdwal, Chetan, M. and Roopali Sharma. 2023. *In vitro* screening of Trichoderma isolates against *Rhizoctonia solani* causing aerial blight of Soybean. National Symposium on Crop Heath Management: Safeguarding Crops through Diagnostics and Innovations. 29-30 September, 2023, ICAR- VIPKAS, Almora.
- Participated in the 5th International Conference on "Recent Advances in Agricultural and Industrial Entomology and Environmental Sciences and their Impact on Food and Environmental Security" on September 29-30, 2023 in Entomology Research Institute, Loyola College, Chennai 600034, Tamil Nadu. The conference is jointly organized by Dr. B. Vasantharaj David Foundation and Entomology Research Institute, Chennai.
- Participated in the National Conference on the "Quality Seed Production: Backbone to the National Food Security" organized by G.B.P.U.A.&T., Pantnagar and ICAR-Indian Institute of Seed Science, Mau, U.P. w.e.f. March 04-06, 2024.

CAU, Pasighat

Research articles

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- Ajaykumara K. M., Denisha Rajkhowa, Pavankumar Goudar, Premaradhya N. and Senpon Ngomle. 2023. Jhum cultivation and its effect on Crop Pests in NEH region of India. *Sunshine Agriculture e-newsletter*, ISSN(E): 2583-0821, 3(11), 27-30.
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UAS, Raichur

Research articles

- Sowmya, E., Arunkumar Hosamani. and Mamatha, M. 2022. Mass production of insect pathogenic hypocreale fungi, *Metarhizium anisopliae* on solid substrates and liquid media. *Journal of Biological Control*, 2(3): 169-174.
- Mamatha, M., Arunkumar Hosamani., Sowmya, E., Hanchinal, S. G., Vijaykumar Ghante., Aswathanarayana, D. S. 2023. Exploration of Native Isolates of *Metarhizium rileyi* (Farlow) Samson (Ascomycetes: Hypocreales) in Maize. *Biological Forum – An International Journal*, 15(4): 668-677.
- Veena, K., Arunkumar Hosamani., Prabhuraj, A., Hanchinal, S. G., Mallikarjun Kenganal., Sharanabasappa, S. and Deshmukh. 2023. Efficiency of female age of egg parasitoids on parasitism of *Spodoptera frugiperda* (JE Smith)(Lepidoptera: Noctuidae) eggs of various ages. *Journal of Plant Diseases and Protection*, 1-8.

Reports/Manuals

- Arunkumar Hosamani, Sowmya E, Mamatha M - Biological control of crop pests and weeds, ENT 505 (2+1)
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Extension folders/Bulletins/Manuals

- Arunkumar Hosamani, Mamatha M, Sowmya E, Pramukha keetagala nirvahaneyalli *Metarhizium rileyi* balake, UASR/PC/LL-25/2023-24, January 2023
- Arunkumar Hosamani, Mamatha M, Sowmya E, Keede nirvahaneyalli NPV nanjanuvina pramukapatra. UASR/PC/LL-24/2023-24, January 2023
- Arunkumar Hosamani, Mamatha M, Sowmya E, Keede nirvahanegagi jantuhulugala (Nematodes) utpadane mattu upayoga, UASR/PC/LL-23/2023-24, January 2023.

VI. 7. Participation in national seminars/ symposia/ conferences/ workshops/ meetings

Centres	Name & Designation	Title of training	Place and date
ICAR-CPCRI, Kayankulam	Dr. Jilu V. Sajan, Scientist	Agri-IP online short course on Patents	New Delhi 15th January to 15th February 2024
	Dr A. Joseph Rajkumar, Principal Scientist	AICRP on Biological Control (QRT meeting-2017-2022)	RARS, Anakapalle April 11, 2023
		International Conference on Kerala Studies	Devamatha School, Thrissur on May 21, 2023
		Annual Group Meeting of AICRP on Palms	College of Agriculture, Kahikuchi during September 13-15, 2023
		Project Envisioninzg Workshop on Pest Management in Coconut	RATTC, Kozha on 29-09-2023
		National Science Day programme on Climate Change in Plantation Sector	ICAR-CPCRI, RS, Kayamkulam on 28-02-2024
	Dr KM Anes, Scientist	National Mega Conclave for FPO cooperatives 2023	Pragathi Maidan, New Delhi on July 14, 2023
		ICAR, Foundation day celebrations 2023	ICAR-NAAS complex, Pusa Campus, New Delhi during July 16-18, 2023
		International Seminar on 'exotic and under-utilized horticultural crops: priorities and emerging trends	ICAR-IIHR, Bengaluru during 17 to 18, October, 2023
		First International Scientific Conference on coconut conservation, valorisation and exchanges of resources and germplasm for economic development of the coconut industry	In virtual mode during November 27-28, 2023 at Philippines
	Dr. Jilu V. Sajan, Scientist	1st International Scientific Conference on Coconut Research and Development	ICC, Philippines (Hybrid) 27-30 November 2023
SKUAST, Srinagar	Dr. Mudasir Gani	"Organic farming in Kashmir: How to reap its potential"	Directorate of Research, SKUAST-K, Shalimar, Srinagar w.e.f. 2nd – 8th January, 2024.
	Dr. Rizwana Khursheed	"Scientific beekeeping" under JKTAD project at for Tribal unemployed educated youth of Kupwara	Bandiora on 21-25 November ,2023.

KAU, Kumara-kom	Ms. Pallavi Nair K	Non-Insect Pest Management – mites, crabs, snails, slugs and avian	04.07.2023 to 06 07 .2023 conducted by NIPHM Hyderabad
		Smart Farming Driven By Artificial Intelligence during 5-9 February 2024	5-9 February 2024 at ICAR-Central Tuber Crops Research Institute (ICAR-CTCRI), Thiruvananthapuram,
	Dr. Dhanya MK	8th Asian PGPR society for sustainable agriculture national conference on beneficial microps for integrated plant health management	College of Horticulture, Bengaluru, UHS, from 19.09.2023 to 21.09.2023
		Detection and diagnosis (including molecular techniques) of Plant Pathogens/ Quarantine pathogens	NIPHM, Hyderabad from 9/10/2013 to 13/10/2013
		Diagnosis of plant diseases through novel approaches	ICAR-CTCRI from 19/02/2024 to 23/02/2024
ANGRAU, Anakapalle		Awareness programme on Evaluation of NBAIR Biopesticides against Fall armyworm, *Spodoptera frugiperda* in Maize	27.09.23 at RARS, Anakapalle under ICAR- NBAIR and FAO Collaborative project maize FAW
		Goli Narasimha Rao memorial lecture	16.9.23 organised by RARS, Anakapalle.
		pest management in rice using biopesticides in adopted village	Moolapeta along with team on 6.10.23
		ATMA- Skill training to rural youth on sugarcane single node seedling technology (organic)	RARS, Anakapalle, 28.2.24
DrYSPUH&F, Solan	Dr. VGS Chandel	Farm Production of Bio-inputs organised	Hyderabad w.e.f. 12-04-2023 to 21-04-2023
		Development Programme on Implementation of NEP-2020	12-06-2023 to 20-06-2023
		advance Statistical Techniques for Efficient Agricultural Experimentation	Solan w.e.f. 24-07-2023 to 31-07-2023

PJTSAU, Hyderabad		Quality Control of Microbial Bio pesticides	NIPHM- Hyderabad from Oct-30 to 8th Nov. 2023
MPKV, Pune	Dr. S. A. More	World Honeybee Day Programee	CBRTI, Pune on 20/05/23
		Next Level Approach towards Smart Farming, Inmnovations and Agri enterprunership	Agriculture Education Group AEEFWS during 15/08/2023 to 29/08/2023
DrYSRHU, Ambajapeta	Dr. P.C. Vengaiah, Senior Scientist Dr. Ch. V. Narasimha Rao, DAATTC, Principal Scientist (Entomology, Smt. B. Neeraja, Scientist	Cocoa for the farmers under the sponsorship of Directorate of Cashew and Coconut Development Board	Dr. YSRHU-HRS, Ambajipeta 24.03.23
	Shri A. Kireeti, Scientist	Global Connect Programme under the chairmanship	Dr.YSRHU, VRGudem 20.04.23
		National conference on ethnic vegetables	27th to 28th May, 2023,
AAU, Anand	Dr. N. B. Patel, Principal Research Scientist	Importance of biological control and biopesticides in cotton	Biological Control Research Laboratory, AAU, Anand on date 26/09/2023
		Culturing techniques and utilization of bio-agents/bio-pesticides in cotton ecosystem	Anand Agricultural University, Anand in collaboration with Better Cotton Initiative (BCI), India during 15-17 December 2023
		Integrated Pest Management (IPM)	AGMOOCS, July 11 - September 15, 2023
		Sample Size and Sampling Methods in Agriculture and Allied Sciences	30 July, 2023, Anand Agriculture University

AAU, Jorhat	Dr. Nomi Sarmah	GIS	AAU, Jorhat from 4.7.23- 5.7. 2023.
		Entrepreneurship development	EDII, Ahemedabad from 27.03.23- 01.04.23
	Dr. Anjumoni Devee	Predators, parasitoids and microbials as biocontrol agents in pest management	27.5.2023 at AAU, Jorhat
		Insect pests of Soybean and their management	22.02.24 at AICRP BC, Laboratory of Biocontrol, AAU, Jorhat
IGKV, Raipur	Dr. Yogesh Kumar Meshram, Associate Professor	21 Days Summer School (Online) on "Emerging Challenges and Opportunities in Biotic and Abiotic Stress Management (ECO-BASM-2023)"	Meerut (UP) 10-30 August 2023.
	Dr. Rashmi Gauraha Technical Assistant	Exhibition, live demonstration of bio-agents and deliver lecture in Innovation Fair	Jagdalpur (Bastar) on 4th to 6th March, 2024
	Dr Y. K. Meshram Associate Professor	Exhibition, live demonstration of bio-agents and deliver lecture in Innovation Fair	Ambikapur (Surguja) on 11th to 12th March, 2024
CAU, Pasighat		Production Technology of Bio-fertilizers using Industry scale Bio-fermenter organized	CPGS-AS, CAU (I), Barapani, Meghalaya (01 to 07th May, 2023)
		Natural Farming: Present Status and Future Propsects	28th Aug 2023 to 10th Sep 2023 at College of Agriculture, CAU, Kyrdemkulai, Meghalaya
UAS, Raichur	Dr. Arunkumar Hosamani	Encompassed various aspects of utilizing bio-control agents for pest management, fostering entrepreneurship in bio-control agents production and importance of Entomopathogenic fungi for the management of insect pests	13 - 19, June 2023 MARS, UAS, Raichur
		entrepreneurship development in bio-control agent production	10 - 19, March 2023 UAS, Raichur

VI. 8. News paper clipping

MPUAT, Udaipur

दैनिक नवज्योति

जैविक नियंत्रण से प्राकृतिक खेती करने की आवश्यकता : डॉ कर्नाटक

ब्यूरो/नवज्योति, उदयपुर। अखिल भारतीय समन्वित जैव नियंत्रण अनुसंधान परियोजना एवं निदेशक अनुसंधान के तत्वावधान में एमपीयूएटी के संघटक आरसीए कॉलेज में एक दिवसीय कृषि कृषक प्रशिक्षण एवं आदान वितरण कार्यक्रम हुआ।

प्रशिक्षण में 150 किसानों ने हिस्सा लिया। प्रशिक्षण में परियोजना समन्वयक डॉ मनोज कुमार महला ने फसलों में लगने वाले प्रमुख कीट के जैविक नियंत्रण के बारे में जानकारी दी। कुलपति डॉ अजीत कुमार कर्नाटक ने किसानों को कीटनाशकों के अंधाधुंध प्रयोग के दुष्प्रभाव बताते हुए आवश्यकतानुसार ही कीटनाशक के साथ जैविक नियंत्रण तथा प्राकृतिक खेती पर बल दिया। आरसीए के अधिष्ठाता डॉ लोकेश गुप्ता ने खेती के साथ कुक्कुट पालन, डेयरी पालन तथा बकरी पालन के बारे में बताया। कृषि विभाग के संयुक्त निदेशक डॉ माधो सिंह चंपावत ने सरकार की विभिन्न परियोजना के बारे में किसानों को जानकारी दी। प्रशिक्षण में वैज्ञानिकों ने किसानों को कीट नियंत्रण के बारे में एवं डॉ श्रवण यादव ने किसानों को जैविक कृषि की उपयोगिता के बारे में जानकारी दी।

राजस्थान पत्रिका

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जैविक नियंत्रण कर प्राकृतिक खेती पर बल

पत्रिका न्यूज नेटवर्क
patrika.com

उदयपुर. राजस्थान कृषि महाविद्यालय के प्रसार शिक्षा निदेशालय सभागार में अखिल भारतीय समन्वित जैव नियंत्रण अनुसंधान परियोजना एवं निदेशक अनुसंधान के तत्वावधान में एक दिवसीय कृषि कृषक प्रशिक्षण एवं आदान वितरण कार्यक्रम हुआ। प्रशिक्षण में 150 किसानों ने भाग लिया। परियोजना समन्वयक डॉ मनोज कुमार महला ने फसलों में लगने वाले प्रमुख कीट के जैविक नियंत्रण के बारे में बताया। कुलपति डॉ अजीत कुमार कर्नाटक ने कीटनाशकों का अंधाधुंध प्रयोग के बारे में जानकारी दी तथा आवश्यकतानुसार कीटनाशक के साथ-साथ जैविक नियंत्रण तथा प्राकृतिक खेती पर बल दिया। अधिष्ठाता डॉ लोकेश गुप्ता ने समयोजित खेती, कुक्कुट पालन, डेयरी पालन आदि की जानकारी दी। कृषि विभाग के संयुक्त निदेशक डॉ माधो सिंह चंपावत, डॉ. श्रवण यादव ने भी विचार व्यक्त किए। कुलपति कर्नाटक ने किसानों को वर्मी बेड, ट्राइकोडरमा एवं सब्जियों के उन्नत किस्मों के बीजों का वितरण किया। कुलसचिव बीडी कुमावत, कृषि अनुसंधान अधिकारी डॉ महेंद्र यादव एवं कीट विज्ञान विभाग के छात्र वह छात्राए उपस्थित रहे। संचालन डॉ दीपक जैन ने किया।

कृषि कृषक प्रशिक्षण एवं आदान वितरण कार्यक्रम में मंचस्थ अतिथि।

Fig 48. news paper clip

VI. 9. Training Conducted

Centres	Title of lecture	Programme	Place & date
CPCRI, Kayan-gulam	Advances in Palm Health Man-agement	Profitability Enhancement through Processing and Value Addition of Neera and Co-conut- based Value-added Products	ICAR-CPCRI, Kasaragod on 15-05-2023.
	Exotic whiteflies on coconut-De-coding to Diminution	Doctoral thesis viva-voce	TNAU, Coimbatore on 22-06-2023
	Importance of Pests and Diseases in Farming and Symptoms of Damage and IPM Concepts	DAESI programme for Input dealers	ICAR-KVK, Alappuzha on 30-05-2023 and 06-06-2023
	Biodiversity, Biocontrol and Bios-ecurity issues on Coconut	National Level HRD Pro-gramme on Integrated Pest Management-Kharif	CIPMC, Kochi during September 06, 2023
	Insights into the Molecular Char-acterization of Pests and Diseases in Coconut	National Seminar on Advances in Molecular Taxonomy and Phylogenetics	Government College, Nattakom, Kottayam on 12-12-2023
	Exotic Whiteflies and Biological Control	AAPMHE, ICAR-IIHR, Ben-galuru	Online on 29-12-2023
	Composite cropping for climate smart farming and doubling income	South India Coconut Festival	Palladam, Tamil Nadu on 28-01-2024
	Current technological updates on the bio-suppression of exotic whiteflies	Interface meeting on coconut technologies	CRS, Aliyarnagar on 05-02-2024

ANGRAU, Anakapalle	Role of Biopesticides and Biocontrol agents in Organic farming	Open and Distance learning Centre	07.09.2023 ANGRAU, Anakapalle
UBKV, Pundibari	Training	Training cum input distribution programme for tribal farmers	23.08.2023 at Singimari, Patlakhawa
	Apiculture	DAESI programme	ATC, Cooch Behar on 10.05.23
	Biological Control of Insect pests	DAESI programme	KVK, Cooch Behar on 31.08.23
DrYSPUH&F, Solan	Training	ecofriendly management of crop pests	13.6.2023 at Rekong Peo, Kinnaur, Himachal Pradesh
SKUAST, Srinagar	"Discussion about the management of flowering for better production in mango"	Transfer of technology for management alternate bearing problem through hormonal intervention in mango varieties of Jammu region	**10.05.2023,** Jammu region
	Discussion about the post fruiting management in mango	PIMC meeting cum one day training programme	**12.05.2023,** Jammu region
PAU, Ludhiana	Biocontrol agents – importance and how to use in the cotton crop	Sustainable Cotton Production	Green revolution Cell (Tata Trust) on April 26, 2023
	Use of biocontrol agents	KVK Hanumangarh	PAU Ludhiana on June 28, 2023
	Bio-suppression of sugarcane pests	32rd Biocontrol Workers' Group Meeting	MPKV, Pune on July 20-21, 2023
TNAU, Coimbatore	Mass production of bio control agents	Stakeholders	
MPUAT, Udaipur	Biopesticides in tomato crop and there utility and input distribution	On campus	21/02/2024

IGKV, Raipur	Technical guidance and support farmer's field for management of rice stem borer by Trichocards.	Farmers training	Tusda, Mahasamund on 01/09/2023
	Training and deliver lecture on Biocontrol, distribution of live bio-agents and Agriculture - inputs to tribal farmers.	Training under TSP	Gariyaband on 22/09/2023
	Training and deliver lecture on Biocontrol, distribution of live bio-agents and Agriculture - inputs to tribal farmers.	Training under TSP	Ambikapur (Surguja) on 24/09/2023
	Training and deliver lecture on Biocontrol, distribution of live bio-agents and Agriculture - inputs to tribal farmers.	Training under TSP	Katghora, Korba on 25/09/2023
	Exhibition of live Bio-agents and demonstration	National Level Farmer's Mela (Farm Tech Asia)	Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh on 23rd February to 26th February, 2024
KAU, Thrissur	In-house training on scientific mass culturing technique of *Neoseilus indicus*		30-11-2023 at NBAIR, Bengaluru
	Writing Winning Research Proposals	HRD training programme	05-03-2024 organised by Central Training Institute, Mannuthy, KAU
GBPUAT, Pantnagar	training imparted to progressive farmers from Sitarganj	Farmers training	Uttarakhand on mass production of Bioagents
	Training imparted to Government Officers from Department of Tourism	Farmers training	Uttarakhand on mass production of Bioagents

VI. 10. Participation in meetings

SKUAST, Srinagar

- Dr. Mudasir Gani, participated in the Quinquennial review meeting of AICRP on Biological control of crop pests at Assam Agricultural University, Jorhat, Assam w.e.f. 30& 31 May, 2023.
- Dr. Rizwana Khurshid and Dr. Mudasir Gani participated in the XXXII Annual Review Meeting of AICRP on Biological Control of Crop Pests at College of Agriculture, MPKV, Pune w.e.f 20 & 21 July, 2023.

- Dr. Rizwana Khurshid and Dr. Mudasir Gani participated in the meeting on the management of apple fruit borer and apple blotch leaf miner at SKUAST-K, Shalimar, Srinagar.
- Dr. Rizwana Khurshid and Dr. Mudasir Gani participated in the meeting on the management of mite infesting apple at SKUAST-K, Shalimar, Srinagar.
- Dr. Rizwana Khurshid attended meeting on "**Kashur bee keeping cluster" at** Civil secretariat Srinagar on 03-02-2023.
- Dr. Rizwana Khurshid attended meeting on "**Kashur bee keeping cluster" at** old secretariat Srinagar on 23-12-2023.

KAU-Vellayani

- Dr. Reji Rani O.P,Professor and PI, participated in the brain storming meeting on management of mealybugs in cassava Present status and future strategies: 23rd May 2023 at ICAR-CTCRI TVM and presented a paper
- Dr. Reji Rani O.P,Professor and PI, participated in the "International Plant Science symposium – Advanced Technologies and Innovative practices for climate smart agriculture: Bridging Academia, Industry and Society" as the evaluator of presentations held on 18-19th January 2024 at CoA Vellayani, KAU, TVM
- Dr. Reji Rani O.P,Professor and PI, participated in the "International Conference on climate resilient rice "7th March2024 at CoA Vellayani, KAU, TVM
- Dr. Reji Rani OP, Professor and PI, attended the Annual review meeting of AICRP on biological control at MPKV Pune during 20-21st July 2023

ANGRAU, Anakapalle

- M .Visalakshi participated in 32nd Annual group meet on AICRP on Biological control of crop pests at College of Agriculture, MPKV, Pune held from 20-21st July, 2023
- M .Visalakshi attended National webinar on role of Post harvest technologies and machinery in ensuring food security organised by AICRP on Post harvest technology at RARS,Anakaplle through online underANGRAU Diamond jubilee webinar series 1 on 26.8.2023.
- M.Visalakshi attended Webinar on natural resource management for sustainable soil and crop productivity on 13.9.23 organised by RARS, Anakapalle on the eve of diamond jubilee celebrations of ANGRAU
- M .Visalakshi participated in Short course on Organic farming/Natural farming organized at RARS,Anakapalle , gave lecture as resource person on Topic: Astras for plant protection in Organic farming/Natural farming along with demonstration on 23.11.23.
- M.Visalakshi participated in Agritech, 2023 held at LAM, Guntur during 3-5 December, 2023 as per the oral instructions of Associate Director of Research, RARS,Anakapalle and arranged exhibits on Biocontrol and explained about the importance to the dignitaries and visitors in Agritech, 2023.

- M.Visalakshi attended Webinar Series 1 on the eve of diamond jubilee celebrations of ANGRAU on natural resource management for sustainable soil and crop productivity on 13.9.23 organised by RARS,Anakapalle.
- M.Visalakshi participated in KCP endowment lecture delivered by Dr. Viswanathan, Director, IISR, Lucknow on 30.10.23 at M/s. KCK Sugars, Vuyyuru organised by RARS,Anakapalle.

UBKV, Pundibari

- Participated in the Quinquennial Review Meeting (QRT) of AICRP-Biological Control held at Assam Agricultural University, Jorhat on 30.05.23 to 31.05.23.
- Participated in the 32nd Annual Group Meeting of AICRP-Biological Control held at College of Agriculture, MPKV, Pune during 20 to 21 July, 2023.
- Participated and presented research paper on " Promotion of biological control strategies in Terai zone of West Bengal" in the National Conference held at UBKV, Pundibari on 05.03.24 to 06.03.24.

DrYSPUHF, Solan

- Dr SC Verma and Dr VGS Chandel attended QRT meeting on dated 30-31/5/2023 at Assam Agriculture University Jorhat and presented QRT report of the centre.
- Dr VGS Chandel attended AICRP Annual Meeting on Biocontrol of insect-pests of crops w.e.f 19.10.2023 to 22.10.2023.
- Dr SC Verma attended meeting at NCERT at New Delhi regarding formulation of course curriculum on Natural Farming for incorporation in Vatika-1 to 10+2 class syllabus.

Foreign visits

- Dr Subhash Chander Verma visited Germany at KOB, Ravens burg w.e.f. 15th July,2023 to 31st July,2023 and got experienced for biological control of insect-pests of apple.
- Dr Vishav Gaurav Singh Chandel visited Agriculture and forestry University, Rampur, Chitwan, Nepal w.e.f.18-12-2023 to 24-12-2023 and interacted with the scientist working in Entomology especially on biocontrol.

MPKV, Pune

- Dr. S. A. More participated in World Honeybee Day organized by the CBRTI, Pune on 20/05/23.
- Dr. B. A. Bade and S. A. More attended the meeting under the chairmanship of Hon. Vice Chancellor on 18.05.2023 and explained the progress report of AICRP on Biocontrol
- Dr. B. A. Bade attended the meeting under the chairmanship of Associate Dean at COA, Pune on 22.05.2023 regarding the accreditation of college
- Dr. B. A. Bade and Dr. S. A. More, attended online meeting of attended XXXII Annual AICRP Biocontrol Workers Group Meeting at Pune and presented the annual report of Center on 19/07/2023 to 20/07/2023.

- Dr. B. A. Bade and Dr. S. A. More attended RRC Meeting of Entomology at MPKV, Rahuri on 21 and 22/01/2024 and presented report of the Biocontrol Center, Pune
- Dr. B. A. Bade and Dr. S. A. More attended Research Planning Meeting of Entomology at MPKV, Rahuri during 23/01/2024 and presented planning of the Biocontrol Center, Pune.
- Dr. B. A. Bade and Dr. S. A. More attended Meeting of Biopesticide Registration under the chairmanship of Hon., Vice chancellor Dr. P. G. Patil MPKV at College of Agriculture, Pune on 22/12/2023.

DrYSRHU, Ambajapeta

- Scientists of Dr.YSRHU-HRS, Ambajipeta participated in the International Conference on Trade and Marketing of coconut products organised by ICC in collaboration with CDB at Hyderabad from 27-28 february, 2023 and other scientists of Dr YSRHU - HRS, Ambajipeta participated virtually.
- On 06.12.2023, Scientists of Dr.YSRHU-HRS, Ambajipeta attended online review meeting on weather and crop status in concerned districts affected due to severe cyclonic storm Michaung and submitted the cyclone report of the Dr. B. R. Ambedkar Konaseema district.
- On 23.12.2023, Scientists from Dr. YSRHU-HRS, Ambajipeta Participated in valedictory function of Dr.YSRHU year of Banana at Dr.YSRHU-HRS, Kovvur. The Chief Guests were Shri. Kakani Govardhan Reddy, Agriculture minister of Andhra Pradesh and Honourable Vice Chancellor, Dr. T. Janakiram, Dr. YSR Horticultural University and later interacted with the scientists during visit to the exhibition stalls of Dr.YSRHU-HRS, Ambajipeta and were explained about coconut varieties/hybrids and biocontrol agents of coconut pests and diseases.
- On 06.12.2023, Scientist of Dr.YSRHU-HRS, Ambajipeta attended online Review meeting on weather and crop status in concerned districts affected due to severe cyclonic storm MICHAUNG pronounced as MIGJAUM and submitted the cyclone report of the station.
- On 20.12.2023, Scientists of Dr.YSRHU-HRS, Ambajipeta participated in Zoom Meeting on the Topic 'Committee meeting on Dr.YSRHU Committee Year of Banana - Concluding Celebrations under the chairmainship of Directorate of Research, Dr.YSRHU-VRgudem.
- On 02.02.2024, Scientists of Dr.YSRHU-HRS, Ambajipeta participated online meeting on the Topic "CDB Project-Standardization of conversion factor" organized by ICAR-CPCRI, Kasargod.
- On 03.02.2024, Smt B. Neeraja, Scientist (Plant Pathology) and Dr. V. Anoosha, Scientist (Entomology), Dr.YSRHU, HRS, Ambajipeta participated in online training programme of **"Thota pantalalo sasya rakshana"** as a resource persons and delivered the ppt presentations on topic "**Thota pantalanu asistunna purugulu and tegulla yajamanyam"** in the zoom meeting conducted by Director of Extension, Dr.YSRHU under the chairmanship of Dr. L. Naram Naidu, Director of Research and Dr. E. Karuna sree, Director of Extension, Dr. YSR Horticultural University and created awareness about the management of insect pests and diseases in plantation crops especially Coconut, Cocoa and Arecapalm to the Horticulture officers of AP, VHAs and VAAs of Rythu Bharosa Kendras and farmers.

- On 13.02.2024, Dr. N. B. V. Chalapathi Rao, Principal Scientist & Head, Dr.YSRHU-HRS, Ambajipeta participated in Brainstorming Meeting on Elephant Foot Yam for Empowering Stakeholders: Challenges and Strategies at DRYSRHU University headquarters where in the Dr. T. Janakiram Honble Vice Chancellor, Dr. YSRHU, Dr. G. Byju, Director, ICAR-Central Tuber Crops Research Institute, Sreekariyam, Thiruvananthapuram and Dr. L. Naram Naidu Director of Research, DRYSRHU guided and directed the group comprising farmers, Horticultural department staff and Scientists to arrive at recommendations and researchable issues for this important tuber crop.
- On 23.02.2024, Scientists of Dr. YSRHU-HRS, Ambajipeta participated zoom meeting on the topic " Effective ways of writing a Thesis / Research Article" organized by Registrar, Dr. YSRHU, VR Gudem.

AAU, Anand

- Dr. N. B. Patel and Dr. Raghunandan B. L Participated in Research Report (2023-24)-20th Meeting of Agricultural Research Sub Committee of Plant Protection on March 1-2 March, 2024 at Anand Agricultural University, Anand.

AAU, Jorhat

- Organized Quinquennial Review Meeting of AICRP on Biological Control of Crop Pests at AAU Jorhat on 30 & 31 May 2023
- XXXII Annual Review Meeting of All India Coordinated Research Project on Biological Control of Crop Pests attended by Dr. Anjumoni Devee and Dr. Nomi Sarmah on 20.07.23-21.07.2023provided by NBAIRat College of Agriculture, MPKV, Pune.
- Zonal Research Advisory Committee (ZREAC), Rabi, attended by Dr. Anjumoni Devee and Dr. Nomi Sarmah on 29.09.2023 organized by AAU-ARRI- Titabar at AAU-ARRI- Titabar
- Zonal Research Advisory Committee (ZREAC), Kharif, attended by Dr. Anjumoni Devee and Dr. Nomi Sarmah on 21.02.2024 organized by AAU-ARRI- Titabar at AAU-ARRI- Titabar.
- Technology Committee meeting, Rabi, 2023, attended by Dr. Anjumoni Devee and Dr. Nomi Sarmah on 12.10.2023 organized by AAU, Jorhat.
- Technology Committee meeting, Kharif, 2023, attended by Dr. Anjumoni Devee and Dr. Nomi Sarmah on 16.03.24 organized by AAU, Jorhat.
- Presented biocontrol techniques in the Agri-horti show organized by Department of Agriculture, Government of Assam, Guwahati provided by Dr. Nomi Sarmah on 15·12.24-17.12.24at Guwahati.

PAU, Ludhiana

- Drs K.S. Sangha, Neelam Joshi, P.S. Shera, Rabinder Kaur and Sudhendu Sharma participated in Research and Extension Specialists' Workshop for *rabi* crops at PAU Ludhiana on August 10-11, 2023
- Dr P.S. Shera participated and presented PAU centre report (2017-22) during QRT meeting of Network Project on Conservation of Lac insect Genetic Resources held at ICAR-CASRI Jodhpur on September 14-15, 2023

- Dr P.S. Shera participated and presented PAU centre report during 11th Co-ordination Committee meeting of Network Project on Conservation of Lac insect Genetic Resources held online on December 20, 2023
- Dr P.S. Shera attended meeting to discuss the harmful effects of 10 pesticides on *basmati* prohibited in the state of Punjab at PAU Camp Office, Mohali on January 10, 2024
- Dr P.S. Shera participated in the Research Evaluation Committee meeting and presented the research proposal on bio-intensive management of guava fruit borer for inclusion in University POP at PAU Ludhiana on January 22, 2024
- Dr P.S. Shera participated in the Research Evaluation Committee meeting and presented the research proposal on management of fall armyworm with *Bt* based biopesticides for inclusion in University POP at PAU Ludhiana on January 29, 2024
- Dr Neelam Joshi participated in Research and Extension Specialists' Workshop for Horticultural crops at PAU Ludhiana on January 30-31, 2024
- Drs K.S. Sangha, Neelam Joshi, P.S. Shera, Rabinder Kaur and Sudhendu Sharma participated Research and Extension Specialists' Workshop for *kharif* crops at PAU Ludhiana on February 22-23, 2024.

TNAU, Coimbatore

- Dr. S. Jeyarajan Nelson, Professor and Head and then PI of the AICRP scheme participated in the XXXII Annual Review Meeting of AICRP on Biological Control of Crop Pests held at on 20.07.23 and 21.07.23 at College of Agriculture, MPKV, Pune

MPUAT, Udaipur

- 32nd Annual Review Meeting of AICRP on Biological Control of Crop Pests and held on 20 & 21 July 2023 at College of Agriculture, MPKV, Pune.
- Attended the meeting of Zonal Research and Extension Advisory Committee.
- Attended the Research and Extension Advisory Council of the university held during the year

KAU, Thrissur

- Dr. Madhu Subramanian and Dr. Smitha Revi attended the 32nd Annual Review Meeting of AICRP-BC at MPKV Pune from 20th to 21st July 2023.

GBPUAT, Pantnagar

- Participated in the State Level Pest Surveillance and Advisory Committee meeting organized by Directorate of Agriculture, Uttarakhnad on 21.11.2023 to formulate the strategies to combat the pests of Rabi season crops in the state.
- Participated in 32nd Annual Group Meet of AICRP on Biological Control organized by ICAR-NBAIR, held at MPKV, Pune during 20 & 21 July 2023.
- Participated in QRT Meet held at AAU, Jorhat during 30-31st May 2023.

- Participated in Industry- Academia Summit on 18th November 2023 organized by NAHEP.
- Participated in Vasant Utsav held at Rajbhawan, Dehradun from 29th February to 3rd March 2024.
- Participated in Industry- Academia Meet on 4th March 2024 organized by Directorate of Research, Pantnagar.

CAU, Pasighat

- 32nd Annual Review Meeting of AICRP-Biocontrol at COA, Pune during 20 to 21st June, 2023

VI. 11. POP

AAU, Jorhat

- Technology included in PoP Kharif, page: 64 as "Three sprays of *Verticilium lacanni* $1x10^{8}$ *cfu* @ 5ml/lit of water was effective in reducing the aphid (*Aphis craccivora*) population upto 78.28% with a B:C of 1.74. First spray should be done at 15-20 days after germination followed by second and third spray after 15 days interval".
- The technology on BIPM of fruit flies Bactrocera spp. On cucumber was recommended by the Technical committee meeting, Rabi, 2023 of AAU to PoP as "BIPM consisting with racking and weeding, installation of cuelure @ 15/ha (at 25 DAS), destruction of damaged fruits, spraying of neem based insecticides (NSKE) 5% @ 5 ml/lit (at 20 DAS) and spraying of spinosad 45SC @ 0.5ml/lit (at30 DAS) is effective against fruit flies Bactrocera spp. with B:C ratio 2.86"

PAU, Ludhiana

- Management of gram pod borer in chickpea using linseed as an intercrop, sow two rows of linseed (30 cm apart) as intercrop after every 20 rows of gram
- Spot application of soil mixed with *Bt* based biopesticide, Delfin WG @ 25 g per kg soil in plant whorls for the management of fall armyworm in maize
- Spot application of soil mixed with *Bt* based biopesticide, Dipel 8 L @ 25 ml per kg soil in plant whorls for the management of fall armyworm in maize
- Biointensive management of fruit borer involving cultural control, botanicals and biological control in guava
- Management of plant hoppers with Ecotin 5% (azadirachtin 50000 ppm) @ 80 ml per acre in rice under organic and conventional conditions
- Management of plant hoppers with PAU homemade neem extract @ 4 litres per acre in rice under organic and conventional conditions

GBPUAT

1. **Crop: Cabbage**

Disease: Damping off, root rots, fruit rot, wilt, dieback, viral diseases.

- Use of TH/Pf colonized compost.

- Seedling root dip in 10 g/l suspension of TH + Pf.
- Add Pf colonized vermicompost near roots of each planst @ 50 g/ plant at the time of transplanting.
- Rouging of viral infected plants.
- Planting of marigold as a border.
- Soil drenching of neem seed kernel extract (5%) near plant base to suppress cut worms.
- Alternate use of pheromone traps for Helicoverpa and Spodoptera (@ 5 + 5 traps per/acre) at flowering. Replace lure after 1 month.
- Mechanical plucking and destruction of fruit borer damaged fruits.
- Weekly releases of *Trichogramma chilonis* @ 100,000/ha against fruit borer starting with appearance of pest.
- Soil drench (near seedling) with TH/ TH + Pf (10 g/l) for the management of root rot and wilt.

Two to three spays of TH + Pf (1 kg/acre) to manage foliar diseases (need based).

2. Crop: Tomato

Disease: Damping off, wilt, fruit rot, fruit borer.

- Seedling root dip in 10 g/l suspension of TH + PsF.
- Add PsF colonized vermicompost near roots of each plant @ 50 g/ plant at the time of transplanting.
- 2-3 sprays of TH + PsF (@ 10 g/l).
- Release of Trichogramma chilonis @ 1,50,000 eggs/ha for fruit borer starting with pest appearance. Six to eight releases to be made in one season at weekly interval.
- Mechanical destruction of shoot borer by pressing dried shoot tips with finger or by removing and destroying such parts.
- Use of pheromone traps (25 traps/ha; 5 mg lure).

UAS Raichur

- Inclusion of native isolate of *Metarhizium rileyi* (KK-Nr-1) @ 1×10^{8} spores/ml (5g/L) for the management of FAW in Maize ecosystem
- Inclusion of native isolate of *Metarhizium rileyi* (KK-Nr-1) @ 1×10^{8} spores/ml (5g/L) for the management of ground nut leaf miner and defoliators.

VI. 12. Production of biocontrol agents during 2023 – 24

Production of Biocontrol agents	2023-2024
Microbials (Entomopathogens & Plant pathogens suppressing microbes)	84.5 MT
Macrobials (Parasitiods, Predators & Predatory mites)	51.4 Millon

VI. 13. ACRONYMS

AICRP-BC	All India Coordinated Research Project of Biological Control
ICAR-NBAIR	National Bureau of Agricultural Insect Resources, Bengaluru
AAU, Anand	Assam Agricultural University, Jorhat
AAU, Jorhat	Anand Agricultural University, Anand
ANGRAU, Anakapalle	Acharya N.G. Ranga Agricultural University, Anakapalle
GBPUAT, Pantnagar	Govind Ballabh Pant University of Agriculture and Technology, Pantnagar
KAU, Thrissur	Kerala Agricultural University, Thrissur
MPKV, Pune	Mahatma Phule Krishi Vidyapeeth, Pune
PAU, Ludhiana	Punjab Agricultural University, Ludhiana
PJTSAU, Hyderabad	Pandit Jayashankar Telangana State Agricultural University, Hyderabad
SKUAST, Srinagar	Sher-e-Kashmir University of Agricultural Science & Technology, Srinagar
TNAU, Coimbatore	Tamil Nadu Agricultural University, Coimbatore
YSPUHF, Solan	Y.S. Parmar University of Horticulture and Forestry, Solan
CAU, Pasighat	Central Agricultural University, Pasighat
MPUAT, Udaipur	Maharana Pratap University of Agriculture & Technology, Udaipur
OUAT, Bhubaneswar	Orissa University of Agriculture & Technology, Bhubaneswar
UAS, Raichur	University of Agricultural Sciences, Raichur
ICAR-CISH, Lucknow	Central Institute of Subtropical Horticulture, Lucknow
ICAR-CPCRI, Kayangulam	Central Plantation Crops Research Institute, Kayamkulam
ICAR-IIHR, Bangalore	Indian Institute of Horticultural Research, Bangalore
ICAR-IIMR, Hyderabad (Millets)	Indian Institute of Millet Research, Hyderabad
ICAR-IIRR, Hyderabad	Indian Institute of Rice Research, Hyderabad
ICAR-IIVR, Varanasi	Indian Institute of Vegetable Research,Varanasi
ICAR-NCIPM, New Delhi	National Centre for Integrated Pest Management, New Delhi
DRYSRUH, Ambajapeta	Dr. Y S R Horticultural University, Ambajipeta
IGKV, Raipur	Indira Gandhi Krishi Viswavidhyalaya, Raipur
KAU, Kumarakom	KAU-Regional Agricultural Research Station, Kumarakom
KAU, Vellayani	KAU-Regional Agricultural Research Station, Vellayani

UBKV, Pundibari	Uttar Banga Krishi Viswavidyalaya, Pundibari, West Bengal
PDKV, Akola	Panjabrao Deshmukh Krishi Vidyapeeth, Akola
SKUAST, Jammu	Sher-e-Kashmir University of Agricultural Science & Technology, Jammu
KSNUAHS, Shivamogga, Karnataka	Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Shimogga
DRYSRUH, Tirupati	Citrus Research Station, Dr. Y.S. R. Horticultural University, Tirupati
ICAR-SBI, Coimbatore	Sugarcane breeding Institute, Coimbatore
WNC-ICAR-IIMR, Hyderabad	Indian Institute of Millet Research, Hyderabad
NIPHM, Hyderabad	National Institute of Plant health Management, Hyderabad
CoA, Lembucherra, Agartala, Tripura	College of Agriculture, Lembucherra, Agartala, Tripura
ICAR-NRRI, Cuttack	National Rice Research Institute, Cuttack
DFR, Pune	Directorate of Floriculture Research, Pune, Maharashtra
NRCL, Muzaffarpur, Bihar	National Research Centre on Litchi, Muzaffarpur, Bihar
ICAR-CTRI, Rajahmundry, Andra Pradesh	Central Tobacco Research Institute, Rajahmundry, Andra Pradesh
CoA, CSKHP, Krishi Vishvavidyalaya, Palampur, HP	Department of Entomology, College of Agriculture, CSK Himachal Pradesh, Krishi Vishvavidyalaya, Palampur, HP
TCRS, TNAU, Yethapur, Salem, Tamil Nadu	Tapioca and Castor Research Station, Tamil Nadu, Agricultural University Yethapur, Salem, Tamil Nadu